7th International Conference on

ENERGY AND INFRASTRUCTURE MANAGEMENT

(ICEIM–2020)

CONFERENCE THEME

CONTEMPORARY ISSUES AND CHALLENGES IN ENERGY & INFRASTRUCTURE MANAGEMENT

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Editors

Dr. Satish Pandey
Dr. Asit Acharya
Dr. Lalit Khurana

PANDIT DEENDAYAL PETROLEUM UNIVERSITY
Raisan, Gandhinagar, Gujarat, India

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Foreword

When India as a nation entered in the new millennium, it had aspirations to build a strong knowledge economy and create sustainable society. We had set millennium development goals as benchmark to improve our economy, society and polity. The Government of India set its "*Vision-2020*" in line of those millennium development goals. Later we also added sustainable development goals in our national vision. Today, we are in the year 2020. Where are we now? What we achieved and what we missed? What should be our next course of action? These questions are being asked from common people of India to the government, industry, institutions. People are becoming more aware of climate change issues that impact our lives (forest fires, unexpected floods, warm winters, long rainy season, unexpected viral infections, increased noise and air pollution in cities, ground water depletion, water contamination… naming a few). Our country needs not just 'smart cities' but 'livable cities' and 'prosperous & sustainable villages'. These are challenges of infrastructure development while ensuring inclusive growth for every citizen of the country. We also need to ensure that our villages should also create their own self-sustainable energy resources to fulfill their energy needs. We should ensure that our farmers use their water resources most efficiently and our agriculture production should bring prosperity to our farmers and villages. We need to build schools, colleges, hospitals for huge population in future. We also need to provide efficient infrastructure to our industries for better economic growth and adopt a '*balanced approach'* to invest in energy resources ensuring our commitment to '*low carbon economy'* and '*clean energy for all'*.

Universities are noble institutions meant to contribute in nation-building by nurturing young talent for different sectors. Since its inception, Pandit Deendayal Petroleum University, Gandhinagar has been working as an institution committed to contribute in the field of energy, infrastructure and sustainable development through its various academic and non-academic activities. Different schools and departments of PDPU have been conducting various academic conferences, seminars and workshops to discuss on contemporary issues being faced by energy and infrastructure sectors and bring together academicians, researchers, technologists, industry experts and policy-makers together on common platforms.

School of Petroleum Management was the pioneer in organizing academic conferences to share and disseminate academic research in the field of energy and infrastructure with the industry and policy-makers since its first ever conference "*International Conference on Management of Petroleum Sector (ICOMPS)-Dec 19-21, 2007*". The school is organizing its 7th biennial conference "***International Conference on Energy and Infrastructure Management (ICEIM), February 27–28, 2020***" with an objective & scope to deliberate, discuss and document key contemporary issues relevant to managing energy & infrastructure sector with reference to emerging economies. The core theme of this conference is **"*Contemporary Issues and Challenges in Energy & Infrastructure Management*".**

It is good news to hear from the Conference Organizing Committee that they have received more than 80 papers on different topics related to different sub/themes of the conference. These papers cover topics related to energy security policy; renewable energy policy challenges; sustainability of solar power projects; digitization, artificial intelligence technologies in oil and gas industry; electric vehicles industry in India; development of sustainable airports; geothermal energy resources; wind & solar energy policy in India; corporate environmental citizenship; energy banking in India; Pradhan Mantri Ujjwala Yojana (PMUY): Rural Transformations and Women Development in India; rural infrastructure development in health sector; waste management in oil & gas industry; child labor & human rights violations in oil & gas industry… naming a few.

We believe that this conference will become a common platform to disseminate new researches done by various researchers from different universities/institutes before industry professionals and policy-makers in the government. We hope that these new researches will suggest new directions to innovations in energy and infrastructure industries and government policies pertaining to these sectors.

We wish all the best to our conference participants who are the real knowledge champions of their universities/institutes/organizations. We strongly believe that all of us at PDPU will make this conference a good experience for every participant of the conference and this conference will achieve its objectives effectively.

We welcome you all to ICEIM–2020.

Mr. D. Rajagopalan
IAS (Retd.) Chairperson
(Standing Committee)
Member, Governing Council
Pandit Deendayal Petroleum
University

Dr. S. Sundar Manoharan
Director-General
Pandit Deendayal Petroleum
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Dr. C. Gopalkrishnan
Director
School of Petroleum Management
Pandit Deendayal Petroleum
University

Message for the International Conference

Dear Conference Participants,

It gives me immense pleasure to note that the School of Petroleum Management (SPM), Pandit Deendayal Petroleum University, Gandhinagar is organizing an ***International Conference on Energy and Infrastructure Management (ICEIM–2020), February 27–28, 2020*** with an objective & scope to deliberate, discuss and document key contemporary issues relevant to managing in today's challenging and uncertain times or the turbulent times.

Today we face disruption from economic changes, new working styles, technology—every aspect of work has either been a disruptor or been disrupted, and, therefore, disruption is the new normal. Rapid changes are being fueled by a combination of changing cultures, technology, and business practices. Agile change management, data driven methods, lean thinking, digital change management and digital adoption are changing our management practices and many managers have yet to integrate these ideas into their everyday work flows. Peter Drucker in his celebrated book, '*Managing in turbulent times*' aptly explained, "it is concerned with action rather than understanding, with decisions rather than analysis." It deals with the strategies needed to transform rapid changes into opportunities, to turn the threat of change into productive and profitable action that contributes positively to our society, the economy, and the individual. The recurring theme in change management today is technology and the biggest factor impacting the future of change management will also be technology. This will require an even greater commitment to change management. Technology implementation, digital adoption, and digital transformation are and will be dramatically impacting the workforce.

It was indeed good news to hear from the Conference Organizing Committee that they have received approximately 80 papers so far from more than 130 authors on different topics related to energy security policy; renewable energy policy challenges; sustainability of solar power projects; digitization, artificial intelligence technologies in oil and gas industry; electric vehicles industry in India; development of sustainable airports; geothermal energy resources; wind & solar energy policy in India; corporate environmental citizenship; energy banking in India; Pradhan Mantri Ujjwala Yojana (PMUY): Rural Transformations and Women Development in India; Rural Infrastructure Development in Health Sector; Waste Management in Oil & Gas Industry; Child Labor & Human Rights Violations in Oil & Gas Industry … Naming A Few.

It is very encouraging that this conference gets it support from industry and I indeed felt honoured and humbled when the Patrons of the conference and members of organizing committee approached me for my advice and with their invitation to address the conference participants. I wish it was possible for me to be present in the conference and interact with participants as well as with my academic fraternity at PDPU but unfortunately my current personal engagements do not allow me to travel outside my country.

My best wishes are with the conference participants. I am very hopeful that this conference will be able to generate robust discussions on different topics of the conference leading to new management practices to deal with today's challenging and uncertain times.

Dr. Raghuvar Dutt Pathak
Adjunct Professor &
Former Head of Graduate School of Business &
Director of MBA Programme
The University of the South Pacific
Laucala Campus, Private Mail Bag, Suva, Fiji, Islands

Preface

"We simply must balance our demand for energy with our rapidly shrinking resources. By acting now we can control our future instead of letting the future control us."

—Jimmy Carter (US Ex-President)

Energy security is the prerequisite for any nation to ensure sustainable development and inclusive growth in this competitive world. No country produces enough energy in the required forms to satisfy its increasing social needs, thus triggering the possibility of international conflicts. India has put in visible nisus to inscribe its Energy security and consequently it plans to appear in the list of the energy surplus nations. India today faces this formidable challenge of not only meeting her energy needs but also providing adequate & varied energy of desired quality to the users at a reasonable cost in a sustainable manner. India has embarked on a high growth strategy to achieve all-round development. Energy Intensity, which is a measure of energy efficiency of an economy, indicates that India uses more energy to produce one unit of GDP, than nations like UK, Germany, Japan and US. The high growth envisaged by us require greater amount of energy while the domestic sources of energy is increasingly subjected to more number of competing uses. In today's macro-economic context, India gaze at an acute prospect of having to incur huge foreign exchange outgo to buy expensive energy from abroad. Energy security has indeed become synonymous with national security.

Energy is one of the most important building blocks in human development, and as such, acts as a key factor in determining the economic development of all the countries across the globe. In an effort to meet the demands of a developing nation, the energy sector has witnessed a rapid growth. It is important to note that the non-renewable resources are significantly depleted by human use, whereas renewable resources are produced by ongoing processes that can sustain indefinite human exploitation. India has made rapid strides towards economic self-reliance over the last few years. Impressive progress has been made in the fields of industry, agriculture, communication, transport and other sectors necessitating growing consumption of energy for developmental and economic activities. India, with a population of more than 136 billion and a fast growing economy, has seen its energy demand increasing rapidly as the country continues to urbanize and the development of its manufacturing sector. This rapidly growing demand of energy has major implications for the global energy market. The Government of India has made remarkable progress in providing access to the required energy to in providing access of the same to maximum beneficiaries by implementing a range of energy market reforms vis-a-vis this growing demand is met through various energy sources. India also continues to develop its energy and infrastructural framework needed to attract the investment required to satisfy her growing needs of energy and infrastructure. In recent years, government of India has increasingly focused on innovation as a means to augment clean energy transitions while meeting the climate targets under the Paris Agreement. The concerns of the government also include multilateral innovation partnerships which reflect in its bold policies and decisions including Mission Innovation and many others.

According to Indian Energy Security Scenarios (IESS) which has been developed as energy scenario building tool, India's usage and demand at 2047 remains grim. With increased economic development, there is expected to be an increase in mobility and demand for both inter-city and intra-city passenger transport in India over the next few decades. This will put an additional pressure. Energy security has therefore acquired centre stage of policy formulation for e.g. India Technology Vision 2035. The increasing gap between the energy demand and supply and other problem associated with conventional energy sources has inspired to look beyond and make a progressive shift towards renewable energy. Not only are they indigenous, non-polluting but are virtually in-exhaustive. India, being a tropical country, enjoys abundant sunshine. India's topography provides ample opportunity for using solar, wind and small hydro resources. Country with its vast land resources can sustain production of significant quantities of biomass. To secure the energy, thus India should take steps like increasing the share of renewable, promoting green energy, implementing the energy policy effectively. The Indian government

in its budgetary proposals for the FY 2020-21 has announced allocation of 220 billion ($3.08 billion) for the power and renewable sectors viz. wind power, solar power (both grid-connected and off-grid), green energy corridor and power system development fund. The budget has also provided incentives for states that are taking measures for cleaner air in big cities for which ₹44 billion ($615 million) has been allocated in the Indian Budget-2020. The government underlined its ongoing efforts to provide clean energy through solar power and '*Ujjwala*' program that provides clean cooking fuel to households. Committed to doubling farmers' income by 2022, the Budget-2020 points out that integrated farming systems in rain-fed areas would be expanded. Multi-tier cropping, beekeeping, solar pumps, solar energy production in the non-cropping season would be added. In nutshell, we have to be conscious of the need to conserve our resources through their utilization in a truly sustainable manner. Efficient use of resources has to begin from our homes. The educational systems have to be utilized extensively for integrating the concept of sustainability into the social systems.

Infrastructure Industry in India has registered modest progress in the recent years. Creation of infrastructure is vital for India's economic development as the opportunities for future growth the country. A country's level of human and economic development is closely related to its levels of achievement in infrastructure. The poor state of infrastructure, stretched to limits by the growing population and increasing regional and rural-urban disparities, implies that major improvement in infrastructure is absolutely essential to sustain further progress and high rate of economic growth. If these infrastructure investment plans are properly implemented, they can propel India's economic growth to a higher trajectory. For India to maintain the growth momentum, it is essential to strengthen infrastructure facilities such as transportation, energy, communication, and so on. However, performance of physical infrastructure in Indian economy in the last one and a half decades has been mixed and uneven. As well as being in short supply, India's infrastructure in most cases is also of poor quality by world standards. In fact, India's high rate of economic growth will be difficult to sustain if infrastructure development does not increase and keep pace with demand. Therefore, a number of measures are needed to address the various infrastructure constraints that the country faces and improve the productivity of infrastructure sector.

For India to maintain the growth momentum, it is essential to strengthen infrastructure facilities such as transportation, energy, communication, and so on. However, performance of physical infrastructure in Indian economy in the last one and a half decades has been mixed and uneven. As well as being in short supply, India's infrastructure in most cases is also of poor quality by world standards. In fact, India's high rate of economic growth will be difficult to sustain if infrastructure development does not increase and keep pace with demand. Therefore, a number of measures are needed to address the various infrastructure constraints that the country faces and improve the productivity of infrastructure sector. As per the recent report of Ministry of Statistics and Programme Implementation-released in November 2019, more than 400 infrastructure projects in the country have surpassed their estimated cost while another 578 projects have seen an average delay of 38.8 months. The development of complex infrastructure systems depends upon adoption of emerging innovative technologies. Fiscal constraints and the technological complexity of today's infrastructure require a more extensive involvement of private sector agents, which comes with many opportunities but also with risks that need to be managed. These developments have evolved against the background of changing and often increasing demand patterns in fields such as energy and broadband access, where prolonging the status quo into the future would not be enough to meet the demands of a data driven economy or the targets of climate change policy. The governance of infrastructure—the planning, financing, contracting, and building of the public physical infrastructure essential for economic and social activities—is facing a somewhat paradoxical situation: while governments have become more reliant on private agents, their role remains critical. Without the financial, regulatory, and coordinating role of governments, infrastructure investment would simply not happen.

To augment India's infrastructure and create jobs, in the recent budget announcements of 2020, the government has focused on infrastructure for economic development and 6,500 projects across various

sectors, including housing, water, clean energy, healthcare for all, education, airports, irrigation projects by allocating Rs. 103 Lakh Crore for infra projects under National Infrastructure Pipeline (NIP), which will be launched besides providing about Rs 1.70 Lakh Crore for 12 lots of highway bundles of over 6,000 km under the transport infrastructure to be monetised by 2024 and accelerating highways construction envisioning ease of living for citizens. The Indian government has also proposed to set up 2,500 km of access control highways, 9,000 km of economic corridor and 2,000 km of coastal and land port roads and 2,000 km of strategic highways. Further, the FASTag mechanism encourages towards greater commercialization of highways enabling the National Highway Authority of India (NHAI) to raise more resources. Noting the rapid growth in air traffic in the country, the government has announced that 100 more airports would be developed by 2024 to support the Regional Connectivity Scheme i.e. UDAN. It was also proposed that the air fleet number is expected to double from the present number of 600 by 2024. Similarly, The Union Budget, 2020 reinforces the importance of raising resources through Public Private Partnership (PPP) model for network strengthening, connectivity and modernization of Indian Railways. In order to increase the efficiency of sea-ports, the FM proposed to implement a governance framework in line with global benchmarks. As regards the ports and waterways, it has been proposed to corporatize at least 1 major port and subsequently list it on the stock exchanges. For the inland waterways, the government has decided that the Jal Vikas Marg on the 1,620 km Haldia-Allahabad stretch of river Ganga would be completed. Further, the 890 km Dhubri-Sadiya connectivity was proposed to be done by 2022. The government also announced that in consonance with Arth-Ganga, plans are being prepared to energize economic activity along river banks.

To discuss and deliberate on the contemporary issues and challenges on energy and infrastructure, the School of Petroleum Management (SPM), Pandit Deendayal Petroleum University (PDPU), Gandhinagar is organizing its ***7th Biennial International Conference on Energy & Infrastructure Management, 2020 (ICEIM–2020), February 27–28, 2020.*** We have received more than 80 submissions on different topics related to energy, infrastructure management and other streams of management. The papers were blind reviewed and the selected papers have been edited and put together in the proceedings, which includes papers on topics such as energy security policy; renewable energy policy challenges; sustainability of solar power projects; digitization, artificial intelligence technologies in oil and gas industry; electric vehicles industry in India; development of sustainable airports; geothermal energy resources; wind & solar energy policy in India; corporate environmental citizenship; energy banking in India; Pradhan Mantri Ujjwala Yojana (PMUY). , naming a few. This conference is being organized in partnership with *Oil and Natural Gas Corporation* (ONGC), *Indian Oil Corporation Ltd.* (IOCL), Bharat Petroleum Corporation Ltd., *Solar Energy Society of India* (SESI), and *DEW Journal* which are active participants and concerned with knowledge, technology and social development in energy and infrastructure sectors. This year, we have also diversified our partnership with organizations like All India Radio, Doordarshan, India Post, UNICEF, Central Electricity Regulatory Commission (CERC), Institute of Public Enterprises- Hyderabad. The conference organizing committee also expresses sincere thanks to Prof. Julia Storberg-Walker, George Washington University, Washington, USA and Prof. Raghuvar Dutt Pathak, Head, Graduate School of Business Administration, University of South Pacific, Fiji for mentoring us as International Academic Advisors.

We strongly believe that this International Conference will provide ample opportunities to all participants to disseminate new research ideas with industry professionals as well as the policy-makers. It is also believed that this International Conference will initiate new thought process towards the issues and challenges faced by the energy and infrastructure and will definitely add substantially to the existing domain of knowledge. We are pleased to present this proceeding of the International Conference to the academicians, researchers, industry practitioners and policy-makers who all have joined hands towards building the new knowledge development in the area of energy & infrastructure management.

Dr. Satish Pandey	**Dr. Asit Acharya**	**Dr. Lalit Khurana**
Conference Chairperson	Conference Chairperson	Conference Chairperson

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SECTION–I

RENEWABLE ENERGY: TECHNOLOGY DEVELOPMENT & BUSINESS PROSPECTS FOR INDIA

Geothermal Resources: Energy Source for Ladakh

Dr. Prafulla B. Sarolkar
Former Dy Director General,
Geological Survey of India, Nagpur–440022
E-mail: psarolkar@yahoo.co.in

Abstract—Ladakh is recently declared as an Union Territory and is poised to achieve new avenues of development. Ladakh is located in a northern most part of India, a remote place, covered by Himalayan range. The terrain experiences severe winter with temperature dipping to -20°C. The severe winter imposes restrictions on development activity as the working period is mostly from month of May to October. The main source of energy is planned through installation of wind and solar energy. These energy sources are seasonal, depending on variations in weather conditions. A continuous source of energy will be useful for development of Ladakh region.

Geothermal energy is displayed on surface in form of hot springs, steam fumaroles, hot ground and mineral deposition. The hot spring discharge is useful in assessing the temperature of geothermal field and potential of geothermal resource. Geothermal prospect is an area of anomalous heat content over a large area useful for direct heat utilization or electricity generation. The conductive heat transfer data are useful in extrapolating the thermal gradient to know possible temperature in deeper reservoir. Ladakh is bestowed with two promising geothermal prospects viz. Puga Geothermal Field and Chhumathang Geothermal Field, Leh district.

Puga geothermal field, located nearly 190 km away from Leh district, comprises hot springs reported along the Indus Suture Zone over a 3 km stretch, ranging in temperature from 30°C to 84°C. Investigation by drilling total 17 boreholes (36.5 m to 280 m in depth) has revealed temperature upto 123°C at well head. Geochemical thermometer has indicated reservoir temperature of 190°C to 220°C. Potential for geothermal power generation is established at Puga Geothermal field. Chhumthang geothermal field, Ladakh, is located north of Indus River, at an altitude of 4400m, showing hot springs discharging water of 30°C to 87°C, with cumulative discharge of >200 lpm. Investigation by drilling has encountered hot water discharge of 103°C to 120°C, in the boreholes. Aqueous geothermometers indicate reservoir temperature of 145 °C to 175°C (GSI, 2002). A variety of flowers and fruits were grown in the green house. The utilization of geothermal resource for power generation in Ladakh will assure economic development of the region.

Keywords: Hot Springs, Temperature, Drilling, Ladakh

INTRODUCTION

In India, geothermal energy sources are located along the Himalayan belt in the north, Son- Narmada – Tapi lineament in central India, West Coast, and Godavari valley. There are isolated hot springs reported from Gujarat, Jharkhand and North Eastern Region, mostly located in interior parts. The hot springs in India range in temperature from 30°C at Ladakh to 97°C at Tatapani, Chhattisgarh. The estimated reservoir temperature in geothermal fields in India ranges from 110°C in West Coast to >200°C at Puga, Ladakh. The geothermal resources in these areas are a potential source of energy as a substitute to electricity, as well as for direct heat uses, like spa, hot water baths, space heating, food processing, green house cultivation, and aquaculture. The measures for development of geothermal resources in Ladakh and prospects of utilization of hot springs in Ladakh are discussed here.

Table 1: Geothermal Provinces of India (Padhi & Pitale 1995)

Sr. No.	Geothermal Province	Locality	Temp. Gradient	Heat Flow
I	Himalayan Geothermal Province	i. PugaIsunga suture zone. ii. PugaChumthang iii. Parbati Valley, Sutlej valley, Alaknanda valley.	100 °C /m 60±20 °C /m 17±5°C /m	200 mw/m^2 130+30 mw/m^2
II	Naga Lusai Province	Naga Lunai Hill range bordering Burma.	Not available	70-100 mw/m^2

Table 1 (Contd.)...

...Table 1 (Contd.)

III	Andman Nicobar Islands Province	Barren & Narcondam islands	Not available	100-180 mw/m^2
IV	West Coast Province	West Coast tract in Maharashtra.	55±5°C /m	130±10 mw/m^2
V	Cambay Graben Province	Springs in tertiary reactivation area, oil & gas wells.	25 to 55°C /m	130±10 mw/m^2
VI	AravalliProvince	Northwest ridges of Aravalli, in Rajsthan and Haryana, Neotectonic activity.	41±10°C /m	100±25 mw/m^2
VII	Son Narmada tapti Province	Tatapani, Salbardi, Anhoni-Samoni Geothermal prospects.	40-120°C /m	70-300 mw/m^2
VIII & IX	Godavari and Mahanadi Province	Springs along post Gondwana faults, e.g. Manuguru, Raigarh	39±10°C /m	80±21 mw/m^2
X	South Indian Cratonic Province	Isolated springs in shield area	30°C /m	60-90 mw/m^2

HIMALAYAN PROVINCE

PUGA GEOTHERMAL FIELD

Puga geothermal prospect is located 180 km ESE of Leh, at height of 4405 m msl. Nearly 120 hot springs are reported along the Indus Suture Zone over a 3 km stretch, ranging in temperature from 30°C to maximum temperature of 84°C (Krishnaswamy & Ravishanker 1982) and discharge of 5 lps. Granite intruded into Precambrian gneisses and schists may form the reservoir. Geochemical thermometer has indicated reservoir temperature of 190 to 220°C. Oxygen isotope studies have indicated reservoir temperature of 180°C. The geothermal water is meteoric in origin. Deposition of Sulphur is observed in fractures/cracks and borax evaporates are reported around hot springs.

34 boreholes have been drilled in Puga valley, ranging in depth from 28 m to 384.7 m. Total 17 boreholes (36.5 m to 280 m in depth) produce hot water at Puga, with a cumulative discharge of 3000 lpm and maximum temperature of 123°C at well head (GSI 2002). Hydrothermal epidote provides unequivocal evidence of temperature in excess of 250°C during hydrothermal activity (Absar, 1991). Central Electricity Authority estimated feasibility of electricity generation at Puga geothermal prospect (Ramanmurty 1996). Thermal gradient of 83-110°C/km is reported at Puga.

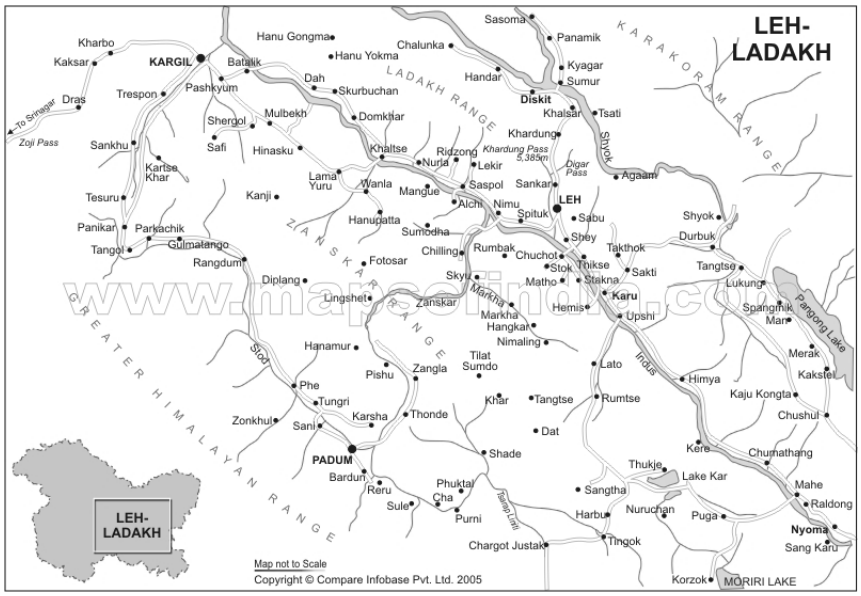

Fig. 1: Location Map of Geothermal Fields in Ladakh

GSI, in association with RRL, Jammu, tested space heating of hutments and extraction of Borax and sulphur from geothermal fluids at Puga. Space heating of 5 m x 5 m x 2.5 m prefabricated hutments was experimented to attain temperature of 20°C inside the room. An experimental poultry farming and mushroom cultivation unit was completed successfully. A research project was taken up with BARC, Mumbai, for extraction Cesium from Geothermal water at Puga. Thermal water was passed through RF resin to recover upto 84% Cs content from the geothermal water (Gupta *et al.,* 1999).

CHHUMATHANG GEOTHERMAL PROSPECT

Chhumthang geothermal area, Ladakh, is located north of Indus River at an altitude of 4400m, over a stretch of one km along the course of Indus River. Seventy three hot spring discharging water of 30 to 87°C are reported, with cumulative discharge of 200 lpm. Maximum temperature recorded on surface is 87°C @1.5 lps (GSI, 1991). Profuse H_2S emission is noticed in hot water ponds. Aqueous geothermometers indicate reservoir temperature of 145 to 175°C (Fournier 1979 & 1981; GSI 2002). An experimental green house was constructed successfully using geothermal water and inside temperature was maintained at 20 to 25°C. A variety of flowers and fruits were grown in the green house. Recently drilled boreholes have shown hot water discharge of 120°C on surface. The boreholes have indicated ground water mixing at shallow level.

CHEMICAL COMPOSITION

The geothermal water at Puga shows temperature varying from 38°C to 81°C, pH of 7.4 to8.6, TDS 2020 to 2278 ppm, $CaCO_3$ from 620 to 708 ppm, Cl 370 to 433 ppm, SO_4 from 123 to 149 ppm, Na from 530 to 640 ppm, K from 68 to 80 ppm, Ca from 2 to 54 ppm, Mg from 1 to 5 ppm, F from 12 to 18 ppm, B from 116 to 140 ppm, and SiO_2 from 120 to 165 ppm (GSI 2002). The non- thermal water at Puga shows temperature of 9 °C, pH 8.0, 114 ppm, $CaCO_3$ 65 ppm, Cl 06 ppm, SO_4 12 ppm, Na 9 ppm, K 3 ppm, Ca 15 ppm, Mg3 ppm, F 01 ppm, B <01 ppm, and SiO_2 09 ppm (GSI 2002), indicating separate source of water.

The pH of hot water samples of Chhumathang area varies from 7.0 to 8.6, while pH of non thermal water varies from 7.0 to 8.0. The hot water composition shows chloride from 70 to 119 ppm, SO_4 varies from 184 to 271 ppm, HC_3O varies from 297 to 519 ppm, Fluorine varies from 5 to 11 ppm, Na from 210 to 325 ppm, K from 20 to 29 ppm, Ca from 6 ppm to 30 ppm, Mg upto 10ppm and SiO_2 varies from 87 to 170 ppm. The cold water streams and surface water show pH of 7.18 to 8.0. Chloride in cold water varies from 5 to 26 ppm, SO_4 varies from 10 to 76 ppm, HCO_3 from 24 to 134 ppm, Na upto 46 ppm, K from 1 to 5 ppm, Mg upto 17 ppm and SiO2 is less than 20 ppm, showing distinct difference in the composition of geothermal and non-thermal water. Area around hot springs show deposition of borax, calcite, sulphur, arsenic and zeolites. The hot water contains higher content of Cl, HCO_3, SO_4, F and SiO_2 as compared to ground/ surface water thus indicating geothermal fluids formed due to water rock interaction. The geothermal water has distinctly different composition as compared to surface/ ground water. The geothermal water is mixed with surface/ground water at various levels, drawing a gradational variation in chemical composition.

TERNARY DIAGRAMMES OF WATER ANALYSIS

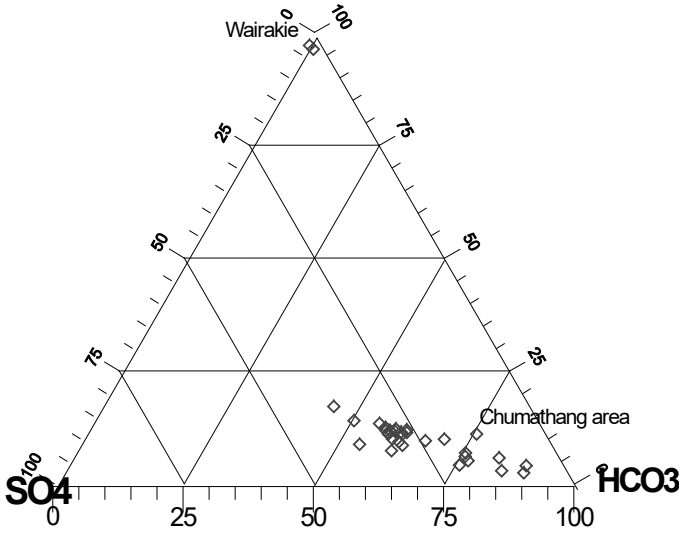

Fig. 2: Cl-SO_4 -HCO_3 Ternary Diagram

The thermal water content of Cl- SO_4 - HCO_3 denotes the quality and type of water indicating the genetic relationship of water. The relative concentration of Cl-HCO_3-SO_4 denotes the interaction of water with surrounding media. The chemical analysis of water was plotted in Cl- HCO_3- SO_4 ternary diagram. The water from Chumathang, hot water as well as surface water samples when plotted in Cl-SO_4- HCO_3 diagram fall mostly in HCO_3 field, with rather high SO_4 content. The plot shows mixing trend indicating geothermal water diluted by shallow surface water, and formation of bicarbonate rich water on margin of geothermal field. Chloride content is comparatively low suggesting that the thermal water is bicarbonate dominated. The geothermal water of Wairakei plots in Chloride dominated field. Thus, the water of Chumathang appears to be marginal water, rather than the actual geothermal water.

The Chumathang water falls in more affinity to HCO_3 field, suggesting that geothermal water is more marginal. The actual geothermal water is yet to be encountered. The thermal water has less Chloride content indicating less geothermal component and contamination by shallow water. The contact between sandstone-granite may be the zone where hot water flashes, forming steam heated water with higher bicarbonate content. Uniform B/Cl ratio suggests that the chloride water is derived from a single reservoir (Ellis 1960, Simmons *et al.,* 1995). The clustering of data of Chumathang water samples near HCO_3 field and linear trend from centre towards HCO_3 field suggest progressive mixing of shallow water with geothermal water. The water samples from Wairakei and Broadlands/ Tauharare (Giggenbach 1997) fall in Cl rich zone in Ternary diagram, indicating that the water is geothermal water from deep reservoir. The Chumathang water falls in partial geothermal water more akin towards HCO_3 bicarbonate field, marginal water with shallow level mixing.

DRILLING

Investigation by drilling was taken up in Puga and Chhumathang area. Thirty four boreholes were drilled in from depth of 28.5m to 384.5m. Borehole GW-2 discharged mixture of hot water and steam at 20m depth. Boreholes Gw-3, 5, 7,8, 10 and GW-11 drilled upto maximum depth of 80m, discharge hot water and steam mixture. The boreholes have yielded 10-15% steam content, with temperature upto 140°C and 2 to 3 bars pressure (GSI 2002)The boreholes at Puga have shown scaling blocking the water flow. Most of the flowing boreholes have shown convective thermal log suggesting connection with deep thermal water, at places affected by shallow surface water.

Six boreholes were drilled in Chumathang area, ranging in depth from 12m to 115m. Maximum temperature of 107°C, was reported in borehole. Later 5 boreholes upto maximum depth of 100m were drilled in Chumathang. Thermal gradient of 36 °C to 104°C / km was recorded in the boreholes. Shallow level ground water mixing has obliterated the thermal profile of the area. At shallow level the thermal structure is obliterated due to heavy mixing of cold water from Indus river. At Chumathang water of 120°C is encountered in a borehole drlled recently (Sarolkar 2019). The investigation has verified feasibility of binary cycle power plant at Chumathang. Earlier at Puga shallow reservoir with potential of 4-5 MW was delineated (Seth Vendantam, 1996). Think geoenergy has opined that potential of 20 MW is possible at Puga geothermal field. A team of researchers from Birla Institute of Technology and Science (BITS), Pilani, have used nine parameters to analyse data relating to Puga in Ladakh, opined that Puga geothermal field has the highest significance level. (BITS, Pilani 2018).

UTILISATION

Besides power generation, the hot water can be utilized for different low temperature, uses in industry and tourism (Lindal 1979).

Geothermal power plant (Temperature >200°C to 100°C): The resource with temperature > 200°C may be used for steam based geothermal power plant. In case of temperatures less than 180°C, Binary cycle power plant is feasible. In Binary cycle power plant, the hot water is used to vapourise a fluid of low boiling point which is used to generate electricity. Useful in hot springs of the Himalayan belt.

Greenhouse (Temperature required, 50°C-80°C): The hot water can be used in space heating and hot bed heating in green hose cultivation. Useful at Puga, chhumthang field in Ladakh, Manikaran, Tapoban, Parbati valley in Himalayan belt.

Food processing- Fruits and see-weed drying, drying of vegetables, onions, and fishes, food processing (Temperature <100°C): Used for the food processing industry. Possible at Tapoban, Parbati valley, Manikaran in Himalayan belt.

Industrial uses- timber washing, sericulture (Temperature 80-140°C): The low temperature hot water is used for sericulture, space heating, vegetable cleaning, and small scale industrial uses. Possible at Puga, Manikaran, Parbati valley in Himalayan belt.

Aquaculture and agriculture, crocodile farming (Temperature <60°C): The hot water of specific composition and temperature is used for aquaculture. Useful in Manikaran, Tapoban, Parbati valley in Himalaya,

Tourism, Spa, Swimming pool (Temperature >40°C): Almost all geothermal localities in Himalaya. Puga-Chhumthang, Parbati valley, Manikaran and Tapoban.

Extraction of rare metals, Mineral water industry (Temperature required, >30°C): **S**eparation of Borax, Sulphur, Cesium, and Helium from hot water at Puga valley and Chhumathang area.

CONCLUSION

The hot springs of Ladakh at Puga and Chhumathang in Himalayan belt, are active geothermal systems useful for development. These geothermal fields indicated reservoir temperature of about 200°C or more which is useful for installation of geothermal power plant. Besides, direct heat uses like spa, hot water bath, tourism, green house cultivation, space heating, soil warming and aquaculture may contribute to developing local industry in remote places.

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Impact of Policies on Wind and Solar Power Deployment in India

Alok Das[1], Hardik K. Jani[2], Dr. Garlapati Nagababu[3] and Dr. Surendra Singh Kachhwaha[4]

[1]School of Technology,
Pandit Deendayal Petroleum University,
Raisan, Gandhinagar–382007 (Gujarat, India)
[2]Research Associate, School of Technology,
Pandit Deendayal Petroleum University,
Raisan, Gandhinagar–382007 (Gujarat, India)
[3]Assistant Professor, School of Technology,
Pandit Deendayal Petroleum University,
Raisan, Gandhinagar–382007 (Gujarat, India)
[4]Professor, School of Technology,
Pandit Deendayal Petroleum University,
Raisan, Gandhinagar–382007 (Gujarat, India)
E-mail: [2]janihardik15@gmail.com, [3]garlapatinagu@gmail.com,
[4]surendra.singh@sot.pdpu.ac.in

Abstract—The main objective of the paper is to study the impact of various policy factors on the growth of wind and solar power generation in India. First the impact of state-wise policy parameters Feed-in Tariff (FIT) rate, Renewable Power Purchase Obligations (RPO), Power Purchase Agreement (PPA) is evaluated in terms of aggregate policy indices indicating the likelihood of wind power deployment through multivariate statistical analysis. The policy provisions with reference to the scale and type of wind and energy technologies along with the evolution of capacity utilization factor (CUF) has been elaborated. Further, the impact of per capita net domestic product (PCNDP) and power demand-supply scenario is also assessed. Finally, the overall impact of aggregate policy indices, total wind power potential, feasibility of captive/third party utilization, repowering policy, actual CUF obtained and the financial cash flow status has been presented. The present study gives an insight to the policy-makers for establishing proper policy framework and to the project developers for identifying the suitable location for the establishment of power projects.

Keywords: Renewable Energy, Wind Energy, Solar Energy, Power Generation, Policy

INTRODUCTION

The wind and solar energy are intermittent source of energy and the availability depends on the natural environmental parameters. However, the amount of energy that can be harnessed relies upon multiple factors like variation in resources with time (seasonal and annual variations), availability of technology, availability of finance and the government support in terms of policies. Availability of technology and finance cannot be directly controlled by any individual project developer or the government. However, the supportive policy framework induces better finance inflow and the freedom to choose proper technology for power generation (Das *et al.,* 2019). Hence, the government policy framework influences the deployment of wind and solar power projects.

Countries form their respective renewable energy (RE) policy framework considering available power potential for different types of energy sources, financial scenario, technological accessibility and the status of conventional power generation systems. In India, the Ministry of New and Renewable Energy (MNRE) declares the national RE policies. Probably, India is the only county to have a ministry specifically dedicated to nonconventional energy sources. Along with MNRE, the Ministry of Power (MOP) declares the

tariff related policies for RE as well as non-RE based power generation. Moreover, the state governments also declare their own RE policies based on state specific scenario of power potential, status of technology and financial cash flow. Feed-In Tariff (FIT) and Renewable Purchase Obligation (RPO) are the important part of the national and state-level renewable energy policies. FIT was announced at state-level in early 2000s and on national level in 2009 (Shrimali *et al.,* 2013). The tariff rate at which the project developer will be paid in exchange of electricity is defined in terms of FIT value decided during the power purchase agreement. RPO deals with the minimum fraction of total power generation that has to be generated through renewable energy sources in different states and over the country as well. The state and central government declares their RPO targets for every year to be followed respectively.

POLICY EFFECTIVENESS

The policy effectiveness can be evaluated based on the Cost Effectiveness Potential (CEP) and Viability Gap Coverage Potential (VGCP). The CEPis the maximum possible reduction in the subsidy cost due to the implementation of the particular policy. The VGCP is the maximum possible reduction in the subsidized levelized cost of electricity (LCOE) due to the implementation of the specific policy. Basically LCOE is the minimum cost necessary for the generation of the electricity including all the costs. Shrimali *et al.* (Shrimali *et al.,* 2014, 2017) conducted a comparative study between present policies, proposed debt policies (under consideration) and no policy scenario for both wind and solar energy sector (See Table 1). The considered existing or expired polices were: Accelerated Depreciation (AD), Generation based Incentives (GBI) and Viability Gap Funding (VGF). The proposed policies were: reduced cost debt, extended tenor debt, reduced cost & extended tenor debt and interest subsidy. As it can be seen, the AD and GBI policies presented poor effectiveness upon both wind and solar energy sectors, which justifies for the deactivation of GBI policy and amendment (permitted depreciation rate reduced to 40% from 80%) in the AD policy.

Table 1: Cost Effectiveness and Viability Gap Coverage Potential for Wind and Solar Energy in India (Data Source: Climate Policy Analysis (CPI) (Shrimali *et al.,* 2014, 2017)

Energy Sector		Wind		Solar	
Policies		Cost Effectiveness Potential (% Reduction in Subsidy Cost)	Viability Gap Coverage Potential (% Reduction in Subsidized LCOE)	Cost Effectiveness Potential (% Reduction in Subsidy Cost)	Viability Gap Coverage Potential (% Reduction in Subsidized LCOE)
Proposed Debt Policies	Reduced Cost Debt	73%	100%	35%	68%
	Extended Tenor Debt	43%	28%	19%	15%
	Reduced Cost & Extended Tenor Debt	84%	100%	61%	100%
	Interest Subsidy	72%	100%	42%	68%
Existing / Expired Policies	Accelerated Depreciation (AD)	35%	44%	20%	28%
	Generation Based Incentive (GBI)	25%	100%	25%	100%
	Viability Gap Funding (VGF)	53%	100%	45%	100%
	No Federal Support (Baseline)	0%	100%	0%	100%

STATE-WISE SCENARIO

Policies for wind energy utilization have national-level and state-level implementation bodies and policy guidelines; whereas, there is no state-specific policy framework for solar energy. The implementation of solar power project is governed by the Solar Energy Corporation of India (SECI) on national level. Some of the states have their solar energy policy for guideline purpose. The implementation of solar power projects vary with projects. Wind power projects have state-specific policy constrains like FIT rate, RPO target, PPA duration and wheeling charges as shown in Table 2. The present status and evolution of the wind power generation with reference to available power potential is shown in Table 3. Other possible influential factors like ratio of installed capacity to power potential, per capita net domestic product (PCNDP) and extent of power generation with respect to requirement are given in Table 4. The study indicates that Gujarat and Tamil Nadu are the most energy-rich states of India in terms of wind energy; and hence, providing tight policy structure. States with lower energy potential like Rajasthan are having generous policy benefits in order to promote the wind power deployment. Moreover, the other factors like capacity to potential ratio, PCNDP and power generation extent are found to be non-influential for wind power projects.

Table 2: Current Status of Wind Power Policies in the States of India

State	FIT (₹/kWh)	Duration of PPA (Years)	RPO Target (%)	Wheeling Charges (%)
Maharashtra (MH)	5.56	13	10	2
Karnataka (KA)	4.5	20	11	5
Gujarat (GJ)	4.19	25	8.25	7
Rajasthan (RJ)	5.74	25	8.9	4
Tamil Nadu (TN)	4.16	20	9	5
Madhya Pradesh (MP)	4.78	25	6.05	2
Andhra Pradesh (AP)	4.84	25	4.75	5

Table 3: Indian Status of Wind Energy (MW) (Data Source: (Panse & Kathuria, 2016), Project Developers)

State	Installed Capacity (MW)			Annual Increment in Installed Capacity (MW/Year)		Current Potential @ 100 m (MW)
	1992	2012	2018	1992–2012	2012–2018	2018–19
MH	1.1	3021.85	4752	151.0375	288.3583	45394
KA	0.55	2135.3	3774	106.7375	273.1167	55854
GJ	16.15	3174.66	5613	157.9255	406.3900	84431
RJ	0	2684.25	4282	134.2125	266.2917	18770
TN	33.38	7162.27	7870	356.4445	117.9550	33799
MP	0.59	385.99	2497	19.2700	351.8350	10483
AP	0.55	447.65	3610	22.3550	527.0583	44228
Mean	**7.4743**	**2716**	**4602**	**135.4261**	**314.3340**	**41851.2857**

Table 4: Other Decisive Factors for Each State (Tiers of Government - Reserve Bank of India, n.d.), (Dubey, 2016)

State	Ratio of Installed Capacity to Potential (%)	Per Capita Net Domestic Product (₹)	Power Geneationexcess (+ve) / Shortfall (-ve) (%)
MH	10.47	117285	7.4
KA	6.76	117988	4.6
GJ	6.65	113229	4.2
RJ	22.81	66989	-0.2
TN	23.28	157116	-3.3
MP	23.82	54416	11.9
AP	8.16	92730	-7.6

WIND-SOLAR HYBRID ENERGY POLICY

In May 2018, MNRE released the National Wind-Solar Hybrid Policy for promoting the hybridization of wind and solar energy generation in India (Jethani, 2018). In India wind and solar resources are complementary to each other. The blending of wind-solar plants will induce the grid stability and also allow taking maximum advantage of land, infrastructure and power evacuation systems. This policy is applicable to new as well as existing projects. The core aim of the policy is to offer a framework for the deployment of large grid connected renewable energy projects. Under the policy, the Wind Turbine Generator (WTG) and Solar PV (SPV) systems will be designed to the sole point of grid connection. Individual wind and solar power projects are designed to optimize power and cost of the project (Modi *et al.,* 2020).

The configuration of WTG and SPV system integration depends upon the type of wind turbine. For the fixed speed wind turbines, the integration will be on the High Tension (HT) side of the AC output bus. For variable speed wind turbines, the systems will be linked to the intermediary DC bus of the AC-DC-AC converter. As per the guidelines, the technology ratio should be lower than 75:25, which means any one system should have at least 25% proportion for getting recognized as a hybrid project. The standards and the regulations will be formed by CERC which shall include metering, forecasting and scheduling methodology, REC mechanism and power transmission permits etc. for the hybrid projects. Along with such regulations, ministry should also formulate the technical guidelines for WTG and SPV systems. All the incentives available for wind and solar plants will also be effective for the hybrid plants.

Hence, the Hybrid wind-solar energy policy is an important factor in the development of wind and solar power projects in India as it integrates the advantages of both the sectors with additional advantages like sharing of resources, infrastructure, power evacuation systems and land. Moreover there are some barriers to the deployment of wind and solar power in India that can be diluted by the hybrid policy, but still significant to be tackled in the near future in order to ensure sustainable deployment.

CONCLUSION

Present study gives brief idea about the wind and solar energy policies along with an overview of wind-solar hybrid energy policy. The study concludes that the energy policies have significant impact on the deployment of wind and solar power projects. State-wise wind energy policy study indicates that Gujarat and Tamil Nadu are more preferable states for the establishment of wind power projects due to higher power potential and other policy benefits. Moreover, the wind-solar hybrid energy policy will have significant role in upcoming time for boosting the utilization of renewable energy sources.

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Need for Policy Modification to Trim the Barriers for the Rooftop Solar Power Project in India

Sayandeep Chandra[1] and Subhankar Mazumdar[2]
[1]Management Trainee,
Tata Consultancy Service Ltd.,
MBA in Finance & Marketing,
Rajiv Gandhi Institute of Petroleum Technology
[2]Management Trainee,
Marketysers Global Consulting,
MBA in Energy & Marketing,
Rajiv Gandhi Institute of Petroleum Technology

Abstract—India, the third-largest producer & fourth largest consumer of the electric energy after the US & China, produced electricity of 1562 TWh in FY 2017-18 and witnessed a growth of 6.2% from the previous year. The major source of electricity generation is relied on thermal power generation and out of the total electricity production, 76% (1177 TWh) is produced from coal that causes toxic emission in the atmosphere. Immoderate dependency on the thermal power generation cultivates two biggest issues – one is energy security and other is environmental challenges. Jawaharlal Nehru National Solar Mission (JNNSM) was adopted in 2009 to eliminate these two challenges and the aim of this mission was to generate 20GW on-grid solar power and 2Gw off-grid energy. In 2015, the ambition was redesigned and the objective was set to 100GW solar power generation, out of which 60GW from on-grid and 40GW from rooftop set up. But the said objective is restricted by financial & policy barriers. The high upfront cost demotivates the potential users and lack of policies awareness shadows the growth of the initiative. Learning from global players such as Germany, Demark will help to formulate the policy accurately. On the other hand the monetary constraint can be voided using different financial tools like government bond and crowd funding method.

Keywords: Thermal Power, JNNSM, Roof-top Solar Power, Policy, Bond & Crowd Funding

INTRODUCTION

The world climate and environment are inextricably linked with any change in energy sector activity, seemingly affecting the latter. With the growing concern for protecting nature and conserve resources, the sustainable development goals are objectified, which is promoted by the United Nations (UN). In contemporary times, enforced policies and regulations, especially related to the energy sector, are now strictly focusing on the same mission.

Solar based power generation has become an epicentre of the surging energy demand. Solar power is a potential solution for millions who do not have access to electricity across the world, but high costs and slow development in technology has left it mostly out of reach. It is, however, changing – with increased investment, cheaper products, and innovative business models, energy generation from solar rays is not only on the rise but could potentially transform the way the world is powered. Here, the policy amendments play the most crucial role to make solar-based rooftop as well as PV power projects benefactor for both the parties, the consumers as well as the power producer, that possess as an economical and commercially viable solution.

GLOBAL POLICY ADOPTION BY DEVELOPED & EMERGING ECONOMIES

In the last 15 years of the timeline, the worldwide cumulative installed solar energy capacity of 3.7 GW in 2004 reached 177GW in 2014, i.e., increasing almost 50 times in ten years (Goel M, 2016). The global investment in renewable energy has been rising steadily and increased five times since 2004, from $62bn to $316bn in 2014 in ten years. The share of capital investment in the solar rooftop and other solar PV

projects was growing more rapidly and was 12% higher than in the previous year and became 67.4bn as in 2015, thus making it one of the fastest-growing industries worldwide. As per the International Energy Agency (IEA) Technology Roadmap - Solar PV Energy envisions total production of SPV electricity to increase to 16% in 2050 with China and India having significant shares. Besides, various alterations are mapped in developed and emerging economies concerning policymaking, to create flexibility for fostering smoother business models based on solar power generations. Germany, China, Japan, Italy, USA are currently front runners in solar PV capacity additions. These countries are considered which act as a road map for development of creating regulation flexibility in the Indian context.

United States of America

The United States of America (USA), has started early and is leading countries in solar energy research and development. In 2000, the California Independent System Operator (CAISO), the entity responsible for open-access transmission service, for interconnection approval. It helped to standardize and streamline the interconnection process for small, which includes commercial and residential roof-top PV systems (Chernyakhovskiy, *et al.,* 2016).

According to National Renewable Energy Laboratory (NREL), the USA estimated that solar rooftop could technically generate 819 TWh/yr (661 GW), which is 22% of the demand for electricity in USA in 2006 (Goel M, 2016). The USA, with a Solar PV capacity of 18.3 GW had adopted 'Public Utility Regulatory Policies Act' to aid energy alternatives way back in 1978. During 1980s Investment Tax credits' (ITC) as well as Production Tax Credits (PTCs) were formulated for incentivizing green energy sources. Initially ITC was reduced to 10% in the promotion of commercial level of development. But in 2005, residential and business ITC raised to 30% and exempted for three years resulting in doubling of solar PV capacity. ITC has undergone many changes and again being reduced to 10%.

In 2010, the Department of Energy (DOE) had established the goal of generating 10-15% of the nation's energy from solar sources by 2030. The DOE announced the solar industry had achieved 70% of cost cut targets in 2016, and it set five years before—and so it unveiled more aggressive unsubsidized-cost goals for 2030: $0.03 per kilowatt-hour for utility-scale solar, $0.04 per kilowatt-hour for commercial rooftop solar, and $0.05 per kilowatt-hour for residential solar (Jeffrey, *et al.,* 2017).

The 'Clean Energy Standard Act' was introduced in 2012. A PACE (Property-Assessed Clean Energy) financing mechanism has been launched with Municipalities providing 100% loan to owners and charging through property tax bills. Out of 3.5 GW capacity in U.S. 1.0GW is from the residential sector, and 1.5 GW is from Rooftop PV erected in commercial buildings, and the remaining 1.0 GW is large scale share owned by utilities.

Germany

The German model builds around the Renewable Energy Law (EEG) started at the beginning of the 1990s with a first subsidy program for "1,000 solar roof-tops" and preliminary feed-in-law, termed as "Stromeinspeisungsgesetz." These measures the new subsidy program for "100,000 rooftops" (HTDP), which was started in 1999, were sufficient to help the national PV market to take-off – this effect was not achieved before the EEG began in 2000; only the combination between EEG and HTDP secured commercially oriented PV investors a full payback of their investment and the breakthrough of the market. The Feed-in-tariff system was regulated by the Renewable Energy Law (EEG), recently amended in 2004: its terms for PV investors have been improved further (Ingrid, *et al.,* 2006).

Germany has more than 38.25 GW of cumulative installations has almost a share of 25% of the world's PV installed capacity. Nearly 1, 00,000 rooftops were adopted in 2009 to incentivize solar power installation in residential buildings with zero interest on loan. The government has also incentivized rooftop by a

significant fall in the costs, by introducing user-friendly policies for installations and Feed-in-Tariff (FIT) periodically updated. The gross metering was launched in 2009 to encourage solar project development independent of the captive load of the consumers (Goel M, 2016).

Household owners get income from preferential tariffs, and small consumers produced electricity for their use, were given the premium FIT of EURO 0.25/ kWh, and those who also supplied back to the grid at EUR 0.47/ kWh. The feed-in tariff for PV power drops faster than any other regenerative power source, in the last 15 years approx. — 80 % for small rooftop installations and 90% for systems of medium size.

The Rooftop PV projects acquired a share of 9% in residential, 26% in commercial and 24% in industrial capacity with 1% from enveloping buildings, and the remaining 40% capacity is from ground-based installations. The German government has decided to support battery back-up in each household to facilitate storage to incentivize rooftop PV use in 2013 further. In addition to financial incentives, regulatory measures included Renewable Resources Act guidelines for interconnection on a priority basis and with low voltage grid.

JAPAN

Japan invested majorly in R & D for grid-connected solar rooftop under its Sunshine and New Sunshine Projects since the 1970s and presently is third among the leading countries with 23.4 GW capacity of solar-based power generations (Goel M, 2016).

The National PV incentive system encouraged with the Feed-in-tariff system, where there is no actual Feed-in-tariff in place but "Net-billing," that works on average electricity prices for grid-connected PV, 24 Yen/kWh for residential use and 10–12 Yen/kWh for industrial use. Besides, the investment support system that facilitates the main subsidy program is the "Residential PV System Dissemination Programme," initiated in 1994. The total number of solar PV systems installed under this program expanded rose to a scale of 2, 00,000 (Ingrid, *et al.,* 2006).

The "Basic Guidelines for New Energy Introduction" was adopted upon in 1994 with a target for PV based solar power generation set at 400MW in 2000 and 4.6GW in 2010. The objective of 100GW is revised in 2030 was set up with a roadmap 'PV2030'. It started to give incentives to small producers from buying power at double the price and capital subsidy & soft loans to larger systems. The 10 to1000 kW of rooftop PV systems has grown significantly. To accelerate further, the FIT was introduced to encourage private sector participation in 2013. On the regulation aspect, the "Electrical Utility Industries Act" provides provisions for utilities as well as Renewable Purchase Obligations, and saving in electricity bills are other incentives.

ITALY

Italy granted the fourth position by having an installed solar power generation capacity of 18.6 GW. The net metering policy was introduced with direct incentives for rooftop PV in 2000. Investment support schemes incorporate incentive system for PV investors, managed by the Environmental Ministry and regional authorities through bureaucratic call-for-proposals, the three sub-programs run under the heading "Tetti Fotovoltaici." It also promotes small, grid-connected PV installations < 20 kWp; with the release of the new feed-in tariff system, these schemes will widely run out in 2006 (Ingrid, *et al.,* 2006).

Besides, the net metering policy has acted generously by providing incentives in 2007 and launched FIT 'Canto Energia' act for RE development was enacted in 2008 (Goel M, 2016). As per the regulation, tax credits are allotted for plants up to the size of 20 kW. Further, new rules for electricity storage connected to the grid have been published in 2014, which amends the target by setting a goal capacity addition of 15GW till 2020.

CHINA

China emerges as the second highest next to Germany in 2014. The country is heavily reliant on coal-based power generation, and it has a share of 68.75% of its total electricity generation. The solar-based power sources were mostly utilized in remote villages and communication towers because of their high cost for supplying electricity. But in 2005, the government enacted 'Renewable Energy Law' to facilitate renewable energy generation, and the number of new supporting regulations and guidelines were introduced, which created a favorable ecosystem for green sources of energy generation.

China's growth story is comprised of two aspects- Financial subsidies and Price Policies. The financial grants feature lucrative investment subsidies, product subsidies and consumer subsidies for the solar industry because of its high cost and relatively low return. The tax policy brings little pressure on the government and generates sufficient impetus to the enterprises, whereas the monetary policy provides low-interest loans and credit guarantees for enterprises. Besides, the price policy combines the government and the market and enforce fixed price policy so that it can rapidly expand the market of solar energy industry (Zhong, *et al.,* 2011).

As China has the advantage of expertise in various research & development, along with skilled human resources created broader public participation . The launch of the Rooftop Subsidy program of $2.4/W and Golden Sun Demonstration (GSD) initiative have given a considerable thrust in 2014 (Goel M, 2016). Under the GSD initiative, one can get 50% support for large grid-connected rooftop of >300kW, and 70% for off-grid systems. China has achieved 28.33 GW Solar PV capacity as of March 2015.

China plans to develop solar power in part through the traditional financial-leasing model. In 2015, Jinko reached an agreement with China Development Bank Leasing Limited (CDBL) under which CDBL would provide financing for at least 200 megawatts of new Chinese solar-project capacity annually for five years. This model has the potential to tap into a broader and more retail-oriented customer base in the country (Jeffrey, *et al.,* 2017).

INDIA'S SOLAR ROOFTOP POLICY SCENARIO

India is geographically landscaped on the high solar insolation region, endowed with significant solar energy potential. The total solar power potential in the country, as estimated by the National Institute of Solar Energy (NISE), is approximately 749 GW including solar rooftop. The Central and the state governments have, from time to time announced various policies for development of solar rooftop in the country. As per National Action Plan on Climate Change (NAPCC), the Government of India had approved the Jawaharlal Nehru National Solar Mission (JNNSM) in January 2010, which paved the way for the growth of solar capacity in the country. A target of 175 GW of installed capacity of renewable energy sources by 2022 was set, including 100 GW of grid-connected solar power, comprising 60 GW utility-scale solar and 40 GW of rooftop solar power generation.

The primary components used to set up a solar rooftop PV system includes PV modules, inverters and mounting structures for infrastructure. Other equipment commonly used are string boxes, transformers, meters, charge controllers, batteries, and generators can also be incorporated into the system depending on the scale of its operation. The cost of the system is considered the most critical aspect of installing a solar rooftop. It broadly depends on the type of policy and the financial incentives and subsidies provided by the government. A 1 kW solar rooftop system typically costs around Rs. 70,000 in India as per Ministry of New & Renewable Energy.

According to the information obtained from Ministry of New & Renewable Energy (MNRE, P&C Division), as on 31st December 2018, it is observed that the solar-based power generation has reached to a total installed capacity of 25.21 GW which is comprised of 1.35 GW of power generation through rooftop based solar PV modules.

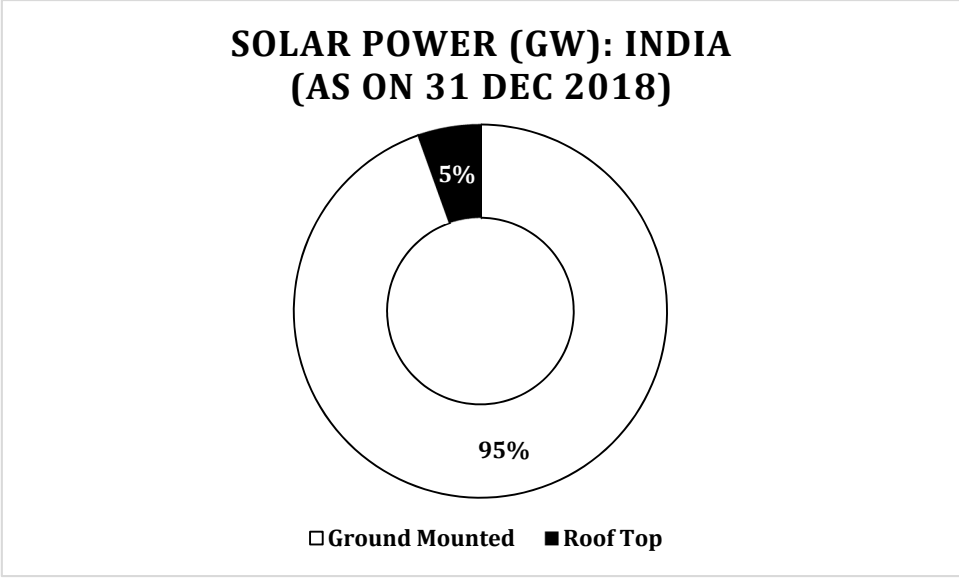


Fig. 1: Solar Power Generation in India

Source: Ministry of New & Renewable Energy, Government of India

FINANCIAL INCENTIVES & ASSISTANCE

MNRE facilitates Central Finance Assistance (CFA) of 30% of the benchmark cost for grid-connected rooftop projects. The benchmark cost for systems up to 10 kWp is Rs. 70,000 per kW; for over 10–100 kWp it is Rs. 65,000 per kW, and for over 100–500 kWp, it is Rs. 60,000 per kW was set in the financial year 2017-2018. CFA is applicable for systems in the residential, institutional, and social sectors installed for personal consumption as well as for the special category states, i.e., Northeastern states, Sikkim, and Union Territories, where 70% of the benchmark cost is adjusted (Kalsotra, *et al.,* 2017). Besides, some states also provide additional benefits to consumers who install rooftop solar systems. In Delhi, consumers avail incentive of Rs. 2 per unit (kWh) on gross solar energy generated in a year. In Gujarat, a subsidy of Rs. 10,000 per kW is provided to domestic consumers (maximum limit of Rs. 20,000 per consumer) in addition to 30% subsidy from Ministry of New & Renewable Energy.

CFA has no incentive schemes for commercial as well as industrial sectors, where installations are eligible for accelerated depreciation benefits. The central government provides other benefits such as custom duty concessions, excise duty relaxation, and soft loans from different banks. Many banks of India have made solar rooftop PV a part of their home loan and home improvement loan schemes. The State governments also provide a wide range of state-specific incentives, which is contained in their state net and gross metering, or solar policies (Sundaray, *et al.,* 2014)

There are two financial models, which are aiding financially for solar rooftop plant development in India, as follows:

Capital Expenditure (CAPEX) Model

In CAPEX model, a consumer purchases a solar power rooftop plant, by investing capital in the entire system. The only challenge of this model is that the owners have to pay for the entire project at the time of installation, which is a hefty amount.

In contrary, owners are eligible for capital subsidies from MNRE. The operations and maintenance (O&M) of the solar rooftop system is either with the rooftop owner or with the solar developer for the first few

years, if stated in the contract. But, the subsidy is not available for commercial and industrial applications; instead, a tax benefit called accelerated depreciation (AD) is provided by the government. Under this scheme, the owner of the PV plant is allowed to depreciate most of the value of an asset in the first few years to reduce the tax liability of the company.

Renewable Energy Service Company (RESCO) Model

In RESCO model, a third party installs the solar rooftop PV plant and sells the generated power to the consumer. The consumer doesn't need to make any investment. The tariff are set in a mutually agreed manner, which the consumer buys solar energy through the power purchase agreement (PPA).

The consumer's advantage is zero investment, where they do not have to pay for the O&M costs as well, as these are usually the responsibility of the service provider of the developer. This model is feasible in case of institutional consumers, residential complexes, etc., as developers are willing to offer long term PPAs as well as O&M contracts for such large-scale installations.

INDIA'S PROGRESSION: STATE-WISE APPROACH AND DEVELOPMENT

The below chart elucidates India's state-wise distribution of solar-based rooftop power generation as of 31st December 2018 (MNRE). The significant contributors to accelerating India's growth story are Maharashtra, Karnataka, Gujarat,Tamil Nadu, Delhi, and Rajasthan. The other states are slowing progressing towards the higher objective of generating 40GW of solar power through rooftop PVs.

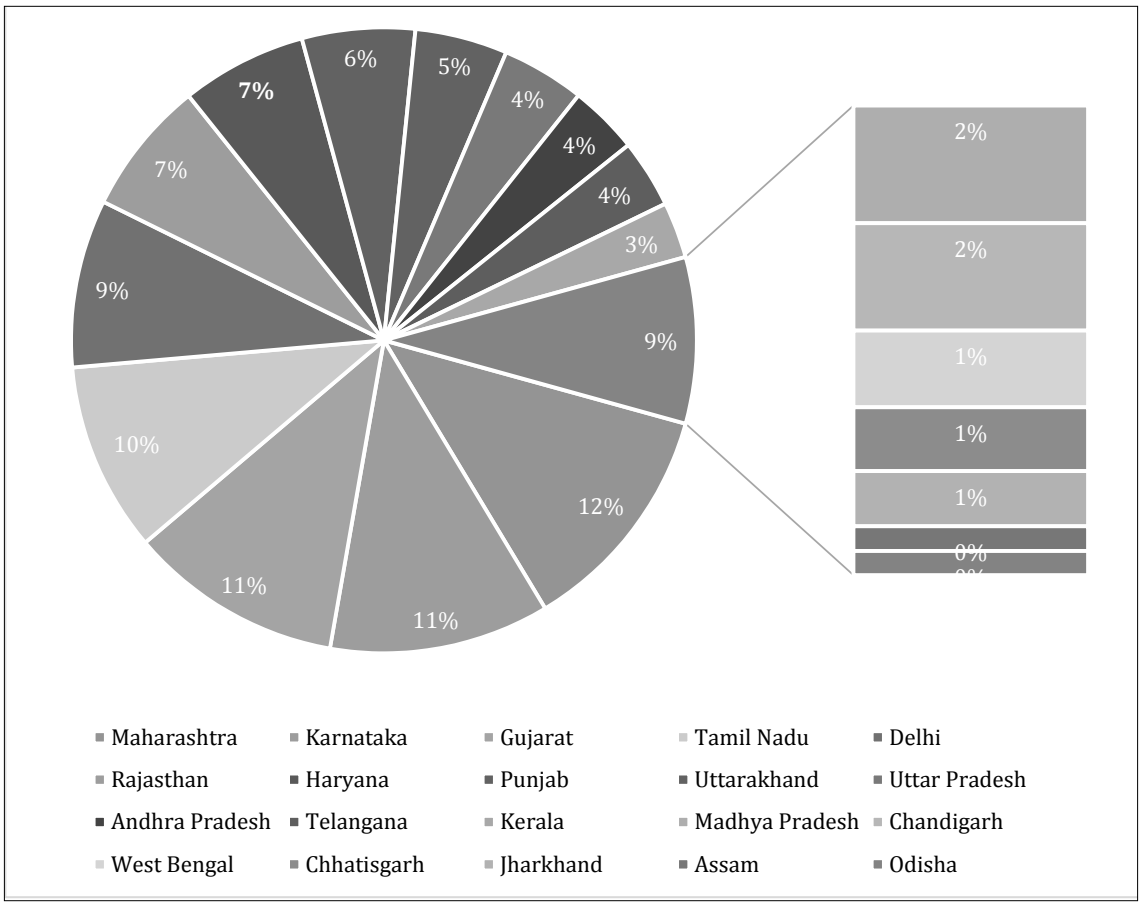


Fig. 2: India: State Wise Installed Solar Roof Top as on 31st Dec 2018 (MW)

Source: Ministry of New & Renewable Energy, Government of India

COMPARATIVE POLICY ANALYSIS: DEVELOPED COUNTRIES VS. INDIA

Policy Parameters	Global Scenario	Indian Scenario
Direct capital subsidy	Yes	Yes
Solar electricity schemes	Yes	Yes
PV specific Solar electricity scheme	Yes	No
Renewable Portfolio Standard (RPS)	Yes	Yes
Solar set aside RPS target	Yes	No
Financing scheme	Yes	Yes
Tax credits/tax benefits	Yes	Yes
Net metering/net-billing/ Self-consumption incentives	Yes	No (Not all the states have implemented)
Sustainable building requirements	Yes	X

INDIA'S TAKE AWAY FROM GLOBAL POLICIES

STAKEHOLDERS RESPONSIBILITY FOR IMPLEMENTATION OF ROOFTOP SOLAR PV PROJECTS

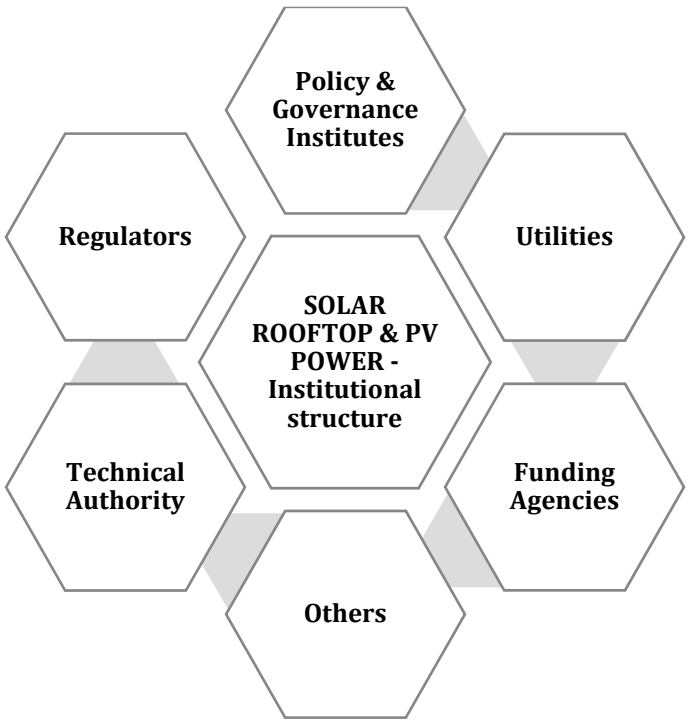


Fig. 3: Solar Rooftop & PV Power-Institutional Structure

Policy & Governance Institutes:	MNRE – Ministry of New and Renewable Energy, NVVN – NTPC Vidyut Vyapar Nigam Limited, SECI – Solar Energy Corporation of India, SERCs– State Electricity Regulatory Commissions, SNA – State Nodal Agencies for Renewable Energy Development
Utilities:	DISCOMS – Distribution Companies, T&D utilities– Transmission and Distribution utilities
Technical Authority:	CEA – Central Electricity Authority

Regulators:	CERC – Central Electricity Regulatory Commission
Funding Agencies:	REDA – Indian Renewable Energy Development Agency, MDBs–Multilateral Development Banks
Others:	Consumers, Equipment Manufacturers, Solar Installer & Distributors

FOR EFFECTIVE WORKING OF THE SOLAR ROOFTOP BASED POWER GENERATIONS, THESE ARE THE MAJOR AMENDS NEEDS TO BE TAKEN CARE OF FROM THE CONSUMER PERSPECTIVE

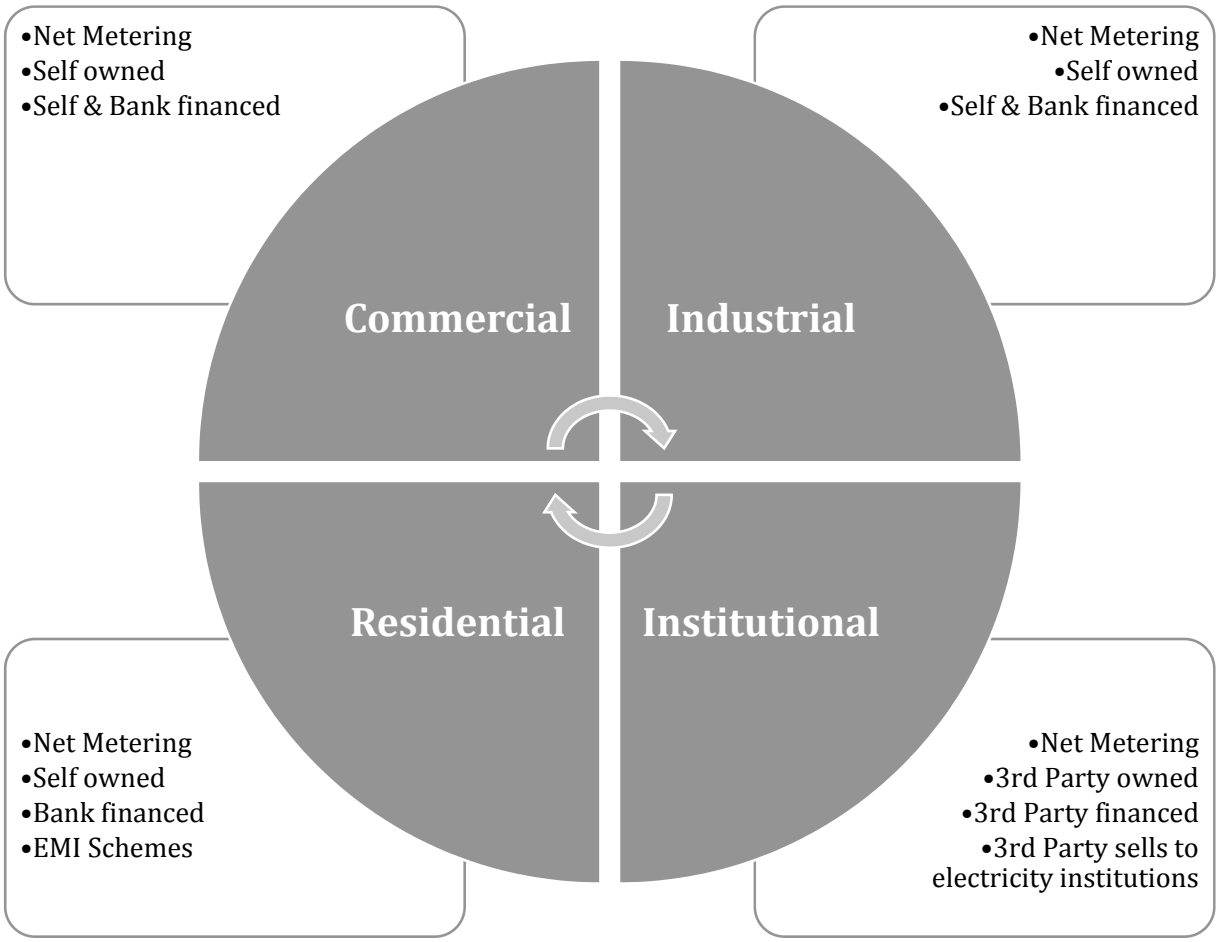


Fig. 4: Sectorial Aspect

FINANCIAL ANALYSIS

Solar energy is available abundantly and cheapest source for power generation. The country, India is blessed with 300 sunny days, and the average intensity of solar radiation is measured as 200MW/ Km square (India Energy Portal). In 2018, globally, energy produced from renewable sources in 2480 terawatt-hour (TWh) and contribution from solar energy was 584 TWh that is approx. 24% of the whole generation. If we focus on the country-wise segmentation, in 2017-18, India has produced 30 TWh from solar power generation out of 121 TWh renewable power generation. Though the country has observed a growth of 42% in the solar power sector from the year 2016-17 to 2017-18, the generation figure is lower than other Asia Pacific countries like China (178 TWh) & Japan (72 TWh) & US (98 TWh) and Germany (47 TWh) (BP statistics, 2019).

According to the Ministry Of Statistics and Programme Implementation (MOSPI), 2019 statistics report the country has a potential of 1096081 MW (2400 TWh) from renewable and out of the figure, solar power has the potential of 748990 MW (1312 TWh) (MOSPI,2019). The statistical report returns a verdict that there exists a drawback that handicaps the growth and obstructs the flow of the work. Policy derivation & implementation is one part of the bottleneck and investment is another hurdle.

Capital investment, maintenance cost, operational cost, etc. are the primary influencer for the common in order to accept the renewable source of power. On the other hand, government subsidies & tax benefits help to push the buyers towards the adaptation of the renewable power system, by making them aware. The Government of India (GoI) drew an ambitious initiative to produce 40GW solar power from rooftop plants, and to achieve this objective commercial & industrial sector, as well as the residential sector, will act as major stakeholders. But high capital expenditure (CAPEX) lessens investors' confidence. At the same time bifurcation of financing mechanism (debt and equity investment) is a matter of concern.

The capital investment is justified with the help of Net Present Value (NPV), Payback Period (PP), and Internal Rate of Return (IRR). Cash flow from the project supports the previously said parameters. The accelerated depreciation method, an indirect financial support mechanism, helps to boost the investors' confidence and realize them tax benefit (NITI Aayog, 2015). The below calculation describes that a 100KW rooftop solar power setup will cost around INR 10 million with an approx. 6years payback period. Also, the cost of 75KW and 50KW is INR 7.5 million and 5.3 million, respectively.

Table 1: Total Cost and O & M Cost According to the Capacity

Capacity (KW)	Cost of Project	Cost/Watt	O & M cost	Payback Period (Year)
100	₹ 96,67,565.90	₹ 96.68	₹ 7,36,576.45	5.46
75	₹ 74,66,744.74	₹ 99.56	₹ 5,68,894.84	4.18
50	₹ 52,65,923.57	₹ 105.32	₹ 4,01,213.22	4.72

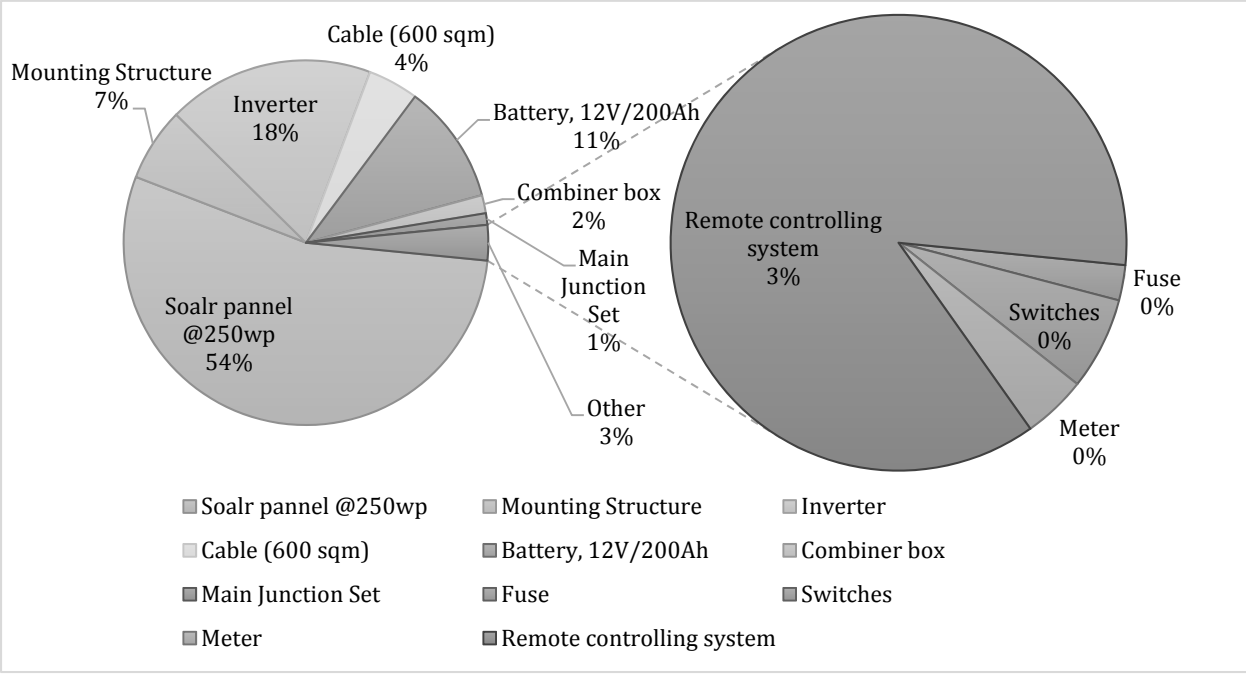


Fig. 5: Total Cost Breakup Component Wise in Percentage

The operation and maintenance (O&M) cost is considered around 7% (excluding primary installation and transport cost). While the solar panel bears approx. 54% and inverter & battery approx. 29% of the total cost. So, the break up demonstrates that the primary three pillars of the solar power system consume a major pie of the composite investment.

The report developed by Climate Group argues that *"Reducing investor risk and providing a level playing field for all investors"* is one of the essential components that accelerates the project of 40GW rooftop solar power generation. Here a term arrives "*investor risk.*" Risk is defined as the contrast between the actual return and the expected return (Shukla, Kukreja, 2014). Here, in case of a rooftop solar power system, risks are associated with consumers' concern and high capital investment (Goel M, 2016).

FINANCIAL STRUCTURE FOR ROOFTOP SOLAR POWER SYSTEM

The rooftop solar power system is halved in residential and commercial (includes industry & institutions) and both the sectors can develop own model or can undergo third party contract. For the later one the supplier owns the infrastructure and vend the generated power. The roof owner is acknowledged either by rent money or by the power supply or maybe by both. But in case of self-developed rooftop solar power system, the owners invest in the infrastructure and either consume the generated power & provide the surplus power to the grid (Net metering) or supply the absolute produced power to the grid (Gross metering) (Sundaray, *et al*., 2014). For the former scenario DISCOM adjusts the billing amount according to the injected power to the grid. On the other hand the developer will be paid according to the average cost of supply (ACOS) [8]. Once the source of revenue is defined, the question arrives for financing the model. Debt & Equity financing model is supported by bank loans, government financing or bonds.

THE BOND CONCEPT

The government bond is a pathway to finance infrastructural and under the initiative of smart city mission, the municipal bond is appreciated for a source to incentivize the development (Deloitte, 2019). In 2017, Pune Municipal Corporation utilize the said financial tool to finance water supply metering project and raised INR 200 crore (Trivedi, *et al.,* 2018). The same tool can be conceptualized for the rooftop solar project in India. In the global context, we can make reference to *"Morris Model"* a hybrid model that helped to generate capital for clean energy in New Jersey. This model is described as a complex financial structure because the model consists of public bonds, power purchase agreement (PPA), and lease revenue. The concept behind the *Morris Model* is the general fund for operational expenditure through a double-barrelled bond (a bond protected by both the projected revenue and the county government). The revenue is realized through PPA, and the infrastructure is leased (NREL, 2011). In Indian context, the proposed solar bond model by Trivedi, *et al.* is slightly different from *Morris Model.* Here, in India, the fund raised by issuing bonds will be utilized for developing multiple residential, commercial and institutional rooftop solar power projects.

TRADE FINANCING

The former discussed model is developed to support the operating expenditure (OPEX). But the CAPEX model explains that the rooftop solar power project is self-financed, and all risks are carried by the financer. In the country the CAPEX model contributes 65% of total rooftop solar power installation (BTI, 2019). In case of Renewable Energy Service Company (RESCO) Model, developers undergo PPA & rooftop leasing and generate revenue by gross metering or net metering. So, a concept of trade financing we have developed for supporting the CAPEX model.

Here, we have considered three scenarios for analyzing the capital cost incurred for installing rooftop solar PV. Three scenarios are for 100kw, 75kw and 50kw.

Table 2: Capital Cost for the 100KW Rooftop Solar Power System

Total Capacity (Watts)		100000			
Sl. No.	**Description**	**Rating**	**Cost/Unit**	**Qty.**	**Total**
1	Soalr pannel1 @250 wp	250wp	₹ 10,000.00	400	₹ 40,00,000.00
2	Mounting structure	1kw	₹ 4,800.00	100	₹ 4,80,000.00
3	Inverter	10kw	₹ 1,35,000.00	10	₹ 13,50,000.00
4	Cable (600 sqm)	4sqm	₹ 2,200.00	150	₹ 3,30,000.00
5	Battery, 12V/200Ah	1920kw	₹ 15,000.00	52	₹ 7,81,250.00
6	Combiner box	60KWP	₹ 59,000.00	2	₹ 1,18,000.00
7	Main junction set	10kw-3p	₹ 7,500.00	10	₹ 75,000.00
8	Fuse	15A	₹ 200.00	29	₹ 5,797.10
9	Switches	15A	₹ 35.00	435	₹ 15,217.39
10	Meter	200-380v/10-60A	₹ 3,500.00	3	₹ 10,500.00
11	Remote controlling system		₹ 2,00,000.00	1	₹ 2,00,000.00
	Total				₹ 73,65,764.49

The installation cost, logistics O&M, and other costs are ignored; only the material costs are considered.

Table 3: Capital Cost for the 75KW Rooftop Solar Power System

Total Capacity (Watts)		75000			
Sl. No.	**Description**	**Rating**	**Cost/Unit**	**Qty.**	**Total**
1	Soalr pannel1 @250 wp	250wp	₹ 10,000.00	300	₹ 30,00,000.00
2	Mounting structure	1kw	₹ 4,800.00	75	₹ 3,60,000.00
3	Inverter	10kw	₹ 1,35,000.00	7.5	₹ 10,12,500.00
4	Cable (600 sqm)	4sqm	₹ 2,200.00	150	₹ 3,30,000.00
5	Battery, 12V/200Ah	1920kw	₹ 15,000.00	39	₹ 5,85,937.50
6	Combiner box	60KWP	₹ 59,000.00	2	₹ 1,18,000.00
7	Main junction set	10kw-3p	₹ 7,500.00	7.5	₹ 56,250.00
8	Fuse	15A	₹ 200.00	22	₹ 4,347.83
9	Switches	15A	₹ 35.00	326	₹ 11,413.04
10	Meter	200-380v/10-60A	₹ 3,500.00	3	₹ 10,500.00
11	Remote controlling system		₹ 2,00,000.00	1	₹ 2,00,000.00
	Total				₹ 56,88,948.37

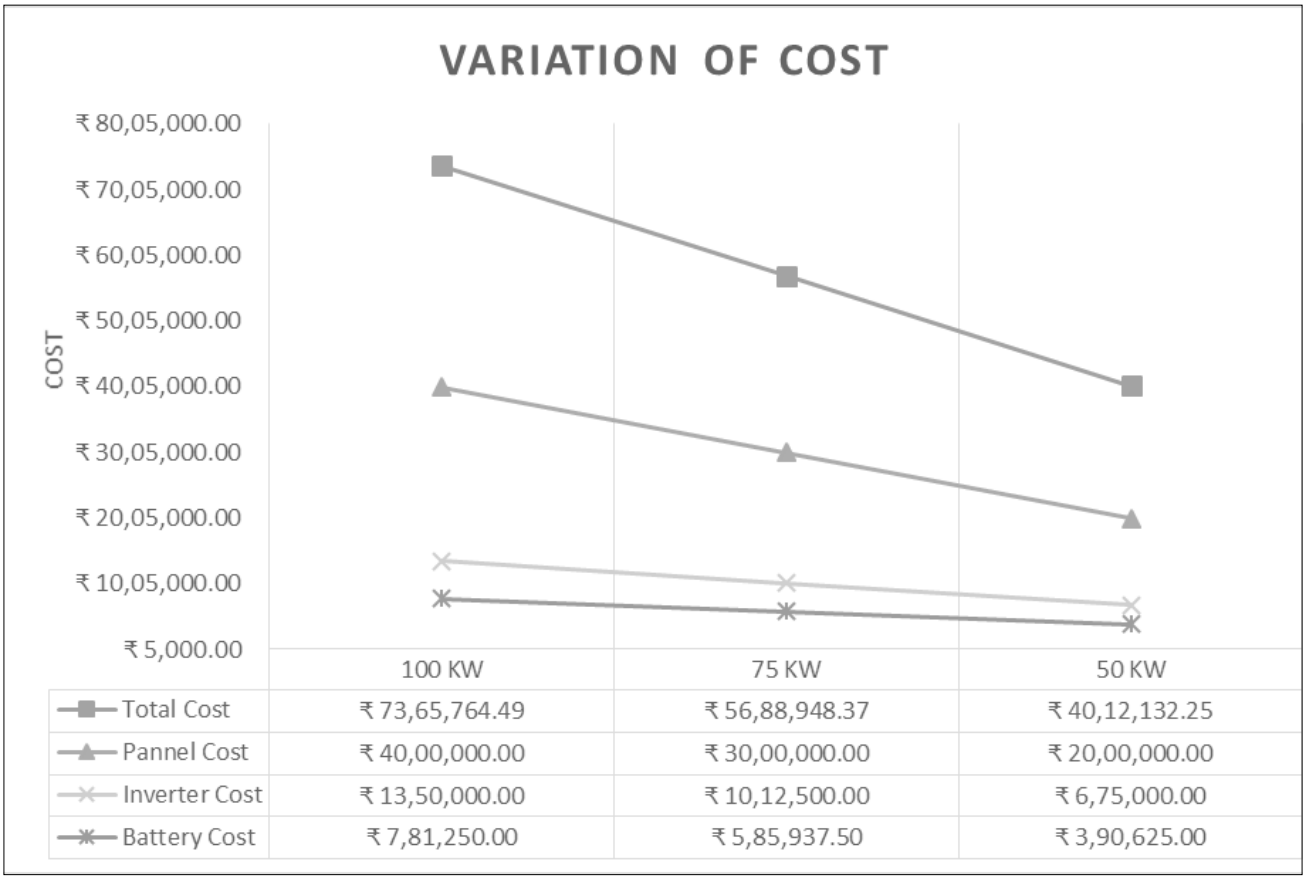
Table 4: Capital Cost for 50KW Rooftop Solar Power System

Total Capacity (Watts)		50000			
Sl. No.	**Description**	**Rating**	**Cost/Unit**	**Qty.**	**Total**
1	Soalr pannel1 @250 wp	250wp	₹ 10,000.00	200	₹ 20,00,000.00
2	Mounting structure	1kw	₹ 4,800.00	50	₹ 2,40,000.00
3	Inverter	10kw	₹ 1,35,000.00	5	₹ 6,75,000.00
4	Cable (600 sqm)	4sqm	₹ 2,200.00	150	₹ 3,30,000.00
5	Battery, 12V/200Ah	1920kw	₹ 15,000.00	26	₹ 3,90,625.00
6	Combiner box	60KWP	₹ 59,000.00	2	₹ 1,18,000.00
7	Main junction set	10kw-3p	₹ 7,500.00	5	₹ 37,500.00
8	Fuse	15A	₹ 200.00	14	₹ 2,898.55
9	Switches	15A	₹ 35.00	217	₹ 7,608.70
10	Meter	200-380v/10-60A	₹ 3,500.00	3	₹ 10,500.00
11	Remote controlling system		₹ 2,00,000.00	1	₹ 2,00,000.00
	Total				₹ 40,12,132.25

From the tables, it can be described that apart from the panel cost (~50% of the total cost), storage (battery) and inverter costs absorb 25% (approx.) of the total capital investment. This sum of the investment (CAPEX) is financed either by debt & equity or full equity, which develops risk in case of return and uncertainty for long term debt repayment. The proposed trade financing model will help to lower the risk as well as uncertainty.

CROWD FUNDING

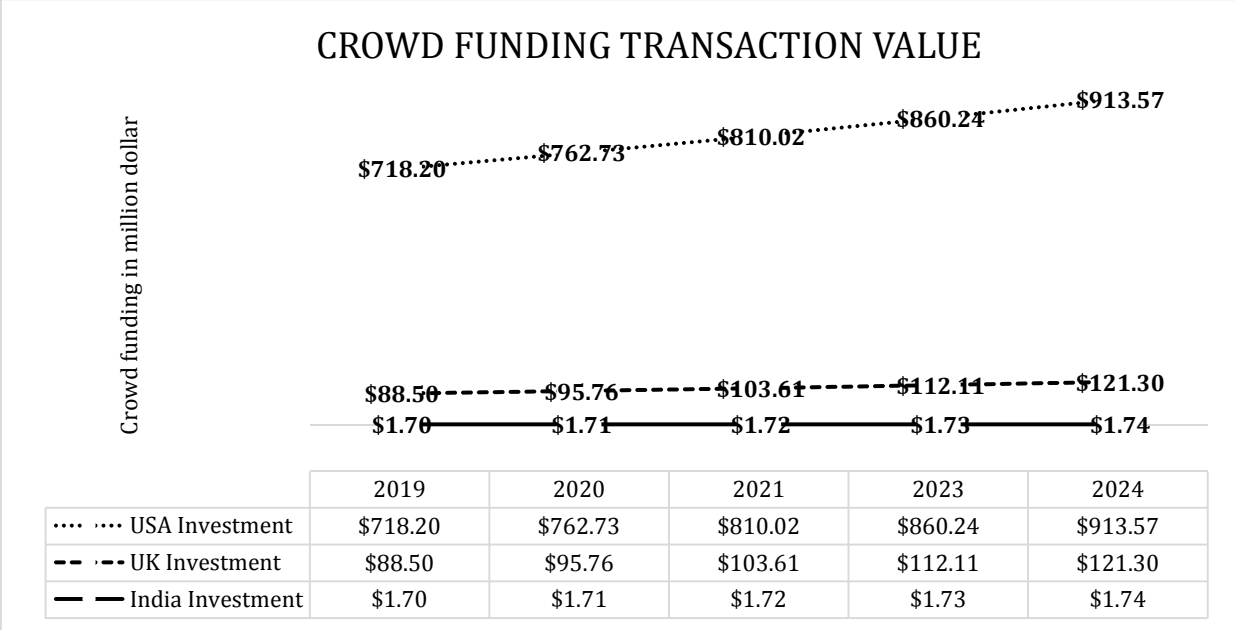
The abstraction of crowdfunding can be defined as gaining capital through public donations (Steinberg, 2012). Wicks argues that crowdfunding is financial support by large public pool (crowd) in lieu of reward or return for equity (Wicks, 2014). But Oxford Dictionary accepts the presence of the *"Internet"* and describes internet as the medium of communication for raising funds [15]. In simple words, the crowdfunding is an unorthodox method for raising capital for any project or business.



	100 KW	75 KW	50 KW
Total Cost	₹ 73,65,764.49	₹ 56,88,948.37	₹ 40,12,132.25
Pannel Cost	₹ 40,00,000.00	₹ 30,00,000.00	₹ 20,00,000.00
Inverter Cost	₹ 13,50,000.00	₹ 10,12,500.00	₹ 6,75,000.00
Battery Cost	₹ 7,81,250.00	₹ 5,85,937.50	₹ 3,90,625.00

Fig. 6: Variation of Cost

The said concept could be applicable for developing a rooftop solar power plant on small to medium scale in India. In 2019, the crowdfunding in UK is US$88.5m, and annual growth rate is 8.2%. The said figure in USA is US$718m and annual growth 6.2%. The values are expected to reach US$121m and US$915m in UK and USA, respectively. While in case of the country, India, the amount is insignificant- US$1.7m [16]. There are four types of crowdfunding models according to the International Organization of Securities Commissions (IOSCO), and that is 1) Peer-to-Peer (P2P), 2) Investment Based Crowd Funding, 3) Reward crowdfunding and 4)Donation Crowd Funding. P2P crowdfunding is taken place under supervision of a platform that introduces investors and borrowers. Debt repayment and interest rate are monitored by the supervisor. Here platform is a trustee and lender buys a share of trust structure from the platform. The entire model works on trust and investment is



	2019	2020	2021	2023	2024
USA Investment	$718.20	$762.73	$810.02	$860.24	$913.57
UK Investment	$88.50	$95.76	$103.61	$112.11	$121.30
India Investment	$1.70	$1.71	$1.72	$1.73	$1.74

Fig. 7: Crowd Funding Transaction Value

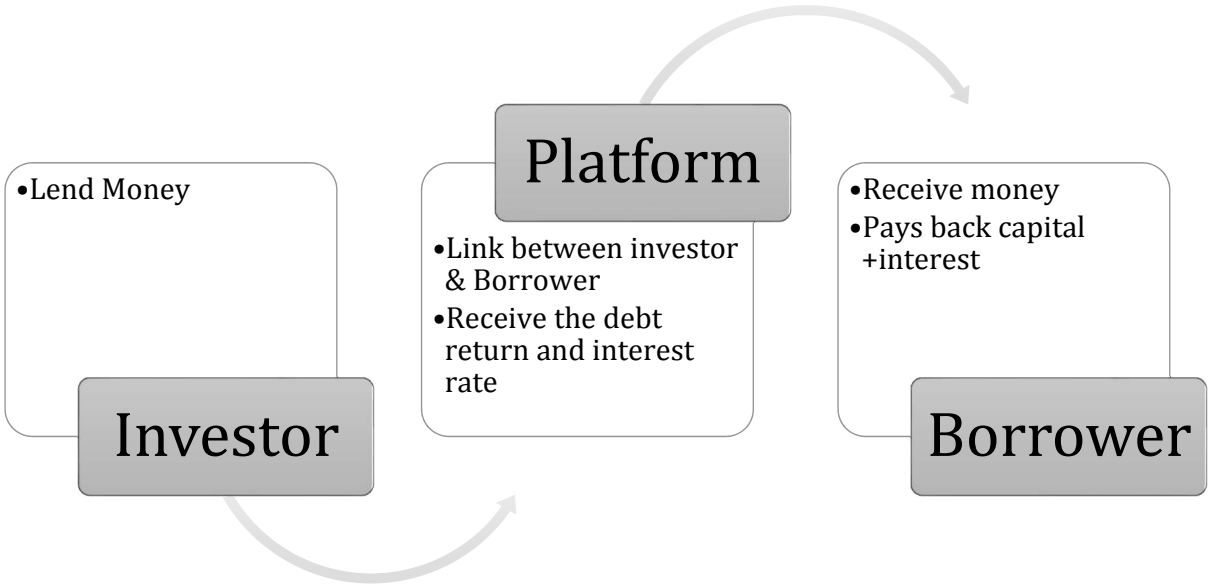


Fig. 8: Peer to Peer Model

associated with risk. The other secure P2P model is a notary model where the bank works as a loan generator. Here bank provides loan support to borrower and platform issue a "note" to the lender for the contribution towards the loan amount. The "note" works as security in this case.

The said model could be applicable for funding a rooftop solar power system. Investors could inject the money through a secure platform (Government monitored, or Public Sector Banks will act as platforms) in the development of the project. The power system will owner will generate revenue by selling surplus energy or gross metering and repay the debt. This model does not need collateral for the debt and convenient for both lender and borrower. The platform will verify the creditworthiness of borrower and provide support for easy fundraising.

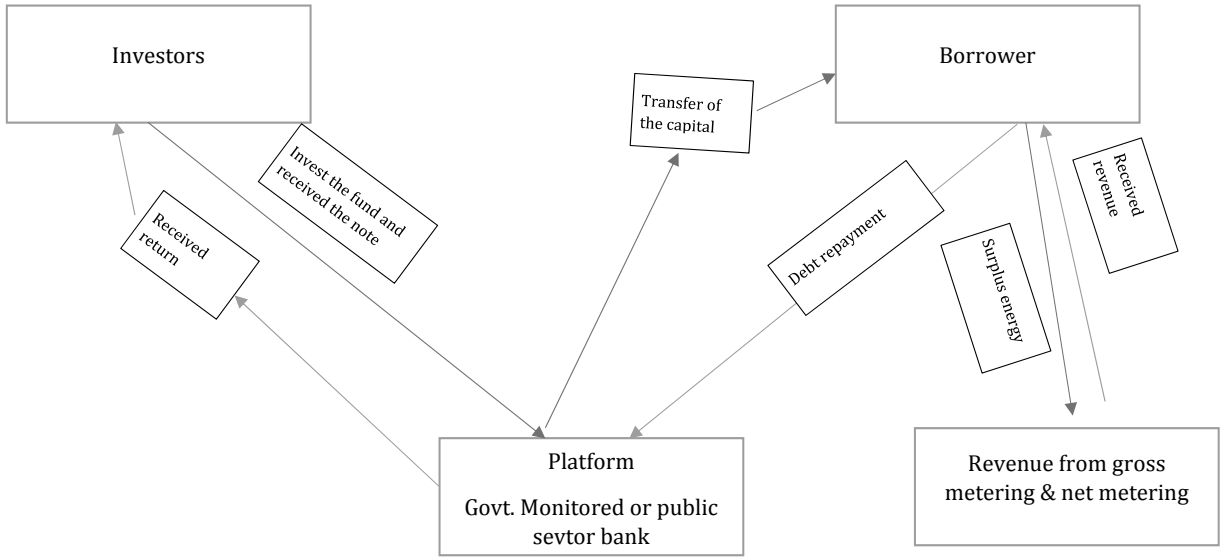


Fig. 9: P2P Model for Rooftop Solar Power Project

THE BENEFIT OF THE P2P MODEL

1. ***Helping Residential and Small Commercial Owners:*** Being the non-traditional pathway, crowdfunding helps the owners of the residential complex, society and small commercials to set up rooftop solar power system by avoiding orthodox methodology of debt financing. The restriction of the traditional loan system reduces the zeal of the rooftop owners or green energy users. Whereas P2P model makes project financing easy by eliminating the wall of restriction. Crowdfunding provides an affordable medium for raising capital.
2. ***No Collateral:*** The traditional loan system insists on collateral as security in order to finance a project. For small commercial or residential owners, sometimes it becomes a constraint to organize collateral equivalent to INR 5m (for 50KW). This market model checks only the credit credential of the borrower, and the burden of the collateral is voided.
3. ***Convenient:*** The crowdfunding model is online platform based. For the borrowers it is advantageous to access the terms & conditions easily and can avail for the loan. Also, flexibility is the bright side of this model. According to the borrower's needs and market, the debt system can be designed.

RISK

Return is always associated with risk. Crowdfunding has a risk of default and insecurity in case of debt repayment (IOSCO, 2014). At the same time the project owner could face issues regarding "stop funding." In the latter case, the ongoing project will be paused for an uncertain time period. At the same time investors may perceive poor return on investment and could hold back the fund. Another type of risk can be experienced, and that is related to the platform or online service provider (mediator). The trustworthiness of the platform is an issue. The customers' data, banking data, and other financial data are shared with the mediators. So, data security, as well as data privacy, is a concern (Jenik, *et al.,* 2017).

At the end of the discussion it can be concluded that the "*Bond model"* is helpful to accumulate the OPEX and maintain the functions work smoothly. Also, bond model is effective for industrial level rooftop solar power projects where investors could expect a good rate of return. But for residential complex, society and commercial institutes can exercise the crowdfunding process in order to access easy capital seed. Financial barriers such as restriction of traditional banking systems decrease the micro-level progress and put a cap over the willingness to install renewable power generation systems. But the P2P model encourages the roof owners to work on the solar power project. Risk is the internal part of the investment or project financing, and we cannot eliminate risk completely. So, the policy of model design should focus on low risk and smooth return.

CONCLUSION

There is a grave need to promote renewable energy in order to shrink the emission of carbon-monoxide and address climate change & global warming. To achieve the ambitious objective, a well-defined road map has to be implemented. At the same time identification of the significant barriers is an essential workflow that has to be consulted. Like India, German also depends on coal for electricity production and almost 35% of the production is generated by burning this black stone. But the impressive fact is that gradually the number is decreased and the share of renewable energy is scaled up. The success story of Germany could be a lesson for India. The financial barrier has to be trimmed with help of CAPEX and OPEX funding model. Modification in the mechanism used for financing the project will be proved worthy and direct subsidies in manufacturing ameliorate the production. Establishment of the joint research centre with a technologically superior country like the USA, Germany will upgrade the indigenous product quality and help the native producers to sustain in the price war.

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Effect of Utility Grid Reliability on Performance of the Solar PV Rooftop Systems

Radhika Savalia[1] and Aniket Baregama[2]
[1,2]Project Officer,
Renewable Energy, Environment and Energy Efficiency (RE4),
Gujarat Energy Research and Management Institute
E-mail: [1]Radhika.s@germi.res.in/ radhika23993.rs@gmail.com,
[2]aniket.b@germi.res.in/ aniketbaregama@gmail.com

Abstract—India's prosperity on the way towards the 175 Gigawatt (GW) objective of the sustainable power source by 2022. India has effectively settled forceful solar and wind vitality strategies to meet this objective. The nation has just introduced 35 GW of wind energy out of the objective of 60 GW by 2022. Concerning utility-scale solar photovoltaic (PV), India has introduced an all-out limit of 25 GW out of 60 GW objective. Although rooftop solar PV capacity introduced in the nation remains at just 1.4 GW against the objective of 40 GW by 2022. There is a ton to be done to distinguish and dispense with bottlenecks and encourage applicable entities. One of the key bottlenecks in the absence of institutional limit at state vitality improvement organizations to adjust rapidly to on-ground advertise substances. Besides, there is additionally a matter of obstruction from the power distribution companies. The paper highlights the spotlight for power distribution companies and electrical networks in order to obtain optimum performance from the most-accepted-distributed solar PV systems and its barrier from our existing networks.

This paper asserts the performance of grid-tied solar PV plants as for dependability of mains-framework-electrical-network by power distribution companies. A 2 kWp residential and 190 kWp commercial solar PV system have been taken for the analysis. A tool has been developed consisting of PV system analyzing factors and grid-reliability matrix. The simulation has been performed on the tool using the monitored field data. The correlation between grid reliability and its impact on the performance via Performance Ratio (PR), Capacity Utilization Factor (CUF) and Specific Yield of solar PV systems has been discussed.

Keywords: Capacity Utilization Factor, Photovoltaic, Gigawatt, Kilowatt, Performance Ratio, Specific Yield

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The Challenges before India's Unprecedented Growth in Renewable Energy Capacity

Anweshkumar Susantakumar Padhy[1], Urvi Prafulbhai Jadav[2] and Suvam Sahoo[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]anwesh.ppgp19@spm.pdpu.ac.in/ anvesh.padhy@gmail.com, [2]urvi.jpgp19@spm.pdpu.ac.in/ urvijadav18@gmail.com, [3]suvam.spgp19@spm.pdpu.ac.in/ suvam1994@gmail.com

Abstract—In a little over a decade (by 2030), India aims to increase by 40%, the country's cumulative installed capacity from non-fossil fuel sources—up from the current 30%—to meet its commitment to reduce emissions under the Paris climate pact.

In the near-term India is aiming to grow its renewable energy capacity to 175GW by 2022—compared to the current 37GW.

Given India's status as the fourth largest greenhouse gas emitter globally, the progress that the country makes towards reducing such emissions will be crucial in limiting the rise in global temperatures to less than two degree Celsius above pre-industrial levels.

As for India's energy deficit—which is calculated as the difference between power demand and the net availability of power—the gap will continue to shrink over the next five years, and the country will likely register a power surplus by 2022.

The surplus will be partly contributed by the growth in renewable energy capacity assuming a 7% real GDP growth rate from the fiscal year ended Mar 31, 2016 (FY16) until FY22—as well as the elasticity of power demand, with real GDP of 1.2x over this period as against a long-term average of 0.9x.

The rising share of renewables in the generation mix and the regulatory support provided to non-fossil fuel sources in terms of priority dispatch—with all renewable energy plants considered by the government as must-run facilities—creates challenges for power generators with a significant installed capacity comprising thermal generation. This situation will be exacerbated by the fact that India will likely register a power surplus by 2022, thereby putting further pressure on the utilization rates of thermal generators.

Around 35% of the new generation capacity (7.1GW) was added during the first 11 months of FY2016 was from renewables.This scenario is a clear shift from previous compositions of new generation capacity, which were heavily dominated by coal.

The share of fossil fuel-based power generation capacity in India will fall to around 55% by 2022 from the current 69%, assuming that current renewable energy expansion plans are implemented, and based on current capacity expansion plans for fossil fuel generation.

The most pronounced impact of rising renewable power in the energy mix will be on unregulated power companies. These companies are directly exposed to the market impact of environmental regulations—such as the clean energy tax—and do not receive the benefit of cost recovery from ratepayers.

This negative effect on unregulated power companies is already evident in more mature markets like Europe,where environmental policies to reduce carbon production have prompted investment in renewables at the expense of thermal generation,which has greatly increased installed total capacity relative to electricity demand.Excess supply has led to depressed prices and margins, resulting in the weakening of such companies' financial profiles.

The credit implications for individual Indian power generators will depend on their current and future generation mix, and how they adapt to the evolving policy environment. In Europe, rising renewable energy capacity coincided with lower GDP growth, and hence, lower overall power consumption growth, which was in turn, amplified by the introduction of energy efficiency measures in some countries.

A key factor required for the successful expansion of renewable energy capacity is the implementation of a clear policy initiative that supports long term investment decisions. Such a situation is especially important, given our estimate that at least USD200 billion will be needed over the next six years to meet India's planned growth of renewable energy capacity.

In addition to the UDAY scheme—which is aimed at reforming Indian power distribution sector—consistent government policies that aim to reduce risks during the project development phase,and provide greater visibility around electricity prices,will encourage growth of renewable energy capacity.

Furthermore,transparent and coordinated policies at a national and state level—with the objective of reducing uncertainties associated with regulation and project development—such as the process around land acquisitions, environmental clearances and connectivity to the grid—and future electricity prices will clearly encourage the sector's growth.Policy initiatives to broaden avenues of funding will also benefit the sector.

Domestic banks will continue to play a major part in financing India's renewable energy sector. However, greater diversity of financing, especially financing from institutional debt investors, will be key to addressing the capital needs associated with renewable energy.

Institutional investors are ideally suited to providing longer-tenor debt, because their liabilities match the long life of infrastructure assets, whereas bank lending tends to be limited to no more than 10 year.

However,policy certainty will be key to attracting significant institutional debt capital. A number of large institutional debt investors are targeting an increase in portfolio allocation to green infrastructure projects,and this focus will no doubt support the growth of renewable energy projects, if the policy environment continues to evolve in a positive way.

The substantial growth in renewable energy over the next 5-7 years will likely entail some missteps in project bidding. For example, the recent competitive bids for solar power—ranging between Rs 4.3 and Rs 5.1 per unit—were at a significant discount to the Central Electricity Regulatory Commission's normative solar tariff for FY2016. This situation heightens challenges associated with the viability of such projects.

In addition,solar independent power producers remain exposed to technical risks post commissioning,given the limited track record of imported solar photovoltaic modules operating in Indian climatic conditions,and uncertainty over warranty cover provided by the module suppliers.

So, it can be safely concluded that India is in the cusp of a great renewable energy revolution where heavy investments ranging from research and development to laying out integrated grids holds great potential in the foreseeable future.

In this research paper,we try to analyze critically the government's policies and it's impact on various stakeholders in the ever expanding arena of renewable energy.

Keywords: Renewable Energy Capacity, Indian Energy Sector Scenario

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Study to Increase Profit Margin by Adopting Solar Power Generation in EV Charging Station

Kanhaiya Jee[1], Akash Raval[2] and Akshay Solanki[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]kanhaiya.jpgp19@spm.pdpu.ac.in,
[2]akash.rpgp19@spm.pdpu.in,
[3]akshay.spgp19@spm.pdpu.ac.in

Abstract—The Indian automobile sector shares approx. 50% of the manufacturing sector and 7% of the total GDP of the country. The Indian government mission 2016-2026 initiated in 2015 aim to increase the total GDP share of automobile sector to 12%. Government is also working to make India a 5 trillion economy by 2022 which is of 2.5 trillion as of now. India is also shifting from BS-4 to Bs-6 by 2020 and government is aiming to shift totally onto electric vehicles by 2030. The main motto behind electric vehicle is sustainable development, decreasing pollution generated by emission and the dependency on world oil market. The decrease in emission by vehicle will reduce the sulphur, carbon and toxic gases. Saving environment is a very big challenge across the world and Indian government has also initiated to save environment. The oil import and oil price in international market is very much affecting the Indian currency.

So electric vehicle needs charging stations like fuel vehicles needs refueling stations. Big companies like Maruti and Toyota collaborated and they already started their project and by the end of 2020 they are planning to launch their 1st electric cars. So there is a very big charging infrastructure market for electric vehicles in India. But what happen to the fuel refilling stations which are already in market and will they accept or install charging stations too? What cost a charging station installation demands?

Charging infrastructure market for electric vehicles in India is because:

1. Counter air pollution with rising fuel price.
2. Policies of government such as FAME-1 and FAME-2 which is pushing people to adopt electric vehicles.
3. OEM investing in electric vehicles
4. Chance for FDI if foreign players enters the charging station market which will boost the economy also.

Companies Which Will be Involved: Automobile OEM's, power distribution companies, smart grid and smart city operators, EV charger supplier, EV charging set up provider, EV manufacturer, battery manufacturer, solar power project developers, research institutions, funding bodies like banks and finance groups.

So the present study aimed to know about the challenges and profitability of installation of charging stations. How they are different from the conventional gasoline filling stations and in how much time will they start making profits. This study also tells about the adaptability of the market. This study will also tell about the booming of battery market for electric vehicles and how stations manage their power generation. Study also give insights about the opportunity for both domestic and foreign players and how the increase in electric vehicles will increase electric demand and what are the roles of electric generation companies.

Keywords: Energy, Charging Station, Electric Vehicle

Feasibility Study of Constructing Solar Power Plants at Various Public Places

Prajakta Naik[1], Umang Trivedi[2] and Sumit S. Mehta[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management, Pandit Deendayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: [1]prajkta.npgp18@spm.pdpu.ac.in, [2]umang.tpgp18@spm.pdpu.ac.in,
[3]sumit.mpgp18@spm.pdpu.ac.in

Abstract—Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis.

It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air.

In today's era Solar power industry is one of the fastest developing industry round the Globe.

India's current installed capacity reached 30.071 GW as of 31 July 2019. India has the lowest capital cost per MW globally to install the solar power plants.

The Indian government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule. In 2015, the target was raised for sustainable renewable energy to 175 Gigawatt to be achieved by 2022, out of which 100 GW is for solar energy (including 40 GW from rooftop solar), targeting an investment of US$100 billion.

With about 300 clear and sunny days in a year, the calculated solar energy incidence on India›s land area is about 5000 trillion kilowatt-hours (kWh) per year (or 5 EWh/yr). The solar energy available in a single year exceeds the possible energy output of all of the fossil fuel energy reserves in India. The daily average solar-power-plant generation capacity in India is 0.20 kWh per m^2 of used land area, equivalent to 1400–1800 peak (rated) capacity operating hours in a year with available, commercially-proven technology.

People are a bit hesitant to adopt the rooftop solar plants as they occupy a lot of roof space. Also, due to the mindset of Indians, they are reluctant of giving away their roof space which is used in various ways round the year. This Problem can be Solved by placing solar panels at different public spaces. This study is focused to find out the Feasibility of Constructing Solar Power Plants using various Public Places. This will in turn also help in meeting India's solar energy target.

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Solar Rooftop Programme—A Paradigm of Climate Mitigation Action in Gujarat: Its Implementation, Finance and Contribution to Achieving National Targets of 2022

Shwetal Shah
Technical Adviser, Climate Change Department, Government of Gujarat and
Ph.D. Scholar, School of Liberal Studies, PDPU, Gandhinagar
E-mail: shwetal.sphd18@sls.pdpu.ac.in

Abstract—Solar Photovoltaic is known source of sustainable energy in increasing energy demand of present time. Solar energy received by the earth surface is more than the total energy required for human needs, the total potential of renewable energies seems to be almost infinite[1]. There are physical, technical, geographic, and financial constrains in tapping the entirely available potential of the Renewable Energy. However, it has been a topic of research and academia till the last decade of 20th century. It got the technical feasibility and commercial viability since last ten years only. This has been largely due to its large-scale adoption by utilities and the private sector. A number of drivers have accelerated the development and deployment of solar energy generation projects across the globe. These range from increased awareness of climate change hazards, energy security considerations, presence of facilitating policy and regulatory frameworks, decline in solar energy generation costs and emergence of new and innovative business models[2].

India is having one of the best potential of solar energy in the world, as it receives immense solar radiation throughout the year, and therefore it got a policy boost in recognition as climate change mitigation action in India's National Action Plan on Climate Change in 2008 under the National Solar Mission[3] (NSM).

As reported by the Renewable Energy Policy Network, the year 2017 was a landmark one for solar photovoltaics (PV), the world added more capacity from solar PV than from any other type of power generating technology. More solar PV was installed than the net capacity additions of fossil fuels and nuclear power combined. In 2017, solar PV was the top source of new power capacity in several major markets, including China, India, Japan and the United States. Globally, at least 98 GW of solar PV capacity was installed (on- and off-grid), increasing total capacity by nearly one-third, for a cumulative total of approximately 402 GW. The top five national markets – China, the United States, India, Japan and Turkey – were responsible for nearly 84% of newly installed capacity. On average, the equivalent of more than 40,000 solar panels were installed each hour of the year.[4]

Realizing its immense potential, Government of India has under taken an ambitious target of 1,00,000 MW (or 100 GW) solar power under the ages of the Ministry of New and Renewable Energy (MNRE). NSM had initial target of 20 GW of grid connected solar PV by 2022, which was immensely up scaled to 100 GW in 2015 along with cumulative Renewable Energy target of 175 GW by 2022. Which includes, 100 GW by Solar, 60 GW by Wind, 10 GW by Biomass power and 5 MW of Small-Hydro Power, for firming India's commitment towards climate actions. Furthermore, India made a sincere attempt globally in harnessing increasing potential of Solar Energy and it's financially viable technology by establishing an International Organization called "International Solar Alliance (ISA)"[5]. Many African countries are energy striving nations and have good potential of Solar Energy, therefore, they are getting practical advantage of ISA initiative, which is providing them cheap, environment friendly and easy to install option of Solar Power.

After announcing SRT target of 40 GW in 2015, Govt. of India revised financial allocation to SRT sector of the 12th Five-year plan from Rs. 600 Crore to 5000 Crore[6]. Under this scheme, MNRE gives certain subsidies for SRT installations residential, institutional (hospital, educational institutes) and social sector, but do not provide subsidy for industrial and commercial establishments. After limited success of SRT till 2018-19, MNRE again enhanced financial allocation for the SRT sector. Now, during 2019 to 2022, 38000 MW of SRT is required to achieve, for which

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allocation of Rs. 11,814 Crore is envisaged[7]. Out of which for 4000 MW of SRT in residential sector, Rs. 6600 Crore is planned as Central Financial Assistance (CFA), and rest is earmarked for assistance to DISCOM directly based on their performance in SRT sector.

Gujarat being a progressive State, took this initiative further and announced, first of its kind MW scale Solar Policy in 2009, with attractive financial incentives. This policy was a remarkable success in demonstrating possibility of large scale power generation through Solar Park and innovative projects like Canal-top Solar. Solar Rooftop (SRT) was not much encouraged in 2009 policy, but, comprehensively introduced only in the revised and updated version of Gujarat's Solar Policy of 2015 edition. Thus Solar Rooftop programme got recognized only after Solar Policy of 2015, as it allowed installation of as small as 1 KW Solar PV Plant. However, availability of bi-directional meter and cap of 50% of connected load for Solar Rooftop capacity become the barrier in the natural growth of Solar Rooftop in Gujarat. In 2017, only in residential Sector the cap of 50% of connected load was removed[8], and therefore, this sector got some momentum after this policy modification. However, there is a cap of 50% connected load in the rest of the sectors like Social, Institutional, Commercial and Industrial, however, recently in September 2019, the upper cap of 50% is removed for MSME Consumers[9].

Moreover, in Gujarat, since 2016, Climate Change Dept. of Government of Gujarat is giving additional subsidy of Rs. 10,000 per KW and up to Rs. 20,000 per beneficiary in residential sector, through Gujarat Energy Development Agency (GEDA), which makes installation of SRT at household level a highly viable option. Since then the SRT is growing rapidly in Gujarat because of Central Financial Assistance (CFA) and additional subsidy of the State Government, still it is challenging to achieve the desired ambitious result due to several reasons. This paper examines SRT's growth limiting factors, suggests recommendations to overcome the hindrances and outlines way forward to attain climate change concerns through mitigation actions.

Keywords: Solar Rooftop, India Renewable Energy Targets, Gujarat Solar Policy

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SECTION–II

OIL AND GAS BUSINESS: CHALLENGES FOR INDIAN ENERGY MARKET

Artificial Intelligence and Machine Learning in Oil and Gas Industry

Hardik Patel[1] and Dr. Sudhir Yadav[2]
[1]M.B.A. (Energy & Infrastructure) Student, School of Petroleum Management,
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India
[2]Professor, School of Petroleum Management, Pandit Deendayal Petroleum University,
Gandhinagar
E-mail: [1]hardik.ppgp18@spm.pdpu.ac.in/ hardikkpatel1996@gmail.com,
[2]sudhir.yadav@spm.pdpu.ac.in

Abstract—21st century is the era of technology and digitalization. Today every industry is using artificial intelligence and data analytics for gaining the more insights about business and for increasing the efficiency as well as effectiveness. Oil is considered as black gold and the prices of oil are volatile and due to that oil exploration and production industry as well as companies in midstream and downstream sector are always at risk. Today Oil and Gas Industry is facing challenges in terms of operations and managing profitability. The paper discusses the role of artificial intelligence and machine learning in increasing the operational efficiency in oil and gas sector. Artificial Intelligence and machine learning can be the solution for problems and challenges faced by the oil and gas sector in upstream, midstream and downstream. The paper also aims to study how artificial intelligence and machine learning can be used to predict the availability of hydrocarbon reserves underneath the land as well as ocean.

The paper further discusses various tools of AI and ML which help reduce risk and improve productivity. Robots designed with AI capabilities for hydrocarbon exploration and production, to improve productivity and cost-effectiveness while reducing worker risk. The paper also discusses about DCS (Distributed Control Systems) and SCADA (Supervisory Control and Data Acquisition) system which is installed on the top of the assets continuously generate data to be further analyzed to increase the operational efficiency. Thus this paper aims to study how the artificial intelligence and machine learning can be used to increase the efficiency and effectiveness in upstream, midstream and downstream sector of oil and gas industry.

Keywords: Oil and Gas, Artificial Intelligence, Machine Learning, Operational Efficiency

INTRODUCTION

Artificial intelligence (AI) and Machine Learning (ML) has been under rapid expansion in recent years, promising to change everything from how we live to the ways companies work, create value, and serve consumers. The reasons of rapid expansion—increasing processing and storage power, abundant data availability, and AI algorithmic advancements—are well known, the effects are not. Few organizations are "AI-ready."

There is often hype about the capabilities and benefits when it comes to new technologies. But for machine learning and artificial intelligence opportunities and benefits are still under hyped. Generally, the impact of new technologies is overestimated in short term and underestimated in long term. Nowadays, there is a lot of talk about Artificial Intelligence and Machine Learning but there is requirement of in-depth knowledge and understanding about AI and ML and how it is going to impact the business. Majority of the organizations are not exploiting the potential of AI/ML, they are just at the beginning of their AI/ML adoption. Lack of talent is one of the major issue due to which organizations are holding back from adopting Artificial Intelligence and Machine Learning.

There is less investment in digital and AI/ML related technologies in oil and gas sector compared to other sectors such as automobile, banking, retail, healthcare, and information technology. This is partly because it's seen as risky, unproven technology and it requires highly skilled programmers and data scientists.

It also requires a substantial amount of investment for long term which many companies are not in position to afford during the downturn. Early adopters of these technologies are the one who are comfortable with the standardized data sets and related terminologies. In the O&G industry, several AI applications have already emerged. Other industries have also made advances that can be transferred to O&G.

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Machine learning and Artificial Intelligence allows computers to act like an human brain and make decisions to solve problems with the help of large volume of data. Both Artificial Intelligence and Machine Learning are designed in such a way that they can learn and improve as an when data is provided from the database or data warehouse. Therefore it gets better continuously at forecasting the outcomes based on the new data without explicit programming.

It may seem like science fiction movie that a computer has ability to assess and solve a problem without human intervention, which is the case for general AI rather than applied AI. General AI has the characteristics of human intelligence including ability to plan, recognize object, reasoning, natural language processing. Today, most of the Artificial Intelligence applications focus on applied AI rather than general AI. Applied AI is a form of Artificial Intelligence that replicate some form of human intelligence for special purpose and that purpose can be solving a specific problem in oil and gas exploration and production industry.

Artificial intelligence and machine learning can be understood breaking down the difference between intelligence, knowledge and learning. Learning and knowledge are the components of intelligence. Let's take an example, wherein you are supposed to solve a problem such as fixing a flat tyre of your car. In order to solve this problem, you need intelligence which includes knowledge and ability to learn. Knowledge is having solved the problem earlier and knowing the discrete steps to solve the problem again. However, learning does not necessarily require that you had solved that problem before. If you can learn then you possess the ability to solve problem. Learning is often considered a framework wherein you can bring similar experiences and then develop the discrete steps to solve a dedicated problem. The historical approach for computers to solve problem was a knowledge based approach which would be a rule based approach with millions of lines of code to solve the problem. An approach with help of AI can include discrete rule based framework but it also could include code giving software an ability to learn and assess circumstances in order to solve the problem more efficiently.

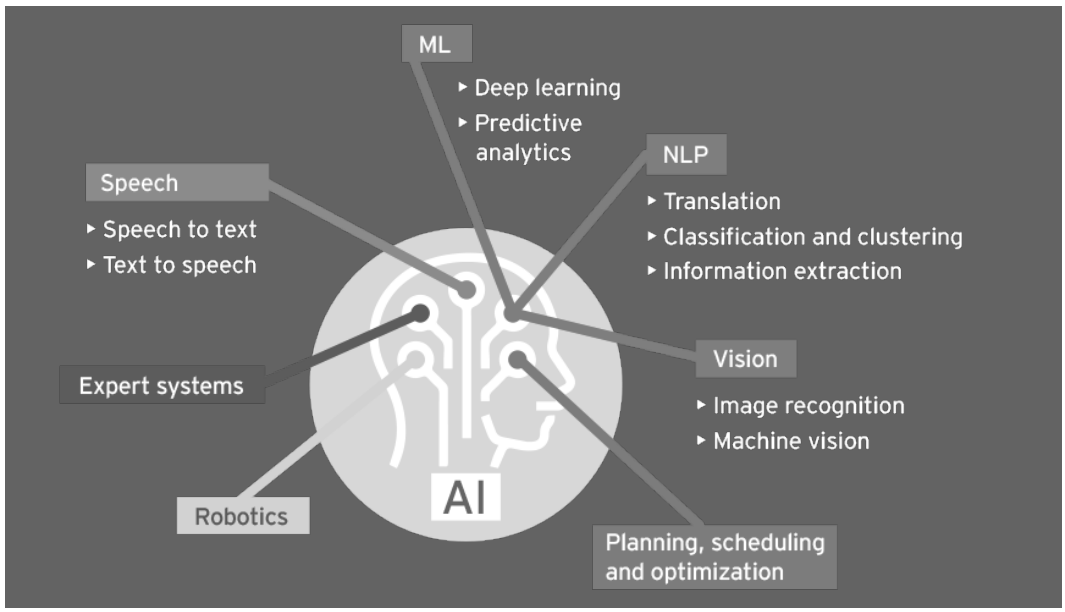

Fig. 1: Artificial Intelligence

DIGITAL INITIATIVES IN OIL AND GAS INDUSTRY

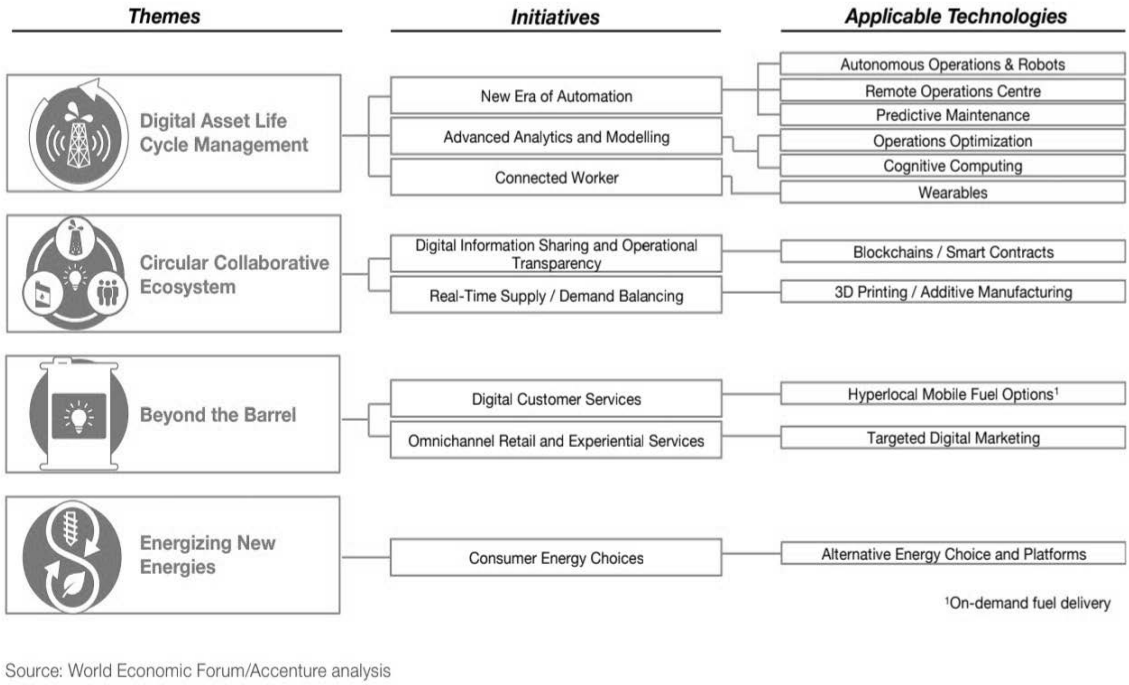

Fig. 2: Digital Initiatives in Oil and Gas Industry

Digital Asset Life Cycle Management: Latest digital technologies along with insights from data can transform operations activities, help in boosting agility and strategic decision making and that results into new operating model.

Circular Collaborative Ecosystem: Integrated digital platforms can be used to enhance collaboration among ecosystem participants, reduction in cost, fast track innovation and increased operational efficiency and effectiveness.

Beyond the Barrel: New opportunities for oil and gas operators and new services for customers can be opened up with the help of innovative customer engagement models that offer flexibility and personalized experience to customers.

Energizing New Energies: The digitalization of energy sector promotes new energy sources and supports innovative models for optimizing and marketing energy. Oil and gas industry needs to understand the impact of this technological change on the energy system to remain relevant to customers.

AI/ML OPPORTUNITIES IN OIL AND GAS

There are number of sectors that have invested heavily in the AI/ML value proposition, but the oil and gas sector is lagging behind. The lack of progress in oil and gas shows that there is possibility of opportunities. There are ample of opportunities in oil and gas sector to increase the operational efficiency and cut down the cost. The following are just a few examples where AI/ML could be applied immediately to drive business value.

INTELLIGENT ROBOTS

Robots are designed with artificial intelligence capabilities for upstream exploration and production to improve the productivity, efficiency, effectiveness and cost reduction and also reducing the risk of people

working over there. In December 2016, ExxonMobil announced that it is working with MIT to design AI robots for ocean exploration. While the business advantage of using artificial intelligence in deep sea exploration may not be immediately apparent, the company aims to apply artificial intelligence to boost its natural seep detection capabilities. Natural seeps took place when oil escapes from the rock found underneath the ocean floor. In North America, around 60 percentage of oil underneath the earth surface is due to natural seep. Robots with AI capability can help to detect oil seeps and contribute to protect the ecosystem and serve as indicators for robust energy resources. Intelligent robots can also be utilised in unmanned upstream exploration offshore site wherein you don't require any person to be present to carry out activities related to upstream operations. Health, safety and environmental aspects of offshore exploration and production can be managed efficiently with the help of intelligent robots.

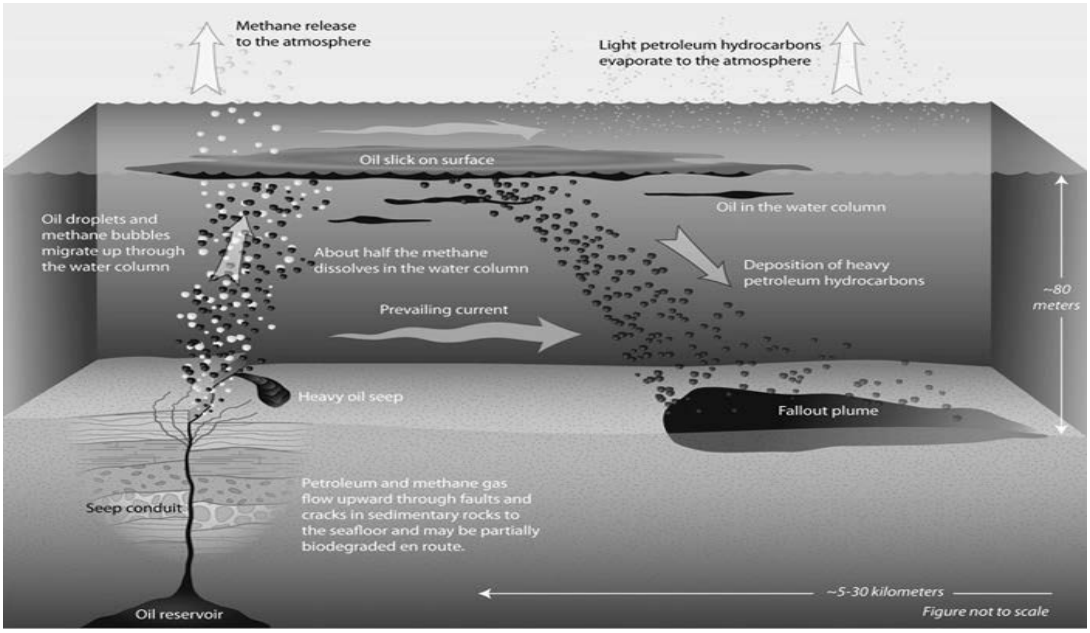

Fig. 3: A Visual Depiction of Natural Oil Seeps

FINANCE

In oil and gas sector, complex accounting is involved where you need highly qualified accountants who moves fund around through cost accounting and cost allocation processes. These activities are cumbersome and time consuming. Oil and gas business is very capital intensive so it is required to make decisions very carefully so that the invested amount do not turn into losses. AI/ML tools could be programmed and taught to learn have a look at the cost and help to redeploy the specialized accountants to more value added analysis, insights and helpful in making informed decision with the help of artificial Intelligence and machine learning techniques. Managers can use dashboards and reports generated with the help of these technologies and make informed decisions and also predict the future cash flow wherein they can also make decision related to future investment.

MAINTENANCE

In oil and gas sector, lot of equipment and tools are being utilized in upstream exploration and production as well as in midstream and downstream sector. Sensors can be placed for collecting the data from each and every equipment wherein this data can be utilized for further analysis and also can be used for preventive maintenance. Breakdown maintenance is very costly and it increases the downtime so it is better to utilize AI and ML techniques to carry out preventive maintenance and also it can be used for predictive maintenance where it predict the time for which the maintenance is supposed to be carried

out and when it is more cost effective. It ultimately reduces the cost of maintenance and also downtime so it helps in increasing the efficiency and effectiveness of the tools and equipment used. It helps to identify the fault in pipeline such as leak, corrosion if any. Drone Technology can be used for monitoring of cross country pipelines. Artificial Intelligence and Machine Learning techniques can be used in refinery to carry out preventive as well as predictive maintenance so that the downtime of refinery can be reduced and it can be worked more efficiently and effectively.

Portfolio Management

It is known that oil prices are very volatile and subject to various factors like geopolitics, economic downturn, trade war etc. In Oil and Gas sector, Larger companies with strong balance sheets generally acquire the assets and entire companies from the smaller in-distress organizations. Executive constantly evaluating their portfolios, trying to make high stake decisions on what to buy and what to sell. Artificial Intelligence and Machine Learning can help executive to assess the historical performance of the target companies and also help to evaluate key metrics like financial statements, financial ratios, and identify the opportunities and make recommendations to buy or sell decision. It influences the various aspect of portfolio management process. The financial institution Blackrock Inc. is applying AI/ML techniques to consistently meet client's investment goals by reducing return volatility and bringing generic value to their portfolios.

Data Analysis

Oil and gas companies employ skilled geologists, petro physicists and geophysicists who analyze complex geological rock formations and well data. To assess where the hydrocarbons can be found and assess specific volumes (proven, probable and possible), these professionals use complex modeling techniques and software. AI/ML, working in tandem with humans, might be able to process the data in more efficient ways, find correlations and develop better recommendations on whether to explore and develop further or walk away, either saving or creating investment value. Mine Portal by Data Cloud is a cloud-based AI platform that does exactly this by analyzing geosciences data by integrating exploration and production (E&P) drill data, block models and control measures into one platform. Data generated from various sensors attached to the devices and equipment can be further analyzed to make informed decisions and to make equipment's working more efficient. SCADA (Supervisory Control and Data Acquisition) and DCS(Distributed Control System) system can be employed so that we can have real time data from the various equipment and that data can be utilized for future analysis.

Health, Safety and Environmental Aspect

Safety is a primary concern in Oil and Gas sector as it involves heavy equipment and machinery in upstream exploration and production as well as transporting people via helicopter to offshore platforms. Oil and gas companies consider safety as one of their prime concern. Many companies have deployed safety management system, behavior driven activities and embedded safety leadership in their operating business unit. Risk management system is being developed which helps to identify the potential hazards and how to mitigate the risk. AI/ML or deep learning has the potential to assess the data and learn from it over period of time to drive deeper insight to root causes and which can further utilized to make better preventive decisions.

Inventory Management

Artificial Intelligence can be helpful to eliminate the need of any inventory checking manually. It can be helpful to use manpower and resources of the organization somewhere else and that too more efficiently. In Oil and Gas sector, oil field services (OFS) companies need to manage their inventory more efficiently

and effectively so that they can have higher return on capital employed. In downstream sector, it is required to manage inventory of various petroleum products like MS(Motor Spirit), HSD(High Speed Diesel), lubricants, LPG, gear oil, FO(Fuel Oil) so that holding cost and ordering cost can be optimized. AI/ML can be used for forecasting of demand of various petroleum products more accurately and which in turn helpful to have inventory accordingly.

CONCLUSION

Oil and Gas sector faces various challenges like reducing cost, increasing speed and quality of decision making and building new capabilities that scale is going to be the difference between surviving and thriving. AI and ML solutions can be useful in labor intensive and manual activities that involve large amount of data which can be analyzed with the help digital technologies. These tools have the potential to help the sector find ways to augment the existing workforce, driving better and faster decision-making, leveraging the huge amounts of data and analysis that is required to explore, exploit and operate oil and gas wells and facilities in game-changing ways. To implement Artificial Intelligence and Machine Learning in organization takes lot of effort, willingness to fail and capability to rethink. Leaders of the Oil and Gas industry has opportunity to be a ahead of the competitors with the help of AI and ML implementation and utilizing the AI/ML in more efficient ways to drive business value.

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Maximizing Assets Value by Digitalisation and Overcoming Challenges in Energy & Infrustructure Managemenent in Oil and Gas Industries

Shibaji Bhaumik
M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Technology,
Pandit Deendayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: shibaji.bbt18@spt.pdpu.ac.in

Abstract—We are at 21st century the age of Data. Today we are so advanced, in each and every field AI, machine learning has evolved and took an important place. In petroleum industries somehow, we lack new technologies in order to save money. Human safety is given as no.1 priority in oil & gas industries and this safety can have more efficiency if we add AI & machine learning to it.

The work environment of the Oil & Gas industry is considered very difficult and highly risky in terms of safety and occupational hazards. The professionals employed in upstream (exploration and production) industry work under difficult work conditions e.g. adverse weather, risk of fire, gas leakage, oil spill, unexpected technical failures to name a few. Another important stressor is physical and social isolation; as most of the workers and professionals are located in remote locations (mostly on seashores or deep-sea oil installations). They are far away from their family, no social contacts with their friends and family, and work for continuous long hours in very crowded work stations (oil rigs). The combined impact of crowding and social isolation leads to workplace aggression and bullying behaviour in some cases (Warren Shepell Report 2005). There are complaints of psychosomatic health problems, sleep disorders, sea sickness, alcohol and drug abuse, smoking and obesity naming a few, among oil professionals (Parkes 1998).

Error made by human results in devastating effects to nature eg. piper alpha platform accident, deep water horizon. This little error can be minimized by using new modern technologies.

The infrastructure management plays a great role in oil and natural gas industries.

Quote “It is the capacity for maintenance which is the best test for the vigor and stamina of a society. Any society can be galvanized for awhile to building something, but the will and the skill to keep things in good repair day-in and day-out are fairly rare.” By Eric Hoffer.

The cost of infrastructure monitoring and management like license cost, product maintaince, dedicated hardware, installation, training cost.

The way we can increase infrastructure management are virtualization, automation, infrastructure consolidation managing service level agreements, increase data centre efficiency in terms of energy, improved data centre efficiency in terms of energy, improved data center availability & improved data centre manageability.

Change in geography also change the working environment. In india the oil and gas market is dominated by govt companies.

Digitalization can help in improving Efficiency, Safety and Environment protection in oil and Gas sector. A case study shows how advanced condition monitoring technologies—plus analytical expertise—can optimize maintenance of mission-critical equipment in offshore environments, while lowering costs and improving safety.

1. Data-driven remote conditioning, monitoring, optimizes offshore maintenance reduces costs.
2. Remote Condition Monitoring
3. Support for low-manning platform

Keywords: Human Error, Safety Management, Digitalization and Social Development

Multiple Zone Well Completion Technology: Challenges in Technology Commercialization

Supratik Dass[1], Prerna Bhushan[2] and Mansi Rai[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deendayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: [1]supratik.dpgp18@spm.pdpu.ac.in
[2]prerna.bpgp18@spm.pdpu.ac.in
[3]mansi.rpgp18@spm.pdpu.ac.in

Abstract—A majority of the world oil production is extracted from matured fields. The recovery factor from mature fields under primary and secondary production has become a major concern for the industry as it will be critical in meeting the growing energy demand in the coming years. Hence, the need for Improved Oil Recovery methods are evident to meet energy demands in coming years.

Over the years, several techniques for multiple zone well completions were evolved in the oil industry but due to some or the other reasons the popularity of multiple zone well completions lost. Earlier attempts for multiple zone completions were to use multiple tubing completions and commingling large number of reservoirs. Now a new concept of well completion is available in which all the advantages of multiple tubing completions and commingle production can be retained with a single tubing well completions. The name of the concept well is DASS well. DASS well stands for Dynamically Active Super Solution wells. The well architecture is radically different from existing well completions.

As part of the research paper we present a comprehensive analysis on the challenges faced to commercialize the new multiple zone well completion technology. As part of the research we will be analyzing the strategies to overcome the challenges faced by the new technology. The research will also focus on the opportunities the new technology has over other oil exploration technologies.

Keywords: Improved Oil Recovery, Multiple Zone Completion, Recovery Factor

A Qualitative Study on CGD Companies, Allocation Policy of Domestic Natural Gas by MoPNG and How it Will Cater in Near Future with Upcoming New Geographical Areas Along with Changes in Pricing Policy

Arpan Barooah
M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deendayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: arpan.bpgp18@spm.pdpu.ac.in

Abstract—To have a natural gas-based economy in India and enhance the contribution of gas in the energy basket to 15%, the Government has envisaged developing additional 15,000 km of gas pipeline network. At present, the gas grid within the country preponderantly connects the western, northern and south-eastern gas markets with major gas sources. As a commitment to produce the clean energy throughout the country, the govt. has approved a capital grant of 5176 Cr.

The objective of the paper is to present Natural Gas sourcing plan adopted by CGD companies, Demand Estimation for a particular G.A. Gas Sourcing Cost estimation for that G.A on Y-O-Y basis from the first year of allocation through Weighted Average Cost of Gas (WACOG).

The paper also aims to discuss current gas allocation policy by MoPNG to CGD companies for Domestic and CNG segment customer and how it will change in near future with upcoming new G.A's and CGD companies and its impact on customers.

Keywords: Natural Gas, CGD, Gas Pricing and Allocation Policy, Impact of Upcoming CGD Companies on Allocation Policy of Gas and Pricing Effect on Customers

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Digitization in Oil and Gas Industry

Vishwa Bhatt[1] and Dhaval Deshpande[2]
[1,2]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: [1]vishwa.bpgp13@spm.pdpu.ac.in,
[2]dhaval.dpgp18@spm.pdpu.ac.in

Abstract—Since the commercial revolution, the Oil & Gas enterprise has performed a pivotal function in the monetary transformation of the sector, fuelling the need for heat, light and mobility of the world. Today the Oil and Gas sector has the opportunity to redefine its boundaries through digitization. After a length of falling crude prices and, frequent budget and schedule overruns, collectively with extra demands of climate alternate duty and difficulties in attracting skills, the Oil & Gas industry can provide realistic solutions. Digitization can act as an enabler to address these challenges and offer ease to all its stakeholders. While digitization will be a source of tremendous exchange, there are a number of challenges that want to be triumph over to recognize its full capability for each business and society. In a few instances, the gains from digitization have been inequitable with the benefits no longer achieving individuals who want it maximum. At the same time, the exponential boom in global statistics flows has created new risks round statistics privacy and security. In this paper we will see how latest technology and digitization have made operations in Oil and Gas industry more efficient.

The Oil and Gas industry is no stranger to big records, technology and digital innovation. As early as the 1980s, Oil and Gas organizations started to undertake virtual technologies, with a focus on better expertise a reservoir's aid and production ability, improving health and protection, and boosting marginal operational efficiencies at oil fields round the sector. A wave of digital oilfield initiatives swept via most of the enterprise in the Nineteen Nineties and the early a part of this century. However, for most of this decade, the industry has now not taken gain of the opportunities that derive from the use of data and era in a significant manner. A single drilling rig at an oilfield, as an instance, can generate terabytes of statistics each day, however handiest a small fraction of it's miles used for choice-making. As different capital intensive industries (which include aviation and automobile) have revolutionized their operating models via a holistic utility of virtual technology, the possibility for the Oil and Gas industry to leverage the transformational impact of digitalization has turn out to be successful.

Review on the Optimization and Cross Pipeline Network Design

Bharat Sharma[1] and Sunil Kr. Khare[2]
[1]Department of Petroleum and Earth Science, UPES Dehradun,
Assistant Manager, Business Development & Technical Services, HPCL, Mumbai
[2]Department of Petroleum and Earth Science, UPES Dehradun
E-mail: [1]bharatpsu@gmail.com

Abstract—Refined petroleum product transportation has greater importance for oil and gas industry; so, this transportation should be carried out efficiently. The foremost transport modes includes pipeline, railway, waterway and road. Compared with different transportation modes, pipelines have the benefits of being capable to deal with huge volumes, having precise continuity with 24-hour uninterrupted transportation, being unaffected by climate conditions in the transportation process, secure way and having a low unit freight transportation cost. Capital costs are usually very high for such networks and it is therefore sensible that they are designed to give maximum value for the money invested. Certainly multi-objective function optimization of pipeline design and operation has gained attention of various researchers over the past few years. It is combination of various problem statements like optimal gas distribution, potential expansion of existing pipeline network, strategic load scheduling with appropriate management of pumping units and pipeline pressure, optimization of power consumption according to required flow rate, tariff calculation, along with linear-nonlinear constraints. This paper critically reviews methods available to solve these complex problems and provides summarized comparison in terms of their computational efficiency and limitations. Methods discussed are Mixed-Integer Nonlinear Programming (MINLP), Generalized Reduced Gradient (GRG) and stochastic Techniques such as Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Genetic Algorithm (GA) & hybrid algorithms. Such comparative assessments will assist pipeline operators in taking rational decision over its prerequisite problem statement.

Keywords: Pipeline Network, Multi-Objective Design, Optimization, Compressor Stations

Plastic Control Measures Including Bans and Impact Analysis on Petrochemical Industry in Future

Sandeep R. Thawani
MBA (Energy & Infra.) from SPM, PDPU & B.E. (E.C)-RPGV
E-mail: sandeep.r.thawani@gmail.com/ sandeep.thawani@opalindia.in

Abstract—Plastic Industry occupies significant share in developing any country's economy. In India alone it contributes to Automotive, Construction, Electronics, healthcare sector etc with over 30,000 processing units producing various plastic end items.

Current per capita consumption of Plastic (11 KG) which is lower than Global average. The plastics processing industry registered growth from 8.3 MMTPA to 13.4 MMTPA, as per a 2017 report by FICCI. It will be further estimated to cross 20 MMTA by 2020. An increase in the consumption of plastics has resulted in a rise of plastic waste as proper measure & technology of plastic recycling are yet not in place. Various government of various countries including India are taking various policy initiatives in curbing plastic pollution e.g. In 2018, as the global host to UN World Environment Day, India had promised to phase out single-use plastic by 2022 with the theme 'Beat Plastic Pollution'. Packaging and single-use items currently represent 38% of global demand for plastics.

Hence, various initiatives of controlling plastic pollution and plastic bans has significant impact to exiting plastic processing units as well as petrochemical manufactures, we supply main feedstock these processing units. In the time when both private and Govt promoted Oil & Gas players both globally and India have identified & already planning to expand and/or invest in Petrochemical plants as demand of their existing finished product in form of fuels is likely to go down with more electrical vehicles to come on roads in coming decade, understanding what shall impact to Petrochemical demands in coming time needs to be critically studied.

This Research papers shall give highlights of existing Plastic consumption pattern and petchem manufacturing capacity in India, various pollution control measures including ban on selected types of plastic usage at national and International level with impact on its consumption pattern & Petchem Industry during short, Mid-term & Long-term period.

Keywords: Plastic Consumption Pattern, Plastic Pollution Control & Bans, Impact on Petchem Industrys

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SECTION–III

ENERGY ECONOMICS & EMERGING BUSINESS TRENDS FOR ENERGY & INFRASTRUCTURE SECTOR

Landfill Mining: Case Study of Pirana Dump Site

Helly K. Gandhi[1], Akshat K. Patel[2] and Dr. Devanshu Pandit[3]
[1,2]Student, Faculty of Technology, CEPT University
[3]Professor, Faculty of Technology, CEPT University

Abstract—Ahmedabad dumps 3500-4000 MT of waste is dumped at Pirana since 1980 which has resulted in 80 lac MT garbage mountains that deteriorates air quality, causes water pollution, and land is degraded. It is further causing health problems for the people living in the surrounding area. Ahmedabad Municipal Corporation has undertaken bio-remediation of this legacy waste since last six months, and initial results of simple trammel operation are encouraging, and it is expected that the entire site will be cleared in a period of about 4 years. This case study documents the process and management adopted by AMC in treatment and disposal of waste. This study may be useful to ULBs in effectively planning the management of waste.

Keywords: Municipal Solid Waste (MSW), Ahmedabad Municipal Corporation (AMC), Bio-Mining, Waste Treatment

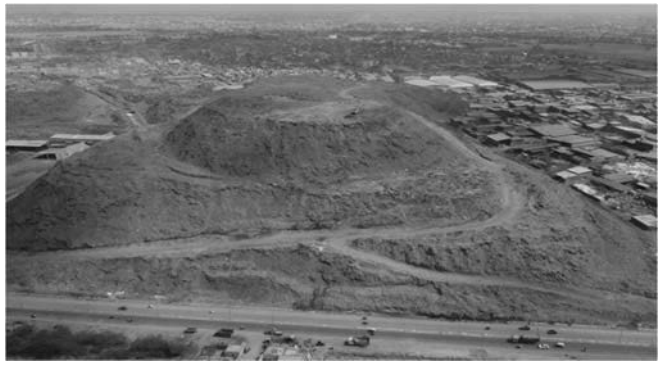
INTRODUCTION

As per Central Pollution Control Board (CPCB) of India, more than 4000 legacy waste dump sites in India needs immediate remediation to comply with MSWM Rules 2016 and curb harmful impact of waste on environment (NGT, 2019). National Green Tribunal (NGT) of India in its order O.A. No. 519/2019 dated 17.07.2019 has stated that dump sites remediation should start at the earliest. It also directed to identify and standardized technologies, their cost breakups for operation and maintenance, and suggested that business models and associated procurement processes be identified and standardized. NGT has also asked to identify and empanel service providers.

Lack of scientific management of waste has compromised the environmental condition of the city by deteriorating quality of air, ground, and leachate is polluting ground water too. Due to the continuous physical, chemical and microbial processes occurring at the land fill, gas is generated. This landfill gas consists of 50% of methane gas and 50% of carbon dioxide and other gases such as hydrogen sulfide (H2S) which causes foul smell. Methane gas is one of the contributors of greenhouse gas which is responsible for global warming. (Garg & Bhargava, 2013). According to National Clean Air Program (NCAP), two cities of Gujarat i.e. Surat and Ahmedabad have been included in one of the 102 non-attainment cities which are recognized for implementing mitigation actions due to poor air quality of air (NCAP, 2019). Continuous fire on MSW due to the exothermic reaction results in formation of methane gas which is another important reason for the poor air quality. There is increasing demand of water in urban as well as rural areas causing scarcity of water, the situation has worsened due to leachate polluting ground water. There is a tremendous pressure from people, media, judiciary, and government regulatory authorities to clear Pirana dump site.

Ahmedabad is fifth most populous city of India with amount of waste generation of 3500-4000 Metric Tons per day. While Ahmedabad Municipal Corporation (AMC) has several waste treatment plants; their operational efficiency is not matching with the waste generation rate that has resulted in Ahmedabad's in-famous Pirana Waste Mountain. Municipal solid waste is being disposed here since 1980 (SWM Department AMC, 2019). Ahmedabad is having spread of 464 Sq. Km. which dumps its waste in 0.84 Sq. Km. of area of Pirana dump site. It is estimated that total MSW accumulated at the site is more than 80 lac MT as legacy waste in three dump mounds (SWM Department AMC, 2019).

AMC has set up a scientific landfill site at Gyaspur, however due to technical issues related to leachate management it is not in use since its construction in 2009. AMC is planning to revive it soon considering huge requirement of dumping the inert waste generated from clearing Pirana mounds.



Source: AMC

Source: Google Maps

Fig. 1: Arial View of Pirana Waste Mounds and its Spread

The present case study was undertaken for studying the process of clearing the accumulated waste, properties of the post processed product i.e. RDF and compost, and to evaluate the time required for its closure. The study also looks at the overall effectiveness of the bio-mining activity undertaken by AMC. Considering the process has just started, the assessment can be considered as preliminary and may get strengthened with further research, which is continued.

LITERATURE REVIEW

LANDFILL MINING

Legacy waste needs to be cleared from the environmental point of view. Single largest financial benefit of undertaking a landfill mining is the land reclaimed. Landfill bio-mining scores high on this aspect over bio-capping. Apart from value of the land reclaimed, two major benefits are recyclable materials recovered, and combustibles obtained. Combustibles are taken away by industries to use as a refuse derived fuel (RDF) as it is happening in Ahmedabad. Gross calorific value of the RDF obtained from Ahmedabad solid waste is 3000-3500 K.Cal/Kg (BEIL, 2016). Neutralization of extremely potent pollutant responsible for environmental degradation of land, water and air is probably the most significant benefit achieved by undertaking landfill mining (Dubey, Chakrabarty, & Pandit, 2015). A study carried out in Indonesia revealed that potency of soil material from landfill mining is about 40–83%. Such soil has hardly any application other than use as a soil cover for the active landfill due to contamination (Darwati, 2012). The reclaimed land was used to create another landfill cell.

CASE STUDY OF KUMBAKONAM MUNICIPALITY RECLAIM GARBAGE LAND

Situated in the state of Tamil Nadu in Thanjavur district, 10.5 acres of land is used to dump the waste out of which 7.5 acres have been occupied. City generates 70 MT waste in a day. As waste got accumulated to a height of 7 mtrs. In order to avoid problems of waste dumping in future process of bio-mining was introduced. Tender was floated and the process of bio mining was undertaken.

INDORE'S RISE TO TOP OF SWACHHTA RANKING

Indore is regarded as commercial capital of Madhya Pradesh state in India. In 2014 cleanliness survey by Government of India, Indore ranked 149th. Indore brought in multiple reforms in their systems to become top ranking city in Swachh Survekshan 2017. Indore has maintained its position in 2018 and 2019 too. It is identified that bringing change through effective IEC activities, effective collaboration with corporates to reap benefits of companies corporate social responsibility initiative, and effective

stakeholder management can be attributed to Indore's success (Nidugala and Pant, 2018). Indore is also clearing its legacy waste through simple trommeling activity.

Successful bio-mining in Kumbakonam and Indore helped develop a concept of implementing bio-mining at Pirana dump site.

CASE STUDY OF LEGACY WASTE TREATMENT AT PIRANA, AHMEDABAD

Case study of Pirana for case study of Pirana data secondary data was collected from the reports, publications and presentations of AMC; Central Pollution Control Board reports; and research papers. Primary data was collected by visiting the Pirana landfill sites multiple times, interacting with AMC officers and supervisors, interview of waste processing operators.

Waste Collection Practice by AMC

AMC has adopted 'door to door' waste collection method since 2009. Immediately after effect of MSWM rules 2016, AMC implemented door to door collection of segregated waste at the source. AMC has purchased 1000 community vehicles (EURO-4 type) for the collection of dry and wet waste separately which functions for 48 wards (AMC, 2018). Although theoretically AMC has provided waste segregation, at practically much has to be done for awareness of people about waste segregation.

The vehicles start its function every day from 7:00 A.M. up to 1:00 P.M. Average 1200 MT waste is collected by door-to-door (D2D) method. The collected waste is then transferred to the transfer station. To make the waste collection more efficient, cost effective and to make the maximum use of the vehicles provided, AMC has planned and divided route of vehicles. AMC has constructed refuse stations where in the daily collected waste is dumped and is transferred into the bigger vessel with higher capacity. The transfer stations are divided based on the zones. For East zone, station at Naroda and Rakhiyal is provided. For North zone, it is provided at Sola. For new north zone, station at Sola is provided. For East zone, station at Vadaj is provided. For Central zone, station at Kankaria is provided. The waste is carried by bigger trucks or hook-loader trucks towards the Pirana, which is weighed and it is handed over to the contracted agencies for its further treatment (AMC, 2018). The remaining waste other than the waste given to agencies is dumped at the Pirana.

Waste Treatment by AMC

AMC has done partnership with various companies to treat MSW since year 2000. Over the years more and more partners were added. All the partnership models are of DBFOO type. The existing waste treatment capacity of AMC partners is given in Table 1.

Table 1: Existing Waste Treatment Capacities

Sr. No.	Name of Company	Capacity	Type	Award Year	Agreement Duration	Land Allotted	Project Capital Cost	Operational Since
		(TPD)			(Years)	(Acres)	(Rs. Cr.)	
1	Excel Industries Ltd	300	Compost	1997*	15	25	15.00	Jan-00
2	Bharuch Enviro Engineers Ltd. (BEIL)	250	Compost, RDF	2007	25	15	25.00	Jul-09
3	Creative Eco-Recycle Port Pvt. Ltd.	400	Compost, RDF	2009	25	12.5	50.00	Dec-12

Table 1 (Contd.)...

...Table 1 (Contd.)

4	Amdavad Enviro Projects Pvt Ltd	300	C&D waste	2012	30	5	7.50	Dec-13
5	Abellon Clean Energy Ltd.	1000	W2E	2017	29	13	211.62	Apr-19
6	JITF Urban Infrastructure Limited	1000	W2E	2016	30	14	122.80	Apr-19
	Total	3250						

*renewed in 2013 for another 15 years.
Source: (AMC, 2017)

In addition to above there are two 1 MT capacity green waste to compost plants are set up on PPP basis. A material recovery facility in partnership with NEPRA is under pilot study and is expected to be up scaled soon. The above list does not include plants which have failed and their contracts are cancelled by AMC.

Process Studied at BEIL: Operational since 2009, this plant converts waste to compost and generates Refused Derived Fuel (RDF). Here, waste is kept open to sky on a ground for 45 days in which a culture is mixed to decompose waste faster. Waste is covered entirely to generate anaerobic reaction and semi-compost is formed. Entire waste is emptied in hopper through conveyor belt (C1). Waste material is passed over conveyor belt (C2) where rocks and debris are removed manually. It goes into the Trommel 1 with sieve size 25mm and material less than 25mm falls on the ground and forms a heap. Materials undergo screening to get final compost in which particles with 4mm and 6mm size are screened separately.

For waste particles larger than 25mm, a magnetic separator is provided from where ferrous materials are removed. Remaining waste enters Hammer mill 1 and it cut into sizes. And goes directly into Air Density Sensor where stones and sand are collected. Screening is done in a Trommel 2 where fine stone, sand etc. with size 14 mm are separated. Waste ranging from 75-100mm is cut in hammer mill 2 in loose form which is known as RDF and is sent to cement factories (BEIL, 2019).

Despite having 3250 TPD capacity, actual waste treated is much lower due to various problems. Abellon and JITF plants are newly constructed whereas Excel, BEIL, Creative and AEPL plants are under operation since 7 to 19 years but authentic regarding quantities of waste treated and inert disposed is not available/accessible.

RDF (Refused Derived Fuel)

RDF is obtained from MSW which includes rags, plastic, rubber and other combustible waste or those wastes which do not decompose easily. This raw RDF can be sent to various cement companies, thermal power plants, textile and chemical manufacturing plants to convert waste to energy (BEIL, 2016).

Table 2: RDF Properties at BEIL Plant

Properties	RDF- Fluff
Shape	Irregular
Bulk density (kg/m^3)	400
Moisture	10-12%
Mineral matter	15-25%
Carbon	35-45%
Hydrogen	5-8%
Nitrogen	1-1.5%
Sulphur	0.1-0.2%
Oxygen	25-30%
Gross calorific value	3000-3500 K.cal/Kg

Source: (BEIL, 2016)

Generally used for electricity generation in India, RDF is found to be effective replacement of coal. RDF is processed further and converted into solid cubes which are an effective medium of converting waste to energy. The main advantage of using RDF is reclamation of dump for future use. (Ganesh & Vignesh, 2013).

Fig. 2: RDF and Compost Produced at BEIL Plant

COMPOST

Inert material is obtained from MSW having particle size less than 25 mm consisting of sand, and fine particles.

Table 3: Inert Waste Material Properties

Properties	Inert
Colour	Blackish brown
Size	<25mm
Ph	6.5-7.5
Moisture	15-24%

Source: (BEIL, 2016)

Inert materials are processed further to form organic compost under controlled optimum conditions of moisture, temperature. A culture with required amount of minerals viz. nitrogen, phosphorous, potash, sulfur is mixed. Compost has benefitted in increasing the soil bearing capacity and quality of crops and it is purchased by farmers.

HISTORY OF PIRANA LANDFILL

Current population of Ahmedabad city is 63 lacs. The per capita waste generated by community is around 600 gm. Total amount of waste generated per day is around 3800 MT. In year 2012 AMC invited expression of interest for waste treatment (SWM Department AMC, 2019).

Fig. 3: Pirana Mound Layout

Source: Google Maps

Dump site has three mounds named as:

1. Ajmeri dump
2. Moto dump
3. Excel dump

Pirana is in operation since 1980 with an area of 84 acres occupied by the legacy waste. Dump site has three mounds namely; Ajmeri hill, Moto Dump, Excel Dump. The height of dump ranging from 45m to 65m and is over spilling beyond its capacity. More than 80 Lakhs Cu.M waste was accumulated at Pirana (IL&FS, 2016). Additional waste of 20 lakh MT is expected to have been dumped at Pirana till date. In year 2014, AMC decided to plan a scientific closure of the site on line of Mumbai, Pune projects. IL&FS prepared a detailed project report and proposed to cap the landfill. The cost of capping was estimated to be 374.63 crores. The report never got implemented due to futileness of the capping, particularly with respect to the cost; merely covering a dump was not an acceptable alternative to the authorities. Also, another major drawback of bio-capping was it would not save any land.

According to the NGT, a detailed oral order by Principal Bench at New Delhi was passed which suggested that the legacy waste should not only be capped but also bio-minned according to MSW rules. The process of bio-mining started from July 2019 (SWM Department AMC, 2019).

Bio-Mining of Legacy Waste in Ahmedabad: Current Status

Again, in year 2016, AMC issued an EOI for recovery of Pirana land by treating waste in which four bidders out of five were technically qualified. The average bid price was Rs. 720 crores (SWM Department AMC, 2019). The process was scrapped. AMC decided to run trommel machines as a pilot on site, and decided to increase the capacity gradually.

AMC has started a process of flattening the waste mounds through the process called bio-mining. AMC prepared a proposal to hire machines for bio-mining. The contract required agencies to provide machines to treat the waste, operate, and maintain them. The agencies started their operations from July 2019 (SWM Department AMC, 2019).

Following was included in the scope of the agencies:

- To provide the trommel machines with conveyors on rent.
- To transport the machine to the site provided by AMC.
- To install the machine at site provided by the AMC.
- To provide 01 supervisor, 01 operator, and 04 Labour per trommel machine.
- To carry out necessary maintenance of the machine during the contract period.

Bio-mining is a process of separating waste into two components namely Refused Derived Fuel (RDF) and compost.

Fig. 4: Trommel at Pirana

Table 4: Trommel Specifications

Sr. No.	Descriptions	Size
1.	Capacity	Minimum 300 TPD
2.	Length of trommel	Minimum 7.0 mts.
3.	Diameter of trommel	Minimum 1.8 mts.
4.	Feeding conveyor	1 no.
5.	Reject conveyor	1 no.
6.	Air blower	1 no.
7.	Structure for machine	1 no.
8.	Operating panel	1 no.

Source: (DYMC AMC, 2019)

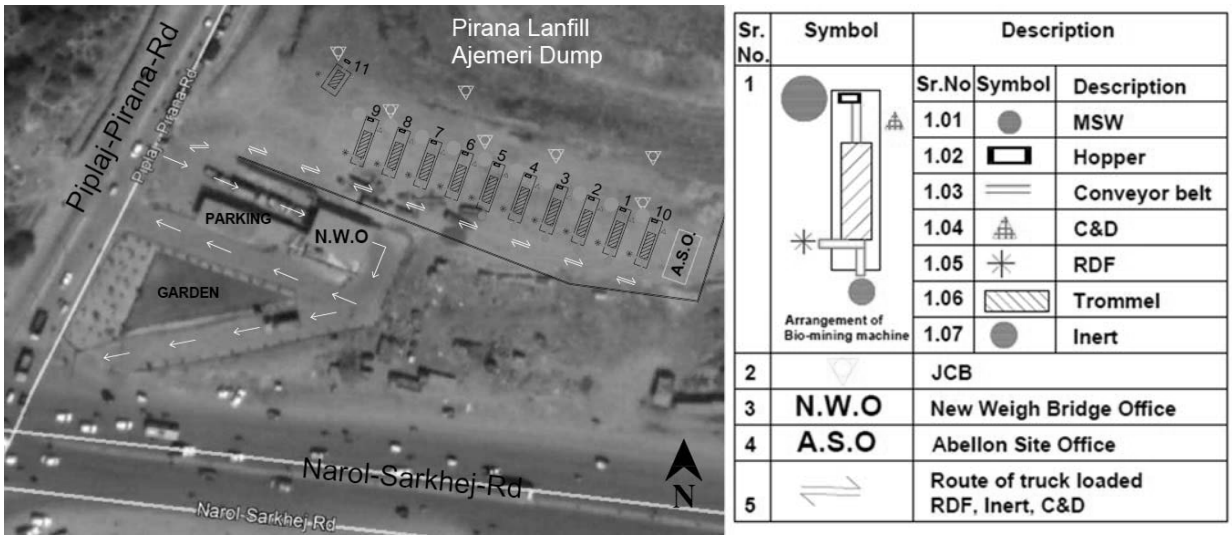


Fig. 5: Job Layout of Pirana Dump

The above mentioned photo is a job layout (figure 5) of the current arrangement of machines. Route of trucks loading and unloading waste is shown. Symbolization of machines, materials, offices, etc. is shown in above.

Process of bio-mining of legacy waste at Pirana is as under:

1. **Loading of waste**

   The legacy waste is scooped out from the mound by the backhoe loader having capacity of 1 cu. m. (1 MT) and is transferred in to the trucks having capacity 10 and 15 MT respectively.

2. **Transfer**

   Trucks ferries waste from waste mound to machines until it is 300 MT.

3. **Feeding of the waste**

   Waste mounted by the truck (300MT) is unloaded near the hopper and from there it is fed to the hopper of the machine by front end loader.

4. **Visual inspection**

   From hopper, waste is transferred to conveyor belt (C1) where debris, brick bats, and rocks of size more than 40 mm are removed manually by a pair of labourers. Waste is transferred to the trommel from conveyor belt.

5. Sieving

Waste inside the trommel rotates along with the perforated sieving drum having sieve size 6mm projecting downwards. Smaller particle waste mainly organic waste, sand, soil, dust gets sieved.

6. Collection of the compost/inert

Particles having size less than 6 mm is passed on to the lower conveyor belt (C2) from where compost is obtained.

7. Collection of Raw Refused Derived Fuel (RDF)

Remaining waste of size more than 6 mm from trommel is transported to another conveyor belt (C3) from where RDF is obtained. The debris that may have escaped by the first set of labourers is manually picked up by another pair of labourers stationed near C3.

As per primary survey, RDF obtained after bio-mining is sent to the thermal power plant of Abellon Clean Energy Ltd (ACEL). Thermal power plants of ACEL are located at four places in Gujarat: two ast Khas and Chanothra in Bhavnagar, whereas the third plant is located at Amreli, Savarkundla, and fourth plant is at Vanthli, Junagadh. The waste is also given to local industry if they demand.

RDF is burnt along with coal to generate energy or steam. Inert obtained at the end of the day is used to fill a land near the dump site. Rocks segregated during the process are used as landfill.

Time Required for Flatting the Land Hill

The following table shows the daily amount of waste provided to the agencies.

Table 5: Current Legacy Waste Processing Setup (3000 TPD)

Trommel No.	Company Name	Waste Allocated (TPD)	Remark
1	Su Sajja Enterprises	300	
2	Su Sajja Enterprises	300	
3	Su Sajja Enterprises	300	
4	Master Waste Care Project Pvt. Ltd.	300	
5	Omkar Enterprise	300	
6	Omkar Enterprise	300	
7	Master Waste Care Project Pvt. Ltd	300	
8	-	0	Closed
9	Master Waste Care Project Pvt. Ltd.	300	
10	Abellon Clean Energy Ltd.	300	
11	KLEEMEN (OEM)	300	Trial basis
TOTAL		3000	Mt

Source: AMC (c), 2019

Assuming a complete working day with no breakdown of the machine and continuous uninterrupted operations.

Total waste at Pirana dump is more than 80 lac MT. Current processing rate is 3000 TPD however, Municipal Corporation has decided to increase the capacity to 6000 MT per day. After successful trial operation of more advanced machine capacity will be increased to 6000 TPD which may reduce the time required to clean up by half.

Time required flattening the land hill with challenges:

At current capacity, time required clearing the dump $t = \frac{\text{total waste in pirana}}{\text{waste processed per day}}$

$=\frac{8000000}{3000}$ = 2667 days (7 years 4 months)

Considering waste processed in a day to be 6000MT. According to AMC, total waste is more than 80 lacs.

Time required clearing the dump $t = \frac{8000000}{6000}$ = 1334 days (3 years 8 months)

According to season and holidays, probable non-working days are 30 days per year.

Hence, 110 days will be required to compensate the non-working days for 3 years 8 months.

Time required to clear the dump = 1444 days (3 years 11 months)

Quantity

Current treatment results in three components: C&D waste, RDF, inert. Breakup of percentage obtained from site record is illustrated in figure 6.

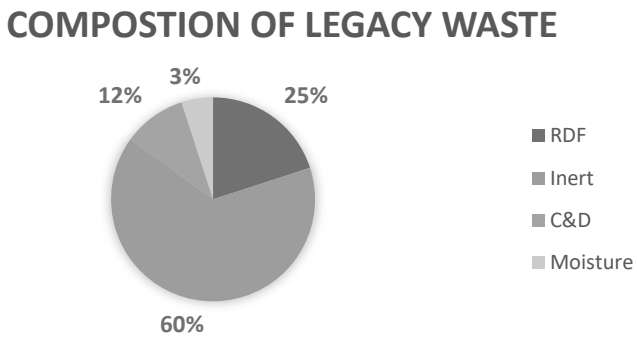


Fig. 6: Percentage Composition of Old Waste

As per the data obtained from the company, the composition of weight of waste obtained in a day is given below in figure 7:

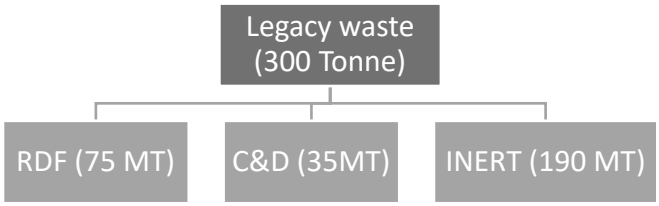


Fig. 7: Treatment Output Per Machine

Table 6: Weight and Proportion in Legacy Waste

Description	Weight (TPD)	Total Weight (MT)
C&D waste	35	9,33,333
RDF	75	20,00,000
Inert	190	50,66,667
MSW	**300**	**80,00,000**

As shown (table 6), Out of 80 lac MT of legacy waste, C&D is 9.33 lac MT, RDF is 20 lac MT, and Inert is 50 lac MT.

CHALLENGES

Major challenges in bio-mining in current practice adopted by AMC are mentioned below:

Power Failure: Electrical surges caused by lightning strikes, damage to power lines, faulty appliances and bad electrical wiring interrupts the functioning of machines. However, AMC has provided generators which may not be sufficient to allow functioning of all machines. It may cause an interruption in daily processing of waste. Probable stoppage caused due to power failure delays work by 30 minutes.

Machine Breakdown: Due to faulty part of machine, unavailability of machine part over loading, and improper maintenance causes interruption for the processing. According to the tender contracted by AMC, every day 2 hours are permitted for maintenance and repair of machine. For any major breakdown, 2 days in a month are permitted. If the breakdown is extended more than 2 days then the payment is reduced.

Non-Working Days: Public holidays, holidays for employees, or non-working days due to any specific reason by the company or the department may break the work process. 10-15 days are granted to workers as non-working days for festivals.

Seasons: Due to presence of moisture content and heavy rain in monsoon season interrupts the process of bio-mining for some time period. Moisture rise delays the work by 10-15 days.

Health & Environment: The plants are set up in open amidst waste dumps is biggest threat to workers, operators and staff. There are no measures to prevent pollution and compliance to the environmental norms is not evident.

Safety: Site is almost open to everyone and there is hardly any control on movement of trucks, JCBs, and other heavy equipment. Standard precautions that are taken during any construction projects or mining projects needs to be introduced.

Quality: Right now fine particles are considered inert waste and experiments are going on about their usability. Till that time the alternative usage is found out, it is going to create another refined dump with lesser organic content than original waste in the mound but full of chemicals.

BID PROCESS MANAGEMENT

The bidding process started with preparation of tender documents. The document reads “Tender for segregating trommel for old dump on rental basis along with 01 supervisor and 01 operator”. Though document lacks standard contractual rigour, it got subscribed. The scope included trammel with basic specifications given to be supplied on monthly rental along with 01 supervisor, 1 operator. As per amendment to the tender, 4 labourer were added to the scope of supply. An agency was required to give a minimum three trommels as per terms. Based on lowest bid received, AMC issued work order to three agencies each with 3 trommels, with monthly rental of Rs 6, 40,000. One trammel run into some technical problems, 8 trommels started working and 1 more from Abellon was also hired on similar terms. An OEM supplier has also put a machine on trial run which has more advanced features.

FINANCIAL

AMC claims the waste treatment is costing Rs. 180/- per MT. However, no detail breakup is given. It translates to 144 crore rupees to clear the dump. If it does within the amount specified, it is significant savings from earlier proposals.

CONCLUSIONS

Bio-mining of legacy waste is now only feasible option available for most ULBs. After the success of Indore in treating the solid waste to reclaim the dump site bio-mining option appears to be feasible solution. Ahmedabad has started bio-mining in 2019 and initial results are encouraging at least in clearing land and getting RDF for industry. Utility of inert material or generating compost from it has not been successfully explored. Also, treatment does not care for fine segregation as a result ferrous waste, aluminum waste, and debris of larger size remains untreated. Need for better machines and treatment is felt. The legacy waste before commissioning of C&D waste treatment plant (in 2009) has been present in the Pirana mound and which may throw surprise as we mine deeper. At current rate and taking into consideration proposed increase in capacity, it may take more than three years to clear the mounds. There is need to look at the environment, safety and labour conditions at treatment site. Treatment causes waste to flutter in the air which causes difficulties to the commuters.

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Energy Management–Technology, Tools, Strategies and Applications for Sustainability

Mit Gandhi[1] and Dr. Sudhir Yadav[2]
[1]Ph.D. Scholar, School of Petroleum Management, Pandit Deendayal Petroleum University
[2]Professor, School of Petroleum Management, Pandit Deendayal Petroleum University, Gandhinagar
E-mail: [1]mitpgandhi1990@gmail.com, [2]sudhir.yadav@spm.pdpu.ac.in

Abstract—The paper reviews research articles published in various international journals on energy management area from 1978 to 2018. Energy management is key to success for sustainability. In addition to economic costs of energy acquisition, it can assume the environmental and social costs, exhaustion of resources and contribute to problems such as climate change. Energy efficiency can be enhanced by selection and adoption of suitable technologies. The paper covers various tools needed to analyze energy consumption pattern. The review shows that tools can be applied to identify significant undiscovered energy waste. It is also appropriate to apply strategies to manage energies at individual, organizational, regional, country and continent level. It emerges that technologies, tools and strategies can be adopted by various application areas such as industries, offices, educational institutes, hospitals, hotels, residences, municipalities and all such kind of places. The paper also highlights implications for organizations, policy makers and future research directions.

Keywords: Energy Management Tools, Technology and Energy Efficiency, Applications of Energy Management, Energy Management Strategies

INTRODUCTION

Energy is a key element in any activity. Responsible consumption and efficient use of energy are two of the key factors which helps to achieve a sustainable future.

Energy is fundamental to all operations of an organization or residential unit. In addition to their own economic costs of energy acquisition, it can assume the environmental and social costs, exhaustion of resources and contribute to problems such as climate change.

Out of various ways discussed which leads to enhancing energy efficiency managing technology is one of the important aspects to close the energy efficiency gap.

While the technology is managed to enhance efficiency, it will also lead to companies having a competitive advantage, reduction in emission of Greenhouse Gases (GHG) and climate change.

Strategies of energy management has very important role to play. The strategies form at country or continent level can be a major driver to policy formulation and implementation. The technologies, tools, softwares and strategies ultimately have to be utilized for various applications.

There is also a need to compile literature wherein how energy saving concepts can be applied to various kinds of organization and units. It would mean how these Energy Management concepts can be utilized in Industries, Offices, Hospitals, Schools, Colleges, Hotels, Houses, Municipalities and all such kinds of organizations.

ENERGY MANAGEMENT-TECHNOLOGIES

A responsible usage of resources like energy is one important aspect of sustainable business development.

Various studies estimate the energy saving potential from 25 to 30 percent in the industrial sector.

The management of technology would normally follow a general procedure (Dörr *et al*., 2013):

- Determining the actual situation
- Assess the actual situation

- Deriving improvement measures
- Implementing the important measures
- Determining the new actual situation
- Evaluate the new actual situation

Process-based Measures

In an industrial environment, the prerequisite for an automated gathering of process-based energy consumption is rarely found.

There are numerous enterprises that measure their energy consumption on plant level with a single electricity and gas meter (Dörr *et al*., 2013). It is important to collect data of energy consumption of major processes which contribute to significant energy usage.

Based on process-based energy usage data once arranged in Pareto diagram provides the processes which need to be focused for deriving process wise specific measures. The process wise energy usage reduction path can then be derived through internal and external knowledge points and where ever found viable it can be implemented.

Combining Managing of Energy Efficiency with Production–Energy Intensive Manufacturing Industries

Particularly in the energy intensive manufacturing industries (e.g. steel, cement, pulp and paper, ceramics and chemicals, energy can account for up to 60% of operating costs, thus representing a strong factor for competitiveness (Bunse, Vodicka, Schönsleben, Brülhart, & Ernst, 2011).

Many industrial companies lack appropriate methods to address energy efficiency in production management.

To gain insight into particular manufacturing processes, physical indicators are more suitable (Phylipsen, Blok, & Worrell, 1997). Energy intensity (EI) and specific energy consumption (SEC) are typical indicators. EI is defined as the ratio of energy consumption to a monitory value. SEC is defined as the ratio of energy consumption to units, such as tonnes of products.

Increased energy efficiency is reflected in reduced EI or SEC (Mukherjee, 2008). Appropriate KPI and/or Benchmarks need to be established to achieve the desired energy efficiency.

Internet of Things

New emerging autonomous technologies, such as internet of things (IoT) are enhancing monitoring of production processes (almost) in real-time (Shrouf & Miragliotta, 2015). An area where IOT plays a major role is in the monitoring of energy consumption (Haller, Karnouskos, & Schroth, 2009). IOT technology (e.g. Smart meters and sensors) provide awareness of energy consumption patterns by collecting real-time energy consumption data. These solutions, enable a very high level of awareness and helps collecting large quantities of energy related data. Sensor data from IOT meters can be sent in a variety of formats.

Applying Lean Six Sigma Approach to Manage Energy Efficiency

LSS (Lean Six Sigma) takes DMAIC into usage (DMAIC- Define, Measure, Analyze, Improve and Control) (Mkhaimer, Arafeh, & Sakhrieh, 2017). This model applies DMAIC approach to the energy management process in companies and incorporates the needed tools to define system requirements, analyze energy

data, establish a system approach to identify energy opportunities and finally to guarantee sustainable system improvements.

LSS offers many statistical, non-statistical and managerial tools which can ease the implementation of energy management practices in an organization.

MANAGING TO SHIFT TO SUSTAINABLE ENERGY TECHNOLOGIES

There is a need to adopt Green Approach for sustainable development. Brundtland Report defined sustainable development as being "development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Duchin, 2015).

Several clean energy technologies can be adopted. Some are:

- Combined heat and power (CHP)
- Fuel Cells
- Hydrogen Production
- Hydro Power
- Wind energy
- Ground Source Head Pumps (SSHPs)

MANAGING WASTE HEAT RECOVERY

Waste heat recovery has been commonly accepted as efficient, clean, reliable and promising approach to increase utilization efficiency of primary energy and reduce the pollutant emissions.

It is now less expensive to save a unit of energy than it is to produce one (Magnuson, 1981). The cost of energy will become an ever-increasing percentage of manufacturing costs. Those manufacturers who save energy will thus have a competitive edge (Magnuson, 1981).

TRANSITION TO DISTRIBUTED ENERGY PROSPECTS

Distributed Energy (DE) refers to a system where energy production and consumption are in close proximity.(Ruggiero, Varho, & Rikkonen, 2015).

Small scale distributed energy is expected to play an important role in future and particularly in rural areas.

In such a system, prosumers (that is, consumers with generation capacities) who produce heat or electricity for their own needs can also send their surplus electrical power into electric grid or share excess heat.

USING DEMAND-SIDE MANAGEMENT TO SELECT ENERGY EFFICIENT TECHNOLOGIES AND PROGRAMS

Demand side management is the planning and implementation of activities that influence use of energy in ways that will produce desired changes in the time pattern and magnitude of energy. It provides many additional alternatives. These demand - side alternatives are equally appropriate for consideration by utilities, energy suppliers, energy-service suppliers and government entities.

Demand side management extends beyond conservation and load management to programs specifically designed to modify energy use in both peak and off-peak periods.

ENERGY MANAGEMENT-TOOLS, STRATEGIES AND SOFTWARE

Establishing Energy Management Tools for Facility Managers

Energy use in offices is increasing very fast due to growth in intensive use of information technology, and Air-Conditioning.

Development of An Energy Management Tools would require:

a. Consumption pattern data collection:
   It involves evaluation of consumption pattern and the identification of energy saving measures.
b. Analysis and bench-mark development:
   The data collected is subject to statistical analysis and co-relation from building to system level.
c. Energy Audits Assessment Tools:
   This can assist and guide the building owner, facility manager and engineers in providing the necessary and required building information and data.
d. Building Energy Bench-marking Tools:
   Energy bench-marking is well recognized as an important tool in identifying the current and future energy requirement of a building or facility.

Strategic Energy Management European 20/20/20 Approach

European Council decided to achieve three ambitious obligations for the 2020 horizon (Stankeviciute & Criqui, 2008).

1. The reduction of 20 percent of greenhouse gas (GHG) emissions (and up to 30 percent if an international agreement justifies it).
2. The savings of 20 percent of energy consumption.
3. The share of 20 percent of renewal energies in the overall energy consumption.

Here, the policy level decisions and subsequent tariffs and incentive instruments are leading the way to achieve energy and environment related objectives for sustainability.

Renewable Energy Strategies for Sustainable Development

Renewable energy is going to play a very important role in the coming years while the non-renewable resources particularly oil and coal are depleting quickly.

For conversion of energy system into a 100% renewable system.

- Oil for transportation must be replaced by other sources.
- Solution based on electricity become key technologies.

Energy Software & Programmes

In different parts of the world, several softwares, models have been developed by researchers, Government authorities and companies who support energy management.

Few of them are listed here, which have potential to be used and applied to different sectors like residences, SMEs, hospitals, etc. where application of energy management concepts will be immensely useful.

Table 1

Software/Model	Utility
iMeasure	Designed for home owners (Kathryn)
sMeasure	Designed for small and medium businesses
BAS	Building Automation System
BRECSU	Energy efficiency: office consumption guide
EMMG	Energy Management Maturity Grid
EnergyPLAN	Energy system analysis model
Passive house	Energy efficiency in a building
BASS Manual	Case studies of hotels that have undertaken energy and water saving programs
Enersol	Microprocessor controlled energy management system
MARKAL	Integrated energy system optimization network
Energiewende	German energy supply secure, affordable and sustainable
NHER	National Home Energy Rating: Energy Efficiency
POLES	Global energy supply, demand, prices forecasting model

Applications of Energy Management in Various Sectors

There are various sectors where Energy Management concepts can be applied. The literature review brought out such sectors for which case studies, focus groups, surveys have been conducted. It emerged that even non-energy intensive sectors would also require implementation of Energy Management for significant savings.

Energy Management-Offices

Many of the offices, both new and old, use much more energy than is necessary. Some of this about 25 percent and sometimes more is avoidable waste; energy consumed to no useful effect (Bordass, 1993).

(Bordass, 1993) mentions that energy efficient buildings will not cost any more to building them a "standard building". Good design, Good execution, Good management and appropriate technology are key ingredients of energy-efficient office buildings.

Energy Management in MSME's

MSME's (Small, Medium and Micro) contribute in a major way as far as no. of organizations, employment, turnover and exports is concerned.

While creating an EnMS for MSME's, it is important to understand barriers to energy efficiency improvements in the manufacturing environment.

The most relevant barriers identified for MSMEs are:

Lack of awareness or education regarding energy efficiency improvements, lack of technical skills, other investments deemed more important, lack of access to capital or other financial restraints, perception of already being efficient, project risks, lack of metering, management, organizational, and regulation related barriers.

HOTEL INDUSTRY-NEED TO EXERCISE OPERATIONAL OPTIONS THAT REDUCE ENERGY USE AND COST

(Stipanuk, 2007) states that Lodging industry is one of the many contributors to the increased demand for energy. Because of the hotel industry's relative prosperity during the past several years, the hotel operators are not among those improving the energy efficiency of their buildings. Energy expenditures are normally between 5 to 10 percent of revenue for Hotel Industry.

RESIDENTIAL SECTOR-ENERGY SAVING OPPORTUNITIES

According to statistics published by the International Energy Agency (IEA) in 2003, International residential use is approximately one-fifth of the total worldwide energy consumption. The bulk of consumption was due to room heating, shower heating, cooking, lighting and electric devices (Carlsson-Kanyama, Engström, & Kok, 2005)

The Residential energy saving can be achieved through several means:

a. Design approach for new buildings: The wall, roof, windows would play a very important role in terms of technology used and space provided.
b. The type and standard of equipment used for room heating/air-conditioning, cooking also plays a important role.
c. The type of fuel utilized for cooking is also a major determinant of energy usage emissions and health parameters.

INDUSTRIAL SECTOR-ENERGY SAVING STRATEGIES

An industrial sector uses more energy than and any other and user sectors and currently this sector is consuming about 37% of the world's total delivered energy. It also includes energy consumed by MSME's.

It has been found that in industrial sectors, a sizable amount of electrical energy, emissions and utility bills can be saved. Huge amount of energy is needed for countries with faster economic growth.

In Industry, energy efficiency can be improved by three different approaches (Abdelaziz, Saidur, & Mekhilef, 2011) as follow:

1. Energy savings by management
2. Energy saving by technologies
3. Energy saving by policy/regulations

CONCLUSIONS-FINDINGS

Among various ways to enhancing energy efficiency, managing technology is one of the important aspects to close the energy efficiency gap.

The adoption of technologies for improving energy efficiency will also lead to competitive advantage, reduction in emission of Greenhouse Gases and climate improvement.

The literature review has brought out various ways and methodologies to manage technologies for enhancing energy efficiency.

It has also been brought out how strategy by a country or geographic region consisting of several countries can take policy decisions and create suitable support system to create mission and goals for many organizations to move in the direction of leading the way towards energy efficient organization and better climatic conditions.

Several software and programs are developed for buildings, residences, organizations. They are listed out for the benefit of relevant users.

The paper brings out many sectors where application of Energy Management Tools will help us to move towards "Green World" and ensure sustainable development.

PRACTICAL IMPLICATIONS

The utilization of various technologies and approaches enumerated in the research paper would be very useful to organizations to save energy. It will prepare organisations to remain competitive in future, reduce environmental impact. It will also lead to improving image among its stakeholders.

The various tools and strategies described has created road map for every entity to manage energy consumption. It has brought out that even MSME's, Offices, and residences have huge undiscovered energy losses which can be identified and brought under control.

LIMITATIONS

The Energy Management concepts can be applied to various sectors. Residential sector, MSME's, Buildings are sectors which are very wide spread and it is a huge task to educate them, create awareness and employ energy management tools up to the last unit.

AVENUES FOR FUTURE RESEARCH DIRECTION

Among technologies mentioned herein, it may be worthwhile to focus on a few research areas which can provide sector-wise solutions. Research on waste heat recovery suitable for ceramic Industries, Iron and Steel Industries and like-wise specific solutions for various energy-efficiency measures can be arrived at.

The research for viable solutions relating to distributed energy have relevance to very large rural areas of India and many other such countries with wide spread rural population.

To bring about concept of Energy Management to small factories, residences requires conceiving cost effective display systems which bring out visible digital data in real time for the uses to become aware of opportunities to save undiscovered energy waste.

A special focused tailor-made sector wise programmes for Hotels, hospitals, schools, hostels, etc. will help to serve many organizations to work on energy management concepts.

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Energy Banking and its Significance in the Economy of South Asia

Sanjeet Kumar Choudhary
M.B.A. Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: sanjeetrschoudhary@gmail.com/ sanjeet.cpgp19@spm.pdpu.ac.in

Abstract—Energy is a vital requirement for the human civilization and is a boon for all the development carried on till date. For the sustainable development without much impact on environment, a clean source of energy is required and it might not be feasible to generate the similar energy everywhere. Hence, transmission of energy from one place to another is necessity.

Currently, South Asian Region has the growing economies of the world and so, it requires power. Few of these are rich in power whilst some are power deficient. If the proper demand and supply is maintained, it not only solves the power crunch but also will be equally efficient for the economic growth of the entire region as a whole. Energy Banking is something that can be boon for the region.

The current study is solely based upon secondary data and tries to emphasize the benefits of Energy Banking in the region and how the concept can be implemented in an effective manner to abstract the most out of it. Which parties should be involved and what shall be their role. It also discusses about how the energy market in the region is going to make a drastic shift and what role renewable energy will have in the future.

The paper will be helpful for knowing the concept of Energy Banking in more detail and can be later on used as a base for the establishment of proper transmission policies between the countries. The political scenario has not been taken into consideration while preparing the paper.

Keywords: Energy Banking, South Asia, Transmission, Renewable Energy

India's Energy Outlook of 2030 based on its Demand, Sufficiency and Energy Sustainability

Chirag Vanpariya
M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: chirag.vpgp18@spm.pdpu.ac.in

Abstract—With the development and revolution in industry and society, World's energy needs are growing at rapid pace at around 2.9% in 2018. Per capita energy consumption is increasing day by day. Increase in population and per capita income are the major reasons of growing energy needs. This energy demand growth comes from developing countries or called emerging markets like China, India, Indonesia, Bangladesh, etc. India is one of the countries having highest GDP growth. India's energy need is growing at 4%. This growth is expected to remain constant or may increase in near future as India is expected to surpass the china in population soon. This shows the energy demand scenario.

As population and per capita energy consumption is expected to grow, will stimulate energy demand. But, with some limitations, all demand from all people are not able to be fulfilled. So, there is always quite shortage of energy supply. Also, part of population living in remote areas don't have access to their primary energy needs mostly cases in developing and underdeveloped countries. So, to supply the energy sufficient to needs, self-sufficiency and renewable kind of concepts are in trends. Energy efficiency contributes to energy sufficiency, but that's not enough. Energy sufficiency can be expressed as reducing the energy demand having same energy supply. For energy sufficiency, Indian government is more focusing on infrastructure development to facilitate the needs of energy from each and every corner in the country.

Now with the development and GDP growth, our energy demand increase which results in higher carbon emissions as our major energy supply comes from fossil fuels and which is expected to remain in near future with reduced demand because of the renewables and other alternative energy sources. Climate change is already started showing its impact on environmental conditions. Development for meeting energy demand is happening but at cost of environmental pollution and degradation which directly or indirectly impacting on human and all other ecosystems. Energy sustainability is the concept explains such developments without impacting on environment. It's another aspect is to consume energy wisely to be able to meet the future demand. Renewables are major contributor to sustainability. Alternative energy sources have been invented and some are in research and developments stage to make our future sustainable. Though natural gas as a fuel results in carbon emission, is considered as a green energy source as it emits very less carbon compare to other traditional fuels. Also, having other benefits, too, consumption growth in India was 8.1% in 2018. Government of India is promoting development of infrastructure in natural gas sector along with private firms as having the goal of making India a gas-based economy. Electric vehicles growth is also contributing to sustainability and is expected to grow further. Energy efficiency is contributed a lot in achieving energy sustainability till today and will contribute further in future.

Energy demand, sufficiency and sustainability are the major issues the industry and government are facing. Efforts to solve these issues are good but not enough to solve completely. More disrupting technologies and innovations may be the solutions along with sound government policies to solve such issues.

Keywords: Demand, Sufficiency, Sustainability, 2030

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A Review on the Opportunities and Challenges Faced in Energy and Infrastructure Sectors: A Case Study of Indian Scenario

N. Chaudhari[1], G. Raj[2] and Dr. J. Shah[3]
[1,2]PG Student, Urban Infrastructure,
Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad
[3]Assistant Professor, Civil Engineering Department,
Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad
E-mail: [1]nirav.chaudhari.18mc@iitram.ac.in

Abstract—For the development and growth of any country electricity plays a vital role. Consumption of power is a critical Index of advancement of the country & standard of living. The economic growth rate of 8-9% on a continuous basis is required for us to fastening with the rest of the world.

Three vital elements of the power sector are Generation, Transmission and Distribution. Indian electricity distribution accommodates to nearly 150 million users with an associated load of about 400 GW that brings the country among the largest electricity consumer bases in the world. Now a days unauthorized allocation, corruption and illegal activities in the coal industries are significant challenges which can be controlled by various policies and acts which helps in regulating and to secure accessibility of coal blocks to cater the demand of different sectors of the economy in an eco-friendly, sustainable and cost-effective manner.

Developments for efficiency improvement of solar plants are the significant challenges for the renewable sector. Generation of electricity in India is majorly relying on coal. India has enough coal reserves in its forest's areas. However, due to strict forest consent or regulations, this coal cannot be consumed very often for power generation. To overcome these challenges and essential policies and regulations are required to make the best use of these resources.

Significant investment is required to improve the efficiency and capacity of the Indian electricity distribution and transmission grid. Government is also emphasizing more on to the cutting of power consumption by various techniques and awareness. In India a large amount of electricity is being consumed by Railways which is having very less efficiency, so reducing the railway Inefficiencies required a huge technological advancement. New development and innovation are necessary to increase the effectiveness of the coal-based plant.

India's total nuclear plants presently account for less than 2% of total power capacity. There is enormous scope in nuclear sector for generation of energy. Countries like Japan and France are highly dependent on nuclear source because of their high-end technological advancement. So, make the best, and prompt use of nuclear energy is a significant challenge. Nuclear technology and safety parameters are widely considered to be cutting-edge, and the critical parts required for Indian reactors are not locally available which leads to the high cost of generation.

Other challenges are to ensuring the cost of power must be affordable to everyone. Insufficient funds to maintain and improve the infrastructure system leads to deteriorating within its life cycle time. However, high cost and lack of a comprehensive approach to managing infrastructure also play a vital role in that. In today's world, disaster plays a critical role in decreasing the GDP of any country. So, sustainable, resilient design and construction can help us in preventing the infrastructure from catastrophe. The inadequate design process, material variability, climate, environment etc.

Political interference in operations, tariff setting and managerial decision making also create problem in developing and operating of infrastructure system. Current institutional arrangements do not produce proper structures and incentives for improvement of operational efficiency and quality of service Management.

Robust Demand, Policy Support and increasing requirement of Investment are the other associated challenges with Infrastructure development. In countries like India, we are lagging little behind developed nation in some of the parameters which must be overcome in coming days some of them are lack of technological readiness, Lack of Innovations, Labour inefficiency and Inappropriate education and skill training.

A large number of projects are delayed which turning many bank loans into NPAs and limiting further bank lending to infrastructure projects. The current practice of financing large infrastructure projects based on revenue streams spread over 20 to 30 years, but with project debt having tenure of 10 to 15 years, is unsustainable. In the absence of long-term financing instruments, it is becoming increasingly difficult to finance the growing requirements of infrastructure.

Some of the challenges associated with developing the infrastructure are Land acquisition, Project preparation, Dispute resolution and access to finance. Large No. of Procedures and approvals also creates a big problem in developing the infrastructure. Delaying in approvals and land-acquisition processes that put a strain on the long-lasting and sometimes opaque tendering processes. Awarding of work contract and doing of initial formality takes too many times. And if procedures are not transparent and unbiased enough, investors hardly mobilize resources to bid.

The capacity-based revenue model and an asset management strategy achieved by utilizing reliable equipment, plant designs that include proper redundancy and durability, and best-in-class management information systems leads to Operational Excellence, which is going to plays a crucial role in managing any infrastructure.

Risk tolerance for all asset must be a chunk of strategy. Consideration of Risk assessment is going to be next hurdles to maintain the safety standards along with human life and environment with any unwanted activities. Here, Risk Factors comprises of financial, regulatory/legal, public health, environmental and safety. Sustainable development is very much required in infrastructure development. However, meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.

The 12th Five Year Plan had projected infrastructure development at Rs 65 lakh crore to be equally met from budgetary resources and from debt and equity participation by commercial banks, international agencies, National Bank for Agricultural and Rural Development (NABARD), Non-Banking Financial Companies (NBFCs), financial institutions, mutual funds, and other large strategic investors. (Times of India) However, financial intermediation of a huge pool of savings, particularly on a large scale, requires a well-diversified and complex financial system, a deep bond market, suitable and innovative products, and a liquid capital market with investors that have appetite for long-term financial products. Infrastructure projects are long gestation ventures with the average pay back ranging from eight to fifteen years. Initially, projects suffer losses due to high financial burden, administrative costs, and remuneration of project cost. Under the Public private partnership model, the risk is borne by the private sector. At the end of the concession period, projects are handed over to authorities at no value. The private sector typically recoups the cost and generates an internal rate of return over the concession period, either through toll, annuity, or grant. [1]

Keywords: Physical Infrastructure, Renewable Sector, Coal Industries, Technological Advancement

Waste Management in Context of India

Dhruv Patel[1] and Charmy Shah[2]
[1,2]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]dhruv.ppgp19@spm.pdpu.ac.in/ dhp1511@gmail.com,
[2]charmy.spgp19@spm.pdpu.ac.in

Abstract—India is one of the largest waste producing country all around the world. Around 1.5 lakh metric ton daily waste is being collected, out of which only 20% is treated at the plants rest of the waste is being thrown on land. According to the press information bureau, India generates 62 million ton of waste (mixed waste containing both recyclable and non-recyclable waste) every year, with an average annual growth rate of 4% (PIB 2016). This waste can be categorized into various sections. The Union Ministry of Environment, Forests and Climate Change (MoEF&CC) recently notified the new Solid Waste Management Rules (SWM), 2016. These rules are the sixth category of waste management rules brought out by the ministry, as it has earlier notified plastic, e-waste, biomedical, hazardous and construction and demolition waste management rules.

The ministry of environment, forests and climate change provided the detail that, after conducting a study across 60 major cities if the country the central pollution control board had estimated that these metropolitan areas generate around 4059-ton plastic waste per day. Figures show that India generates nearly 26000 metric ton of plastic waste on a daily basis and 94 lakh ton trash every year. The global E-waste monitor 2017 stated that India had produced 20 lakh ton of E-waste. Of the estimated 20 lakh ton of E-waste, the CPCB said, only 69414 metric ton of garbage was collected, dismantled and recycled between 2017 and 2018. This amounted to barely 0.7% of the total E-waste processed.

This study is about waste handling, processing and reusing that waste in day to day life. In above paragraph situation regarding waste management in India is stated. Now further study will discuss about how to overcome this situation or problems. Waste generation is not problem of India only, every developing countries and developed countries are contributing in producing waste. Developed countries already have technologies to deal with various types of waste. But compare to them, developing country like India wants more growth on economy to become a developed country so production of waste is high compare to developed countries and awareness to handle this waste is very low in overall population of India. Ultimately what India need is sustainable growth with less impact on Environment and Next Human Generation.

Further detailed study will go on How to reduce waste in India, where population is too huge. What are the types of waste which is generated on daily basis and their respective proportion in total waste? Waste management through technological advancement by various world wide examples and case studies regarding waste. Indian municipal role into waste management and operation management. Public private partnership and leading firms, who recycle or demolish waste and prepare product out of that in cheaper prices. Also, paper will throw light on waste- to-energy conversation of organic waste. The study will conclude by suggestion on recycling industry implementation and reduce the burden on future generation.

Keywords: Waste Production, Waste Management, Reduction and Reuse of Waste

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Inter-River Linking Project and its Scope in India Managing the Mismatch of Water Availability in India

Shailender Singh[1], Shaswat Prakash[2] and Chintan Vayeda[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]shailender.spgp19@spm.pdpu.ac.in, [2]shaswat.ppgp19@spm.pdpu.ac.in, [3]chintan.vpgp19@spm.pdpu.ac.in

Abstract—India is a vast country in terms of area as well as population. The geographical location of India has some advantages like the monsoon, rivers, lakes etc and disadvantages as well. India has a diverse source of natural resources, so it is necessary to utilize them effectively and efficiently.

The water resources are diversified such that the northern and eastern part has enough of water resources while the southern and western parts are much dependent on monsoon. The monsoon on which India is very much dependent plays a crucial role, if the monsoon is above average it will cause hazards like floods and if it's below the average it results into droughts.

The uneven geographical and time variance in rainfall leads to situations like floods and droughts. We see the drought situation mostly before the monsoon period and floods during the monsoon. With floods and drought likely to occur in different parts of the country, possibly alongside each other sometimes, there is no option but to make inter-linking of river. Inter-linking of rivers (ILR) has potential to avoid huge losses occurred due to floods and droughts by effectively managing the water availability, using networks of canals and reservoirs.

India today has 5,100 large dams, but it still requires 3,000 more. This project also requires building 15,000 km of new canals which requires a huge capital investment. If brought to fruition it will bring about 35 million hectares-over twice the size of Andhra Pradesh-of additional land under cultivation, can produce 34,000 MW more of hydroelectricity and help in building waterway facilities across the country and supports the vision of honourable Prime Minister to make India in the top 3 economies of the world.

The population of India is rapidly increasing and so the demand of water for the purpose of irrigation, drinking and industrial use. The demand can be satisfied by building infrastructure and capacities to ensure availability of water across India throughout the year. An effective rain water harvesting system need to be developed for excess water to be stored in reservoirs and the river water could be managed by constructing dams and connecting rivers and reservoirs through canals.

This could help in eradicating or minimizing the situation like floods and droughts which may save $7 billion annually on floods and $2.6 billion on draughts. Floods and draughts not only results in economic losses but agricultural, ecological and human losses as well affecting more than 330 million people annually in India.

Interlinking of rivers (ILR) is of national importance. Its aim is to build an effective infrastructure to manage the water resources efficiently in India. The government need to work keenly on this 150-year-old idea of inter-linking of rivers as the honourable Supreme Court has cleared the path for ILR in by disposing the PIL against it in 2012.

The National Water Development Agency (NWDA) has been working towards the development of 14 links under Himalayan rivers component and 16 links under Peninsular rivers component. This would require to build a network of Inter-linked rivers, canals and reservoirs to reduce persistent floods in one part and shortage in another. Dams will be built on rivers to increase the level of water so that the water can flow in canals with the help of gravity which will save a lot in terms of energy requirement for the purpose of flow in man-made canals.

This ambitious project worth around $15 billion. It's a huge investment but India can save $10 billion annually if this project implemented successfully. There would be new scope for the development of waterways by improving and controlling the flow of water it would be safe to use ships and boats in the stream. This would also improve the overall transportation system in India as waterways is the cheapest way to transport cargo.

India currently receives around 4000 billion cubic meter of rainfall every year which is sufficient to provide 1 gallon of water per person each day. The rainfall accounts to 1776 billion cubic meter surface water annually and it is targeting to store 185 billion cubic meter in reservoirs. At present with current infrastructure we can only store 30 days of water which is proposed to be increased to 900 days. There are 99 districts which are drought prone and 40 million hectares of area which is vulnerable to floods.

There are ample opportunities in terms of hydroelectricity generation, irrigation, waterways infrastructure development and to avoid scarcity of water in India, as there are some opportunities it also have some risks like there will be an ecological shift which could affect the many professions like fisheries, we should also understand that making such diversions in natural water flow mechanism might have some serious environmental issue. But the opportunities are far more than the risk involved. This project has the potential to build strong Indian economy.

Keywords: Inter-Linking, Water Security, National Water Grid, NWDC

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SECTION–IV

TRANSPORTATION AND TRANSMISSION TECHNOLOGIES IN INFRASTRUCTURE SECTOR: PROSPECTS & CHALLENGES

Development of Sustainable Airports: A Case Study of Delhi International Airport

Avin Shekhar Chourasia[1], Karunakar Jha[2] and Narender Dalei[3]
[1]Ph.D. Scholar-UPES, Manager-Nippon Koei India Ltd.
[2]Professor-UPES
[3]Assistant Professor (SS)-UPES

Abstract—Air transport is considered an important part of the transportation infrastructure and it has a great impact on urbanization as well as long-term economic growth. Airports significantly add to local economy and facilitates a country's integration into the global economy and also provide social benefits to the society. However, together with the socioeconomic benefits, airports adversely affect to the surrounding environments, ecology and society. Some of the main concern i.e. emission from aircraft, noise while take-off and landing of aircraft, land use, waste disposal and energy consumption, are raised with respect to airport's functioning which requires the attention of the regulatory authorities. The authorities to find the balance approach for the development of airports and to minimize the unfavourable consequences.

Therefore, the efforts to be made to develop the 'sustainable airports'. 'Sustainable development' practices in the airports, improves the social, financial and operational benefits of the airport and also lessen the negative impacts on the environment. A case study of Delhi International Airport is considered for understanding the Sustainable Airport. Last year in 2018, Indira Gandhi International Airport (IGI) was awarded the Wings India Award for 'Most Sustainable and Green Airport', by Ministry of Civil Aviation and FICCI.

After understanding the concept of 'Sustainability', next challenge is to make airport sustainable. The main objective of the paper is to find, how to make airport sustainable, when it is called that the airport is a 'sustainable airport'. After reviewing the relevant literatures, it may be concluded that 'sustainable airports' can be developed by incorporating the sustainability concept in to the airport planning and then taking care of the airport sustainability components i.e. policy making, commerce, social responsibility, environmental and service quality.

The research will help to understand the sustainability concept and provides sustainability components which are responsible for development of Sustainable Airports.

Keywords: Sustainability, Sustainable Development, Sustainable Airport, Airport Development, Delhi International Airport, Sustainability of Delhi Airport

INTRODUCTION

Air transportation is considered an important part of the transportation infrastructure and it has a great impact on Urbanization as well as long-term economic growth. Airports and Aircrafts together make the air transportation possible. Airport consists of airside and landside infrastructures required for the steady operation of aircrafts. Airport infrastructures provide support to aircraft operation and become critical part for the airport sustainability. Airports significantly add to local economy and facilitates a country's integration into the global economy. However, together with the socioeconomic benefits, airports affect the environment in many stages i.e. construction as well as operation.

Airports have always been an immense source of anti-environmental activities. Construction as well as operation of airports negatively affect the environment and human life which are quite noticeable. Airports majorly affect to the surrounding environments, ecology and society. Some of the environmental and sustainable development issues i.e. emission from aircraft, noise while take-off and landing of aircraft, land use, waste treatment & ground congestion and energy/power consumption are the main concerned raised with respect to the operation of airports which requires the attention of regulatory authorities in order to minimise the impact on the environment and social life. The airport authorities to find the balance approach for enhancing the airport capacity of existing airports and possibilities and potentials for further development of new airports by minimizing the accompanying negative impacts.

It is important for the airports to be socially and environmentally responsible. Therefore, the efforts to be made to minimize the adverse impact on the environment and side by side to improve the social life by business activities of the airport. To develop the sustainable airports is the future of airport planning. Such combination of above observations lead to the question of whether 'sustainable' aviation is possible (Boons, Buuren, & Teisman, 2010).

After understanding the concept of 'Sustainability', next challenge is to make airport sustainable. The main objective of the paper is to find, how to make airport sustainable, when it is called that the airport is a 'sustainable airport'.

'Sustainable development' practices in the airport, improves the financial and operational benefits of the airport and provided the social benefits to the society**.** Together, these aspects of sustainability are commonly referred to as the 'triple bottom line'.

SUSTAINABILITY

The definition of term 'Sustainability' is not agreed universally and there are different views for its definition and the process for its achievement. The concept of sustainability was presented in 1987 in Brundtland Report and defined as a process in which the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In addition to natural resources, there is also a need of social and economic resources. Sustainability is not just consideration of the environment or ecology but also the concern for social as well as economic development. As per (Boons, Buuren, & Teisman, 2010), term 'sustainability' used as a concept wherein actors in a specific place and time strike a balance between the economic, ecological and social impacts. Further, it may also be concluded that sustainability is a holistic approach by which the environmental, social and economic dimensions are considered altogether to achieve enduring health, wealth and success. Hence, Sustainability is to improving the economic and social quality of life while limiting impacts on the environment to the carrying capacity of nature (Arowoshegbe & Emmanuel, 2016). A new framework was provided by John Elkington in 1990s to measure the sustainability called 'Triple Bottom Line' (TBL), by which the business success defined as the consideration of the impact of an organization's activities on society, environment as well as regional & national economy. Only Profitability of an Organization was in consideration before the TBL framework.

Three measures of TBL are: (i) Economic line, (ii) Social line and (iii) Environmental line:

1. Economic Line (Ec): Economic line of TBL is defined as the consideration of impact of an organization's business practices on the regional and national economy (Elkington, 1997). It measures the contribution to economy growth due to business activities of an organization. Some variables that deal with the economic line are incomes, expenditures, underemployment rate, employment sharing, job growth, revenue generation, GDP contribution, contribution to gross state product, procurement practices, indirect economic impacts and anti-competitive behaviour.
2. Social Line (S): Social line of TBL is defined as the consideration of organization's fair and beneficial business practice to the workforce, labourers, human capital and the community (Elkington, 1997). It measures the profits in terms of human capital due to business activity of the organization. Social sustainability is related to the impact of the company's business on employees, suppliers, investors, customers and local & global communities.
3. Social variables refer to social dimensions which can extend to education, equity and access to social resources, health and well-being and quality of life. Global Reporting Initiatives (GRI) developed guidelines to measure social impact with following variables: employment design, labour management, staff/labour welfare, industrial safety, medical facilities at work

site, provision for training and education, unbiased social activities, fair business practices, implementation of human rights, local resident, supplier/vendor management, public policy, health & safety, customer discretion.

4. Environmental Line (En): Environmental line of TBL is defined as the consideration of impact of an organization's business practices on the environment. The less impact on the environment and the minimum natural resources consumed by the company's business, the longer and more successful is the business. The Environment sustainability can be managed and monitored by reporting the consumption of resources for running the business and impact on environment by discharging the waste, pollution, emission and greenhouse gases.
5. The variables for environment sustainability measures the impact on environment (air pollution, water pollution, noise pollution), consumption of renewable and non-renewable resources, depletion of natural resources. It may also consider the air and water quality, energy consumption, solid and toxic waste, unwarranted nutrients, electricity consumption, waste management, water treatment, ground water recharge and land transformation.

Further, John Elkington, 1994 has addressed the 'Sustainable Development' which involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. Term Sustainable Development is identical to Sustainable Growth. However, Sustainability and Sustainable Development are not identical. Sustainable Development is a 'development' that need to be sustainable in term of economically, environmentally and socially. The same may be measured with TBL.

For aiming the sustainable development, there must be an accountability not only for the financial bottom line but also the social development and environmental protection.

DELHI INTERNATIONAL AIRPORT (INDIRA GANDHI INTERNATIONAL AIRPORT)

Delhi International Airport is owned and operate by DIAL (Delhi International Airport Limited), a consortium of GMR Group-64%, AAI-26% and Fraport AG-10%. The construction and operation of the airport was the responsibility of the consortium.

Delhi International Airport is one of the most sustainable airport in India. In 2018, it was awarded the Wings India Award for 'Most Sustainable and Green Airport', by Ministry of Civil Aviation & FICCI and it has also been declared the world's 4th best airport and APAC's best improved airport for the Air Service Quality by Airports Council International. Delhi International Airport has been set a benchmark for other airports.

It means, Delhi International Airport is performing well in terms of Economic (Ec), Social (S) and Environmental (En) lines, which could be possible due to sustainability initiates have been taken by the Airport Management.

The economic contribution of the airport is significantly on higher side in terms of together employment and value addition (Singh & Saluja, 2017). The airport management has focused on community development by working on major thrust areas i.e. Education Health & Hygiene and Livelihoods.

In term of Environment performance, the airport has controlled its air & noise pollution and reduced its greenhouse gas emission by developing Carbon Accounting and Management System and also installed number of energy efficient systems and high-tech treatment plants for water, sewage & solid waste.

LITERATURE REVIEW

The word Sustainability came into the light after the concept published in the report of World Commission on Environment and Development (WCED) in 1987. This document is more widely recognised as the

Brundtland Report which describes the Sustainability as *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".* The definition of 'sustainable development' provided by the WCED brought out the attention towards requirement of the cautious development that not only fulfil the needs of present generation but also to fulfil the needs of future generation (Kearins & Fryer, 2011). Under the continuing practise of globalization, the aviation (air transportation) can be considered an essential part which needs to be considered as sustainable development (Carlucci, Cira, & Coccorese, 2018). Airport sustainability defined by Airport Cooperative Research Program (ACRP) as "Practices that ensure, protection of the environment including conservation of natural resources". It comprises not only stable growth of economy and employment generation but also to focus on societal progress by recognizing the needs of airport management (staff, managers, vendors, suppliers etc.), other stakeholders and public (ACRP REPORT 80, 2012). Plan for societal development and environmental protection may be different for different airports. It depends upon airport's size, geographic as well as management of the airport. The Sustainable Aviation Guidance Alliance (SAGA) was formed in 2008 which motivates each airport operator to analyse and decide its own delineation of sustainability by which a sustainability program can be planned, implement and maintained (SAGA, 2009). To analyse, define, plan and implement of the own sustainability program, there is a need of an engagement of all key stakeholders of the airport. A 'Stakeholder Engagement Framework' had already been developed by (Amaeshi & Crane, 2006) to assist airport providers and policy makers/regulators for analysing, framing and implementing the strategies for development of sustainable airports and also to provide guidelines for effective functioning of the framework. The presented framework help to match sustainability strategies with non-market environment, solving queries related to sustainable airport as well as in fixing of goals and performance monitoring standards. In 2013 (Adler, Ulku, & Yazhemsky, 2013) have checked the sustainability of 85 small & regional airports of Europe by using Data Envelopment Analysis. They have mentioned that under private ownership/management, the airport perform better with incentive regulation than the airport management who are working with soft budget constraints.

Further, an evaluation model for analysing environmental protection performance of airports was developed by (Chao, Lirn, & Master, 2017), using Fuzzy Delphi Method that assist the regulatory authority and airport management to formulate and implement the strategies for airport development by which the environmental performance of a particular airport can be improved. The said model was also validated in five international airports of China.

For development of sustainable airports, (Freestone, 2009) has provided some fundamental principles towards planning for sustainable aerotropolis which are: Study of economic forecasting data which are the base for further developments, Cautious analysis of impacts of the development on the environment (EIA; Environment Impact Assessment), Integrating the aviation with vision of urban/ metropolitan development, Engagement of stakeholders by sharing the responsibility and purpose, Detailed metropolitan plan in which provision for effective use of land is provided, Detailed plan for environment safety, Integrated transport planning for airport, Strategies for economic development and attracting the investment as well as to retain the investment in an airport region, Framework provided by the government to facilitate the coordination with concerning public and private entities, Regular discussions/ meetings between airport provider and society as a whole, Steadiness of significant planed objectives and territorialities at airport and surrounding area, city, state and national level.

The application of the principles of sustainable development to an airport situation and to reconcile definitions and interpretations before an idealized representation of a sustainable airport is presented, have been studied by (Longhurst, Gibbs, Raper, & Conlan, 1996). They have also concluded that an airport can be sustainable if it; involves their customers for the discussion or arise an issues, maintain an interrelationship with community to identify and restoring the environmental complications, is capable to satisfy its customer's requirements, provide a forum to discuss the living standards at continental and intercontinental level, make attempts to supervise its effects on the environment and ecology, formation

of policies to diminish its impacts on environment and ecology, is attentive to analyse the effects on existing environment due to a new development, is ready to share the reports related to environmental impact due to a new development, is enthusiastic to achieve the sustainable airport and cautious about its actions which negatively affects the environment and responsible for meeting the present needs without affecting the future generations.

Till 2003, many authors were discussing only to develop the sustainable airports but in 2004, a study was conducted to improve the sustainability of existing airport. The concept for improving the sustainability of new airport was provided by (Kaszewski & William, 2004) by controlling airport structures. They mentioned the four course of actions which are related to airport terminal building design and surface access transport, by which the sustainability of an airport can be improved; 1. BAU (business as usual) plan for an airport's surface access transport and terminal building, 2. GTP (green transport plan), 3. GAP (green architecture plan), 4. Considering the best approach by bringing together the course of action no.2 & 3 along with adopting the latest technology for efficient use of resources and renewable energy.

Surrounding people and stakeholders need to be educated about the sustainability. An important principle were given by (Oto, Cobanoglu, & Geray, 2012) that the sustainability cannot be achieved by only adopting the technological innovation in the development but also there is a considerable raise an awareness to stakeholders and public about their acts which negatively affect the environment. To make them aware an education for sustainability is required. An operating airport cannot be made sustainable without conceiving the sustainability awareness. Accordingly an education for sustainability for development of sustainable airport is required for all the stakeholders and surrounding public. They also said that sustainability of an airport can be achieved through education for sustainability and by providing regular coaching/training to its stakeholders, working staff, clients, business partners and the people, about the sustainable development. Only an education for the environmental protection is not sufficient, the concept of 'environmental bioethics' is also obligatory to comprehend the environmental problems arise due to airport development. Consequently an education is essential to address such environmental complications. (Oto, Cobanoglu, & Geray, 2012) have followed the concept of 'biopolitics for the sustainable airports', in education for sustainability (EfS), given by ARIES, 2007. Efs is an approach to incorporate the main theme of sustainability i.e. environmental sustainability, social sustainability and economic sustainability.

Upham and Mills (2005) carried out a research work to suggest and evaluate a core set of environmental and operational sustainability indicators for setting standards for sustainable airports. Some important core indicators were proposed for the environmental and operational sustainability of airports: Considerable numbers of surface access vehicles, Movement of aircrafts, Static power consumption, Emission to environment (toxic gases, waste water & noise), Commuters at terminal, Surface access commuters. In 2011, the impact on environment due to airport operation were checked by (Sabatino, Solazzo & Britter, 2011). They have studied to check the air quality near Heathrow Airport for sustainable development using model inter-comparison study by EDMS model. The results have shown that the comparison of the annual average model outputs from EDMS with data from monitoring stations with and near Heathrow was generally within 20% of NOx and NO_2. The total NOx predictions were quite similar for all the models through EDMS did produce low concentrations in immediate vicinity of major roads.

Further, a new concept of Multi-Airport System was studied by (Fasone, Guiffe, & Maggiore, 2012). According to them a good MAS (Multi-Airport System) which need to be supported by a coordinated managerial approach, can assist the airport to achieve the sustainability at both level as a business and infrastructure. MAS can also be effective to improve the economic and financial performance along with infrastructural competitiveness.

Private partnership having an important role in sustainability of PPP Airports. Building sustainable contract relationship is benefits to the achievement of social benefits, improvement of future social value and protection of the environment.

The definition of airport sustainability was provided by Airport Cooperative Research Program (ACRP) that, it is a practice that assure the environment protection along with conversation of environmental resources. Additionally, it comprises the societal process that recognise the necessity of airport stakeholders, staff, officials and the public, and ensuring the persistent growth of economy as well as employment (ACRP REPORT 80, 2012).

Robert *et al*. identified 4 major factors which affect the contract structure of the PPP (public and private sectors), (i) benefits to local economic development, (ii) access to the public sector market, (iii) tax exemptions and reduction and (iv) incentives to new market penetrations. These factors are considered differently when the investment proportion changes between public and private sectors of PPP airport. The different attention given into the factors will in turn affect airport's sustainability. Therefore, a proper investment distribution in PPP airport is the key to gaining better sustainability performance which aims to balance social, economic and environmental interest.

METHODOLOGY

The research work is based on the secondary data available in the form of electronic means. The literatures, expertise reports, research papers, case studies related to the topic of sustainability, sustainable airports and airport planning etc, are considered. Moreover, some relevant newspaper articles and journals are also examined for understanding the concept of sustainability. The in-depth literature review is conducted to analyse and collect the appropriate information affiliated to the development of sustainable airports. The literatures have been searched via key words of 'sustainability, sustainable development, sustainable airport and PPP airports'.

The implication of the study to focus on plan for development of sustainable airports.

ANALYSIS AND DISCUSSION

Sustainable Airports

What is sustainable airport? How to develop the sustainable airports? However, generally it is defined as the equilibrium of environmental/ecological, financial/economic and social goals. Adoption of Sustainable development practices in the airport, improves the financial and operational benefits of the airport and provided the social benefits to the society (Hassert, 2017). But still it is not clear what the meaning of being sustainable is? And how to achieved the sustainability and how to know that sustainability is arrived?

Unluckily, the mystic answer is not known but from the review of different literatures we may say that 'the answer may vary from airport to airport and basically depends upon exclusive ownership, contract structure, operating characteristics, tenants/concessionaires, services and the region of the world where the airport is located'.

Elements of Sustainable Airports

Sustainable airport shall be a part of integrated transport planning. It shall be fit into the sustainable mobility so that the airport shall be connected to other modes of transport of the city (Nikolova & Hervouet, 2018). Moreover, it shall also be fit into the sustainable aviation so that the airport shall provide the adequate infrastructures for sustainable airplanes. There shall be an appropriate balance between the Economic goals, Ecological goals and Social goals (Boons, Buuren, & Teisman, 2010).

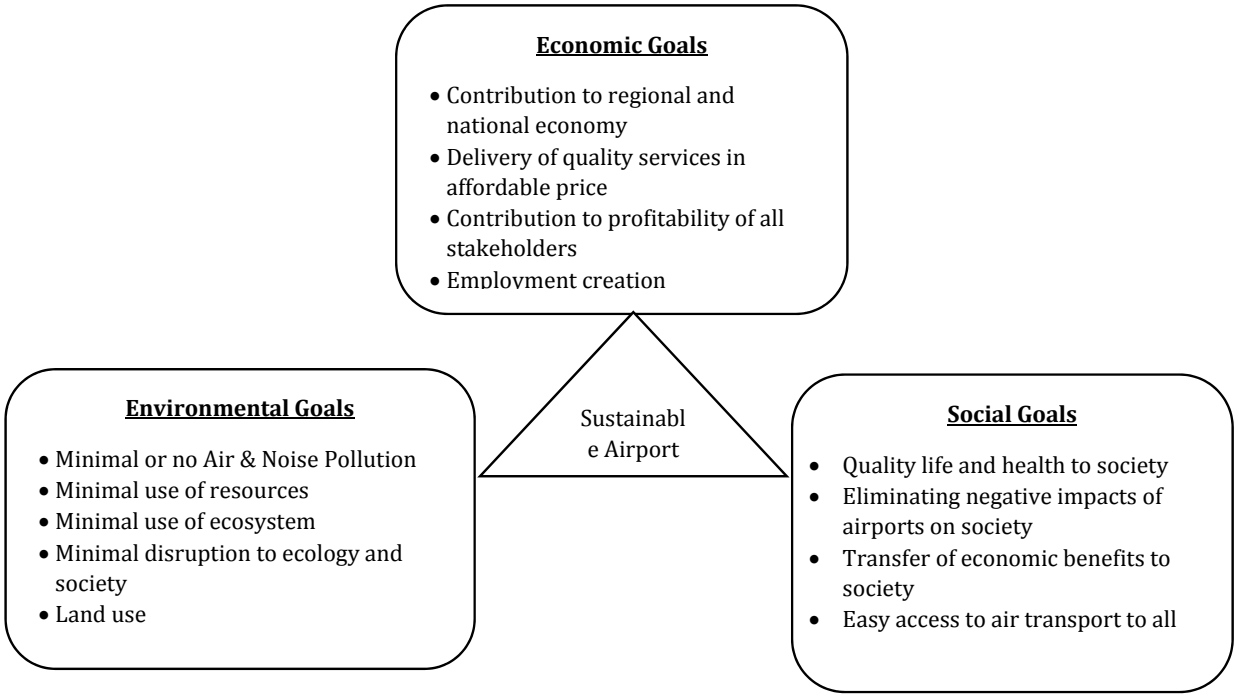

Fig. 1: Elements of Sustainable Airport

Source: Author's compilation; Reference: (Boons, Buuren, & Teisman, 2010)

Airports across the world facing challenges to arrange funds for the development and then to make it profitable in operation stage. Additionally, some new goals and targets are also fixed for improving the environmental performance while frequently managing the scarce funding and inadequate resources. Simultaneously, the airports to be handled the rapidly growing passenger demand while delivering the quality services and meeting the passenger's expectations. Accordingly airports require the strategies and detailed plan for sustainable development by controlling expenses/overheads, improving social life and minimise the impacts on environment. The strategies and plans for development of sustainable airports may be a short-terms as well as long-terms. It should be a core decision of the airport management by involving key stakeholders which are crucial to achieve goals and eventually, maximise efficacy and reduce waste in the developments.

Plan for Sustainable Airports

Planning for sustainable airports or incorporating the sustainability into the airport can be functional in development of greenfield or brownfield airports and also to the operation of existing airports. It may be applied to different components of airports like Runway, Taxiway, Apron, Terminal building, Control tower, Hanger & Parking etc., all such components can contribute to sustainability planning and can help an airport to achieve its ultimate goals of sustainability.

Plan for sustainable airports can be divided into two phases: Construction phase and Operation phase. In this paper, we have considered Operation phase of the airport.

Plan for sustainable airport can be developed and implemented by the airport management. However, the policy and guidelines for the same shall be made by the regulatory authority. The policy makers and regulators have a key role in ensuring the sustainable airports. The regulatory intervention will also help to develop the sustainable airports. They may also incentivise airport operators to more actively look for the sustainable practices.

There are some steps that can be followed in the planning of sustainable airports:

Source: (Airport World; Planning for Sustainability-2017)

- Establishing the environmental context by creating a foundational baseline for benchmarking future initiatives.
- Typical benchmarking process can be followed i.e. planning, analysis, integration, action & maturity.
- Recognise the current positions on sustainability by understanding the vision and culture of the airport organization. There is also a need to review a sustainability mission statement.
- The vision, mission statement and the culture of the organization reveal the willingness of the organization to achieve the sustainability and the current practices towards sustainability shows the present status.
- Develop goals and targets for sustainability by establishing a framework.
- The framework shall consist of the 'main aviation *causes*' and '*effects* of the airport development' for each goals of the sustainability (economic, environmental & social).
- Develop sustainability planning guidance for the key stakeholders of the airport i.e. financiers, engineers, architects, designers, managers, officials, contractors, sub-contractors, suppliers and concessionaires etc. by establishing technology strategies/best practices to accomplish the goals and targets for airport's sustainability.

The above mentioned steps may be similar or differ for each airports but the results will be unique. Various options are available with airports that how they proceed their sustainability planning and how they achieve it. However, the common point is that all airports are focusing to increase the efficiency. If airport's efficiency is increased, the resources utilization in the airport is on higher side by reducing the depletion of resources in its processes. The reduction in waste generation represents adequate utilization of resources and time and lead to potential cost savings. By which the profitability can be achieved.

CONCLUSION

Aviation provides connectivity to the world but adversely affect the environment and surrounding social life. However, it contributes to local as well as national economy and is crucial for increasing job opportunity and country's GDP. Therefore, development of further sustainable airports is must while keeping the ill effects under control. The successful example of Delhi International Airport which has considered environment protection, society improvement along with achievement of economic goals.

Further, sustainable airports are needed and can be developed by taking care of following airport sustainability components:

a. Policy Making: Vision and mission statement for sustainable development, baseline for the benchmarking, development of trade policies related to sustainability, sustainability guidelines & standards, airport design, aircraft design, technology innovation, safety & security, resource management, integrated transport planning, efficient use of airport capacity.

b. Commerce: Return on investment, potential funding, concessions/tenants, stakeholders, regulatory body.

c. Social Responsibility: Community involvement, improvement in human life, equal airport access, job creation, protection of human rights, safe life.

d. Environmental: Energy, air pollution, noise pollution, water pollution, water conservation, solid waste & recycling, land use.

e. Service Quality: Assurance, reliability, responsiveness, tangibility, punctuality, improvement, satisfaction.

By considering the airport components, the sustainable airport is possible.

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A Quantitative Study of Comparison of U-Shaped & Box-Shaped Girder in Context of Indian Metro Rail Systems

Kahan Shah[1], Dr. Devanshu Pandit[2] and Parth Thaker[3]
[1]Final Year Student, Faculty of Technology, CEPT University, Gujarat, India
[2]Professor, Faculty of Technology, CEPT University, Gujarat, India
[3]Design Head, Fuji Silvertech Pvt. Ltd.
E-mail: [1]shah.kahan.bt15@cept.ac.in, [2]devanshu@cept.ac.in,
[3]parththaker2003@gmail.com

Abstract—As the population and traffic of a city grows, public transport should increase. When traffic density increases beyond 8000 PHPDT, for such corridors, metro system should be considered. Metro rail systems are combination of underground and elevated portion. The elevated viaduct portions are made from concrete, steel or composite. Superstructure in elevated viaduct portion consists of girders which can be of different types such as U girders, I-girders, and Box girders. In this research, comparison between two most commonly used girders, the U-type concrete girder (internally prestressed and cast as a whole span) and box-type concrete girder (post-tensioned and casted in segments) is carried out through case studies. A quantitative approach that covers the detailed construction methodology, constructability, material quantities, and time cycle for construction, workforce, quality control, and safety issues have been studied on ongoing metro projects in India. For parameters like cost, time and workforce the quantities are calculated for both and based on those calculations comparison is done between the two girders. While for parameters like constructability, safety and quality the factors are identified which affects the parameters and comparison is made on the basis these points. Case study results in understanding that U-girders are preferable over box-girders in similar applications.

Keywords: Box-Type Girder, U-Type Girder, Constructability, Cost, Time, Quality, Safety, Workmanship

INTRODUCTION

Public transport system are efficient in space utilization and reduces level of air and noise pollution. As the population of a city grows, share of public transport, whether road or rail based, should increase. Road transport can optimally carry 8,000 persons per hour per direction (PHPDT). When traffic density increases beyond this level, average speed of vehicles comes down, journey time increases, air population goes up and commuters are put to increased level of inconvenience. Thus, when traffic density during peak hours crosses this figure, provision of rail-based mass transport, i.e. metro system is considered. After success of Delhi Metro, many cities have adopted metro rail systems and it is operational in the cities of Delhi and NCR, Bengaluru, Chennai, Hyderabad, Jaipur, Kochi, Kolkata, Lucknow and Mumbai (MOHUA, 2019).

Metro rail systems can be underground or elevated. For elevated bridge(viaduct) construction, concrete, steel or composite materials are used. In elevated metro system, a viaduct is constructed above the ground at a height with required clearances from the road level. The viaduct consists of open or deep foundations, based on geotechnical reports whereas super-structure consist of pier, pier-cap, bearings, girders (including deck slab). The most common girder designs are I-shaped girders, U-shaped girders, and Box-shaped girders. Considering urban traffic and space constraints precast is preferred over cast in situ due to obvious advantage it poses.

In viaducts, girders act as a beam that supports the bridge deck on which the rolling stock runs. Concrete girders can be precast or cast-in situ, segmental or whole. Precast girders are transported from casting yard to site and then launched. Girder is the most important construction element of metro projects.

From the construction point of view, girders have a significant percentage of cost associated to it because of the casting yard, complex formwork systems, complex launching systems. Hence, the selection of the type of girder for a particular project becomes vital.

This research builds a comparison of the two most commonly used girders, the U-type girder and Box-type girder. The comparison is made on the aspects of ease of constructability, cost, time-cycle, quality, workmanship, safety associated with the type of girders. `

COMPARATIVE STUDY OF BOX GIRDER AND U GIRDER CONSTRUCTION

In this research, quantitative and qualitative approach is selected for cost and time aspects whereas qualitative approach for remaining parameters. Case study of both the types of girders is carried out to understand the detailed construction methodology, material quantities, time-cycle study, workforce analysis, quality control, and safety issues. The data collected is organised and the common points of comparison were identified.

A case study of an elevated metro is taken up where super-structure is precast segmental box-girder. The box-girder is designed for a medium metro to carry two tracks of standard gauge (1435mm). The whole super-structure is divided into segments on the basis of pier to pier distance and such segment are match-casted in the casting yard using the 'long line' method. After casting of the segments gantry cranes of required capacity are used to lift and place the segments into the stacking yard. When the particular segment needs to be launched at the site onto its particular position the segment is transported from the stacking yard to the site using heavy duty trailers. The casting yard is spread over an area of approximately 28,500 sq.m and consists of offices, testing lab, storage area, batching plants, steel yard, stacking yard, casting beds and area for reinforcement jigs. There are two batching plants of capacity 30 m3/hr & 60m3/hr. There are around 6 casting beds (4-28m & 2-31m) for intermediate segments and 6 casting beds for end segments (EJ-bed) with 6 gantry cranes (3-20T & 3-70T). Stacking yard has a capacity of storing 650 segments.

Typically, there are three types of segments used in the super-structure of viaduct:

1. End Segments: The End-Segments rest on pier, hence for a span there are two such segments.
2. Segments with Future Stressing: These segments are adjacent to end segments and consists of 'blister' which would have a provision to be stressed in the future.
3. Normal Segments: These segments are all the remaining ones from the above two types.

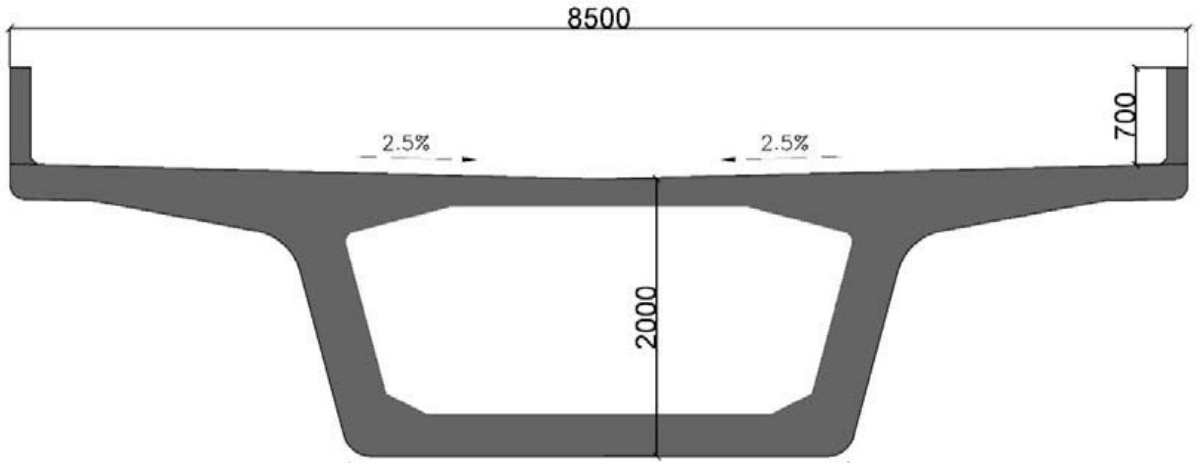


Fig. 1: Typical Section for Box-Girder

Another case study of an elevated metro is taken up viaduct where the super-structure is Precast U-girder. The U-girder is designed for a medium metro to carry one track of standard gauge (1435mm), and so two U-girder spans are used for metro. The whole super-structure is casted on the basis of pier to pier distance using the 'long line' method. After casting of the U-girder gantry cranes of required capacity are used to lift and place the girder into the stacking yard. When the particular girder needs to be launched at the site onto its particular position the girder is transported from the stacking yard to the site using heavy duty trailers. The casting yard is spread over an area of approximately 28500 sq.m and consists of offices, testing lab, storage area, batching plants, steel yard, stacking yard, casting beds and area for reinforcement jigs. There are two batching plants of capacity 60 m3/hr. There are around 4 casting beds (2-28m, 1-25m & 1-18m) for segments with 4 gantry cranes (2-20T & 2-70T). Stacking yard has a capacity of storing 90 segments.

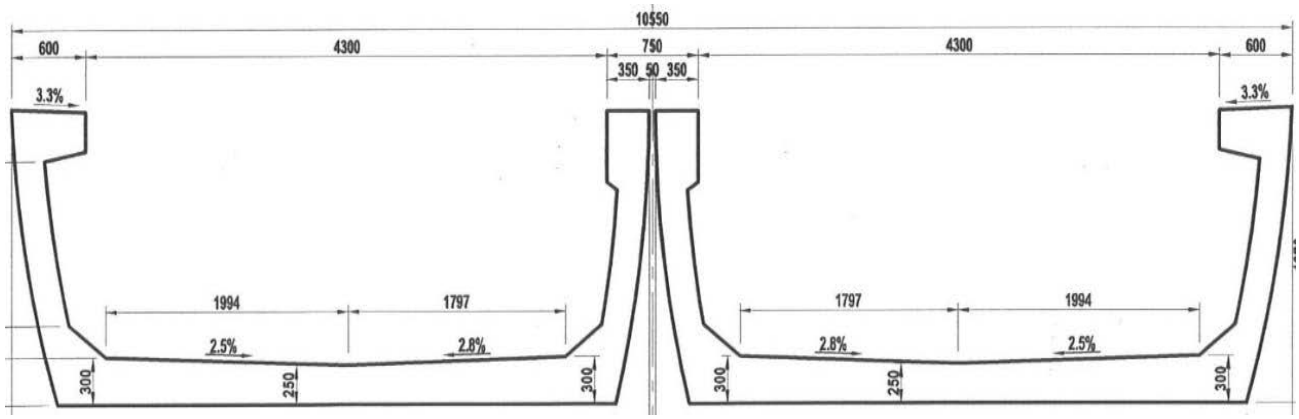


Fig. 2: Typical Section of U-Girder

In both the case studies i.e. the Box-girder and the U-girder a sample of 10 span has been observed for each of the girders. The detailed construction method carried out on site has been observed for both the girders. Cost, time, safety, quality, workmanship are calculated and observed for all the samples and an average result of all the samples is taken into consideration.

CONSTRUCTION METHODOLOGY—BOX GIRDER

The construction methodology adopted for super-structure construction is Precast Segmental Box-Girders match-casted in a casting yard using the "long line" method and then transporting the segments for launching using Launching Girder.

The end-segments (i.e. Segment S1 and S5 shown in fig. 1) are constructed first on a separate bed allotted. The first activity in construction of Segment is the preparation of reinforcement cage for the segment on reinforcement jig using the appropriate standard of reinforcement bars. After the cage is prepared, gantry crane is used to lift the cage from the jig and place in on the casting bed. During this time, Outer formwork (specially designed mild steel formwork used for segment casting) is properly placed at its position, properly oiled & stiffened with the bed. Parapet Form is fixed after the cage is fitted. Bulk head (face formwork) of one side is fixed and HDPE pipes are inserted and fixed with the Bulk head. The profiling of HDPE Pipes is done, and the inner formwork is inserted and fixed. Bulkhead of the remaining side is fixed afterwards. After thorough checking, Concreting is done with boom placer and needle vibrators are used for compaction. After achieving the desired strength the end-segment are lifted and placed on the casting bed for intermediate (i.e. Segment S2, S3, S4 as shown in fig. 1) segments. Match-casting is done for intermediate segments i.e. the normal (S3)and with blisters (S2 & S4). Debonding agent is applied before casting of intermediate segments, otherwise the method is entirely same of intermediate segments.

After casting is completed and desired strength is achieved, the segments are lifted and placed in the stacking yard.

Launching of segments is done using the Launching Girder. The launching girder mainly consists of Truss Boxes, Front support, Middle Support, Rear support, Rear trolley and Sliding Beams. First Two spans are launched by Ground-Launching System and then with the help of cranes the launching girder is established above the viaduct.

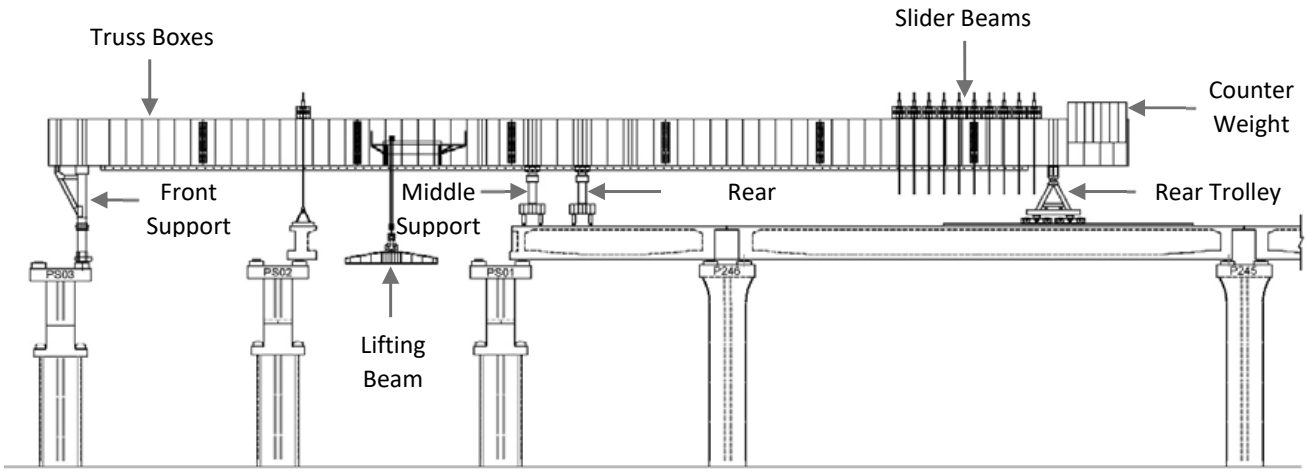


Fig. 3: Launching Girder Assembly

After auto-launching is completed, lifting of segments is carried out. Macalloy bars are inserted into the lifting holes in the segments passing from the temporary stressing beam and lifting tackle is fixed with it. Now, jack is placed on the top of collar plate and the bar passes from this system. Stressing is done in all four macalloy bars. The segments are lifted in sequence and after every segment that is lifted, the slider beams having cables are connected to the temporary stressing beam so that the lifting beams are free and can lift another segment. After all the segments are lifted, dry matching of segments is done and special type of glue is applied to the face of segments and they are joined together by horizontal stressing. The whole span is now rested on the pedestal. Post-tensioning activity is carried out using High Tensile Strands of 15.2 mm diameter, where a jacking machine is used which provides enough force for tensioning. After tensioning, grouting is done with a mix of cement and special agent.

CONSTRUCTION METHODOLOGY—U-GIRDER

The construction methodology adopted for super-structure construction is Precast U-girders casted in whole span in a casting yard using the "long line" method and then transporting the segments for launching using Cranes.

There are dedicated reinforcement jigs provided for each bed and the reinforcement cage is prepared over there. Using Gantry Crane the cage is lifted and placed on to the casting bed. Before its is placed, the outer formwork and side formwork (i.e. specially designed Mild Steel formwork used for U-girder casting) is placed and fixed with the casting bed. The reinforcement cage along with the debonding tubes is fitted in the assembly. The High Tensile Strands are passed through the cage and debonding tubes. Proper alignment and checking is done of the positions of H.T. Strands. Stressing is done from the anchor end and is recorded in the form of load vs extension. Re-aligning is done and concrete of the required grade and standard is placed and compacted. After concrete gains required strength, stressing of H.T. Strands is released and the strands are cut using wheel cutting machine. The U-girders are placed in the stacking yard.

U-girder is loaded onto the multi-axle trailor with the required specifications using 2 no.s of gantry cranes. There has to be proper frame fixed with the trailor and suitable rubber packaging must be done. Prior to the transportation, route survey has to be done and any obstructions or damage in the road has to be addressed. The U-girder has to be brought onto the erection site as per the U-girder orientation. The trailor must be placed based on the locations of the lifting cranes. Total required checking and surveying of the cranes must be completed. Lift plan of the U-girder is prepared on the basis of Weight of the U-girder to be erected, Sequence of erection, Capacity of the crane for maximum radius and maximum boom length as per load chart. Typically, two cranes are required of 400T and 250T. Lifting beams are fixed with the girder and hooks from the crane is fixed with the lifting beam. This whole assembly is lifted and placed onto the pier cap. Before final placing and after placing of U-girder survey is done and checked whether the girder has been in alignment.

CONSTRUCTABILITY COMPARISON

Ease in constructability is a major component as it reduces time, cost and skill required to perform the activity. Comparison can be made between the Box-girder and the U-girder as there are different construction methods ultimately serving the same purpose.

Box-girder is constructed in segments and U-girder is constructed as a whole span. Construction of segments for Box-girder is less challenging as the length of the segments is approximately about 3m and thus reinforcement preparation, formwork, concreting and all other activities are less challenging. While talking about the U-girder, whole span i.e. around 25m is casted at once and thus making reinforcement cages, formwork and concreting of such a big structure becomes challenging.

Prestressing is done for U-girder and Post-Tensioning is done for Box-girder. Prestressing of U-girder has its own challenges and same way post-tensioning for Box-girder has its own. But prestressing is done on ground while casting the girder in casting yard. Additionally, the strands are passed throughout the girder at the time of casting. Here, in box-girder after the segments are casted, launched, glued and rested the post-tensioning activity takes places. The activity is done at quite a height and requires extreme safety measures and also at the time of casting of segments the provision of HDPE pipes and its co-ordinates have to be maintained precisely for every segment and must match after it is launched. Thus, post-tensioning activity is considered far more challenging then the pre-stressing in this case.

Erection of Box-girder segments is done by launching girder and erection of U-girder span is done by cranes. The erection process of box-girder segments is considered challenging as the operation of launching girder is very critical activity. All the segments have to be lifted one at a time and it involves vertical and horizontal stressing activities which are performed by experts on the field. The task of lifting the segments requires precision and expertise. Gluing of the segments is a risky job and requires extreme safety precautions as person can fall to death. On the other hand, the erection of U-girder is done with the help of cranes which require co-ordination between the crane operators and precision in lifting and placing of the girder. Considering both the cases, Launching of the box-girder by launching girder seems to be a more challenging task.

Thus, looking at the overall construction methodology for both the girders i.e. Box-girder and the U-girder, the ease of construction is more in case of U-girder as compared to the Box-girder. U-girder is a better option as compared to the Box-girder in terms of ease of constructability .

COST COMPARISON

Box-girder under the study is capable of carrying two tracks of standard gauge 1435mm. While the U-girder is capable of carrying One track of standard gauge 1435mm. Thus a comparison has to be done between a one Box-girder span and two U-girders span (refer Figure 1 & 2). Thus, a single Box-girder and

two U-girder would serve the same purpose of carrying two rolling stocks. The Box-girder of span 13.90 m is taken under study and U-girder of span 25.00 m is taken under study. The overall cost in casting, launching and all the other activities included in construction of super-structure is taken into account and 'per meter' cost is derived, as one Box-girder and Two U-girder per meter would serve the same purpose of carrying two tracks for metro. This would clearly state the better girder among the two types in terms of cost.

COST SUMMARY SHEET

Table 1: Cost Summary Sheet for Box-Girder and U-Girder

Activty	Box-Girder Span (13.90m)	2no.s U-Girder Span (25.00m)	Box-Girder Cost (per m)	U-Girder Cost (per m)
Reinforcement	1673048	1558852	120363	62354
Formwork	172403	269774	12403	10791
Concreting	670486	1110120	48236	44405
Stressing	133507	347715	9605	13909
Erection	398245	238387	28651	9535
Grouting	12401	NIL	892	NIL
Total	3060090	3524847	**220150**	**140994**

The Box-Girder is **₹ 79156** per meter costlier than U-Girder.
Box-Girder is **1.56 times** costlier the U-Girder.

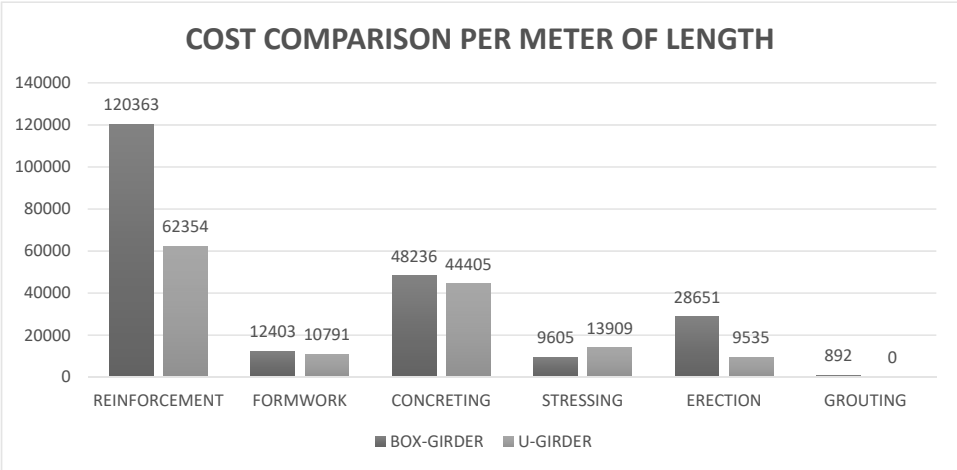


Chart 1: Cost Comparison of Box-Girder and U-Girder

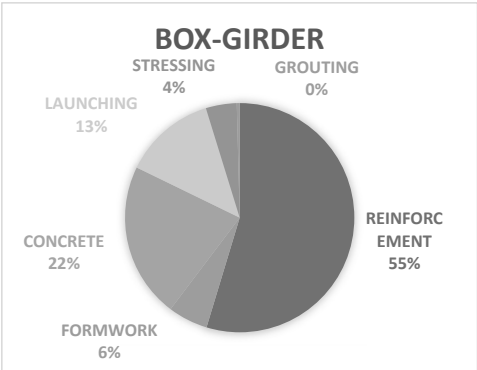


Chart 2: Percentage Cost of Activities for Box-Girder

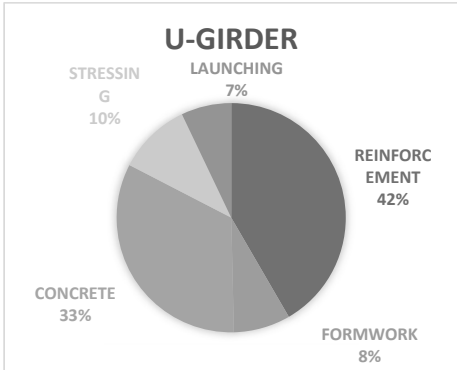


Chart 3: Percentage Cost of Activities for U-Girder

Inferences

- It could be seen form the pie charts, cost of the reinforcement activity for Box-girder is higher than the U-girder. Primary reason being the shape and structure of the box-girder, it uses higher reinforcement than U-girder. Also, segments require higher reinforcement as compared to the whole span for U-girder.
- Formwork costs for both the girders are very nearby, as the formwork systems used by both the girders is quite similar and of same rates.
- Concreting activity for U-girder has higher costs than that for Box-girders, the reason being the grade of concrete. The concrete grade used in U-girder is higher than Box-girder.
- Launching of girders for the both the types are two different activities and thus cannot be compared. So, comparison has to be made at the final outcome i.e. the cost of launching of girders per meter.

Thus, Cost of Box-girder is higher as compared to the U-girder. U-girder is a better option as compared to Box-girder in terms of cost.

TIME COMPARISON

Time taken by the activities involved in construction of Box-girder and U-girder are noted down for samples and an average time for completing every activity is calculated in terms of hours. A total time required by the activities like reinforcement, formwork etc. for 13.90 m span of Box-girder and two numbers of 25.00 m span of U-girder are noted down and shown in the first two columns of the table given below. Now for comparison purpose, the Box-girder values is divided by 13.90 m and for U-girder the values are divided by 25.00 m. Thus, the values obtained for every activity is per meter, as both Box-girder and 2 numbers of U-girder per meter serve the same purpose of carrying two tracks for metro.

Table 2: Time Summary Sheet for Box-Girder and U-Girder

Activty	Box-Girder Span (13.90m)	2no.s U-Girder Span (25.00m)	Box-Girder Cost (per m)	U-Girder Cost (per m)
Reinforcement	67.00	173.00	4.82	6.92
Formwork	30.50	18.50	2.19	0.74
Concreting	17.50	15.50	1.26	0.62
Stressing	9.50	14.50	0.68	0.58
Erection	65.50	21.00	4.71	0.84
Grouting	5.25	NIL	0.38	NIL
Total	195.25	242.50	**14.05**	**9.70**

Time Required per meter of construction of Box-Girder = **14.05 hrs**
Time Required per meter of construction of U-Girder = **9.70 hrs**

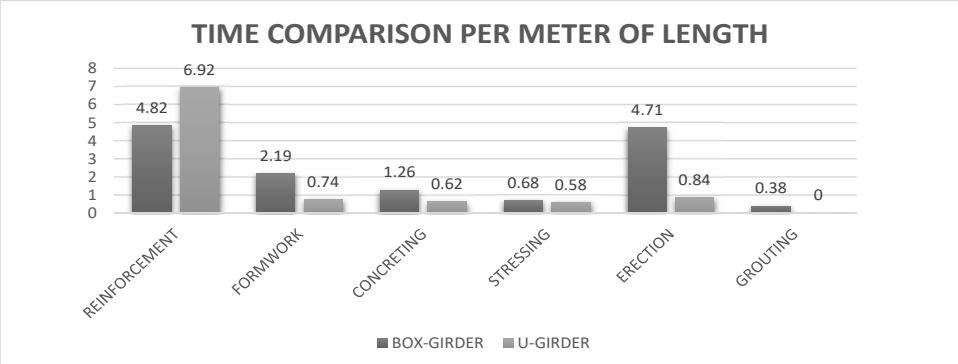
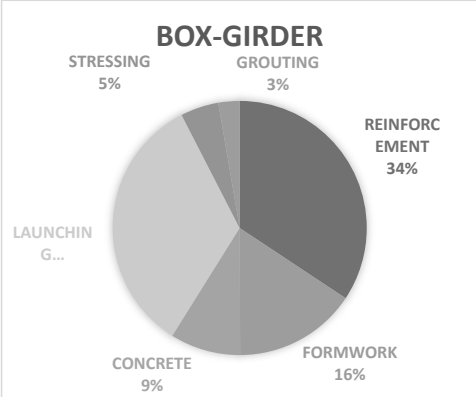


Chart 4: Time Comparison for Box-Girder and U-Girder



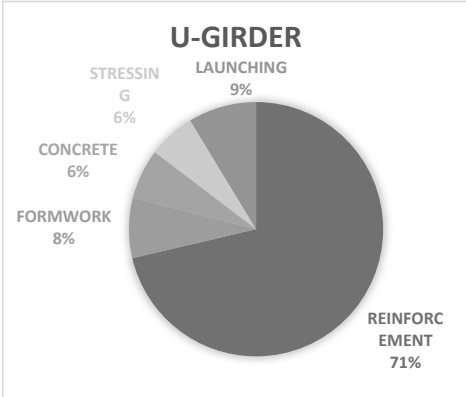


Chart 5: Percentage Time Taken by Activities for Box-Girder **Chart 6: Percentage Time Taken by Activities for U-Girder**

Inferences

- Reinforcement in U-girder is 71% of the total time and for Box-Girder it is 34% of the total time. As U-girder of 25m span is casted at once, the reinforcement cage for the girder has to be fabricated for whole 25m. Operations like preparing, fabricating, lifting, placing, aligning and checking takes up a considerable amount of time. While in Box-girder the operations are done for segments which are approximately 3m in length and therefore it is easy to work with.
- Formwork for Box-girder takes up almost double the time of U-girder, possible reason for this is the easiness in working with the formwork. The formwork are specially designed for the respective girder construction and it is particularly easy to work with. In U-girder the formwork system has to be assembled for whole 25 m at once, while in Box-girder it has to assembled for every segments and then dissemble. Thus, while talking about per meter time taken, when considered for the whole span of box-girder the operations takes up considerable time.
- While talking about Concrete activity, the Box-girder is taking higher time as compared to the U-girder. The reason is believed to be the same as the Formwork activity.
- Pre-stressing in U-girder and Post-Tensioning in Box-girder have almost same amount of time and thus the reason being, it is done at once for the whole span. Here, activity like grouting should be considered as a part of post-tensioning activity and thus the added time and cost.
- Launching of Box-girder takes up considerable amount of time as compared to the time taken for launching of U-girder. Launching is done for both the girders in different manner, for box-girder the launching is done by launching girder and for U-girder the launching is done by cranes. Thus, both the girders launching activity has nothing in common and thus should be looked upon as different activities and the final outcome (i.e. the total time taken) should be compared.

Thus, time required for construction of Box-girder is higher as compared to the U-girder. U-girder is a better option as compared to Box-girder in terms of time.

SAFETY COMPARISON

Table 3: Risk Score Sheet for Box-Girder and U-Girder

Box-Girder		
No.	**Activity**	**Risk Score**
1	Cutting bending of reinforcement	3
2	Transporting bars	2
3	Reinforcement	2
4	Lifting & placing of reinforcement cage	2
5	Outer formwork	2
6	Profiling - formwork	2
7	Bulk head - formwork	3
8	Inner form - formwork	3
9	Preparing & transporting of concrete	2
10	Tests performed	1
11	Concreting	3
12	Finishing	2
13	Curing	1
14	Deshuttering	2
15	Lifting & stacking	5
16	Auto-launching	5
17	Transportation of segments	4
18	Temporary stressing beam	3
19	Vertical pre-stressing	3
20	Fixing of lifting beam	3
21	Lifting of segments	5
22	Dry matching	1
23	Glue preparation and application	2
24	Horizontal stressing	1
25	Passing of strands	5
26	Setting up of jack machine	5
27	Stressing	5
28	Removing of system	5
29	Setting up of system	1
30	Material preparation	1
31	Grouting	5

U-Girder		
No.	**Activity**	**Risk Score**
1	Cutting bending of reinforcement	3
2	Transporting	2
3	Reinforcement	2
4	Lifting & placing of reinforcement cage	2
5	Laying of strands	2
6	Destressing	2
7	Stressing	4
8	Barrel-wedge fixing	2
9	Cable threading	2
10	Laying debonding tube	2
11	Outer formwork	2
12	Bulk head - formwork	3
13	Inner form - formwork	3
14	Deshuttering	2
15	Lifting & stacking	5
16	Lifting & placing u-girder on trailor	5
17	Transportation	3
18	Placing of cranes	2
19	Placing of trailor	1
20	Lifting and erection	5
21	Alignment	5

Note:

Table 4: Risk Scores

RS 1	Small Injuries, No First Aid Requirement
RS 2	Moderate Injuries, First Aid Requirement
RS 3	Serious Injury, Hospitalized for Considerable Time
RS 4	Permanent Serious Injuries
RS 5	Loss of Life

The average Risk score for Box-Girder = **2.87 / 5.00**
The average Risk Score for U-Girder = **2.81 / 5.00**

While comparing the Box-girder and the U-girder in terms of safety, the method adopted to carry out the comparison is by giving 'Risk Score' to all the activities involved in the process of casting and launching of both the girders.

- Risk Score 1: Small injuries, no first aid requirement
- Risk Score 2: Moderate injuries, first aid requirement
- Risk Score 3: Serious injury, hospitalized for considerable time
- Risk Score 4: Permanent serious injuries
- Risk Score 5: Loss of life

Such Risk Score are given to the activities. While giving the scores, the activity's worst possible damage and amount of occurrence is considered.

Box-girder has score of 2.87 out of 5, while U-girder has score of 2.81 out of 5. This suggests that Box-girder has higher risk in construction than the U-girder. But the values are almost nearby, thus it can be considered that both the girders are equally challenging to construct. Here, Box-girder has a greater number of activities which have scores either 4 or 5 and thus, it has to be considered as riskier than the U-girder.

Activities of Box-Girder like auto-launching of the launching girder, post-tensioning and grouting after the span has been erected increases the risk significantly. While on the other hand for U-girder, pre-stressing is done on the ground, launching is done by cranes and thus the risk is reduced substantially. Thus, U-girder is a better option as compared to Box-girder in terms of safety.

Quality Comparison

Quality of a construction element mainly depends on four factors i.e. Design, Materials, Equipment, Method of Construction.

Design: Comparing the Box-girder and U-girder on the basis of the design, more the ease constructability more is chances of better quality. In Box-girder the void has to be constructed and the formwork elements required for achieving the void are complex and requires perfection to achieve the good finish of surface. Additionally, proper compacting of concrete in the void is a difficult job for workers as the height of void is around 1.2 m and also the inner formwork takes most of the place. This results in inferior quality. The parapet wall of the box-girder is thin and requires complex formwork. The compaction of concrete is difficult and firmness of formwork is an issues while placing and compaction of concrete. This could result in improper alignment and inferior quality. The web of the Box-girder have heavy reinforcement and sheathing pipes present and thus placing and compaction of concrete becomes difficult and may result in concrete defects.

In U-girder construction of the web pose difficulty as the web thickness is less and has prestressed cables and pipes are present which could result in improper placing and compaction of concrete thus producing inferior quality of concrete. Maintaining the curve of the web is difficult task as the girder is constructed as a whole span and defect in formwork could result in misalignment.

Materials: Materials used for construction of girders have major effects on the girders. Assuming that the quality of materials used are fitted as per the specifications and thus comparison on this point becomes unnecessary.

Equipment: For casting, stacking and transporting of the girders the equipment used are similar and thus comparison cannot be made on the basis of these equipment's. The Box-girder uses Launching Girder as a method of erection while the U-girder uses Cranes as method of erection. Launching Girder is stabilized

on the super-structure and thus, the lifting process carried out would have less chances of damaging the segments or nearby elements. While on the other hand, the U-girder is lifted with two cranes. The co-ordination between the two crane operators, the lifting of the whole span, the technique of lifting etc. have lot of invariables and thus has greater chances of damaging the girder.

Method of Construction: In Box-girder construction, segments have to be casted and launching individually. Thus, there is a chance of deviation in quality of every segment of the same span. The segments have to be dry-matched before the application of glue on the surface thus the shear key's position has to be precise, if not the whole structure could fail. Specialized glue is used for the segments sticking and forming the whole span and thus it is likely that the strength of the box-girder span is reduced.

In U-girder construction, the whole span is casted at once and thus it is difficult to maintain the quality throughout the span. If proper construction and casting is not done, it could result in inferior quality. If there is failure in some part of the span, the whole span could fail and thus there would be a great financial loss as the company would have to construct it again.

Evaluating the above factors affecting the quality of girder. It can be deduced that Quality of Box-girder is likely to be affected as there are multiple factors involved in the construction of Box-girder. Thus, U-girder is a better option as compared to Box-Girder in terms of quality.

PRODUCTIVITY COMPARISON

Every activity involved in construction of super-structure requires skilled and unskilled workers to complete the tasks. Here, to make a comparison between the Box-girder and the U-girder based on workmanship, all the activities and all the sub-activities involved in construction of super-structure are taken into account, each activity's skilled and unskilled worker requirements are measured as man-hours (in hours) given by the respective worker to a certain activity. All such activity's worker requirement is measured. The outcome is in terms of man-hours skilled worker required and man-hour unskilled worker required. Higher the skilled and unskilled man-hours higher the workmanship required and that means the particular activity requires high skill. Thus, lower the skilled and unskilled man-hours, more favourable it is.

The following tables shows the total skilled and unskilled man-hours required for each activity for both the girders. Here, the box-girder span is 13.90m and U-girder span is 25.00 m and thus the values of man-hours is divided by their respective span length thus, to get man-hours of skilled worker required per meter.

Table 5: Comparison of Skilled Man-Hours between Box-Girder and U-Girder

Activty	Box-Girder Span (13.90m) (Skilled Man-Hrs)	2no.s U-Girder Span (25.00m) (Skilled Man-Hrs)	Box-Girder Cost (Per m) (Skilled Man-Hrs)	U-Girder Cost (Per m) (Skilled Man-Hrs)
Reinforcement	201.00	302.00	14.46	12.08
Formwork	51.00	21.50	3.67	0.86
Concreting	26.00	55.00	1.87	2.20
Stressing	34.50	43.50	2.48	1.74
Erection	181.75	45.00	13.08	1.80
Grouting	10.50	NIL	0.76	NIL
Total	504.75	467.00	**36.31**	**18.68**

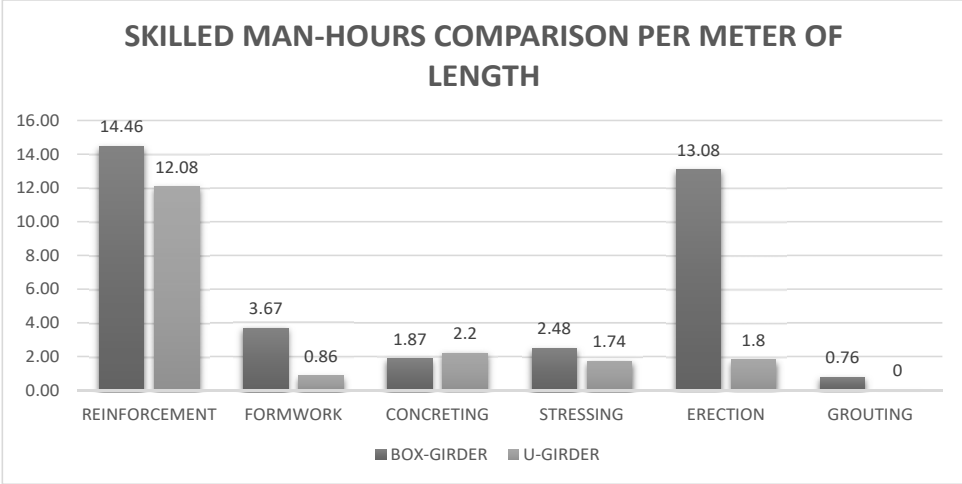


Chart 7: Skilled Man-Hours Comparison between Box-Girder and U-Girder

The skilled man-hours required for Box-Girder per meter of length **= 28.26 man-hours**
The skilled man-hours required for U-Girder per meter of length **= 18.68 man-hours**

Table 6: Comparison of Unskilled Man-Hours between Box-Girder and U-Girder

Activty	Box-Girder Span (13.90m) (Unskilled Man-Hrs)	2no.s U-Girder Span (25.00m) (Unskilled Man-Hrs)	Box-Girder Cost (per m) (Unskilled Man-Hrs)	U-Girder Cost (per m) (Unskilled Man-Hrs)
Reinforcement	257.05	326.00	18.53	13.04
Formwork	94.00	43.00	6.76	1.72
Concreting	89.05	124.00	6.44	4.96
Stressing	48.00	137.00	3.45	5.48
Erection	306.75	119.00	22.07	4.76
Grouting	21.00	NIL	1.51	NIL
Total	816.75	749.00	**58.76**	**29.96**

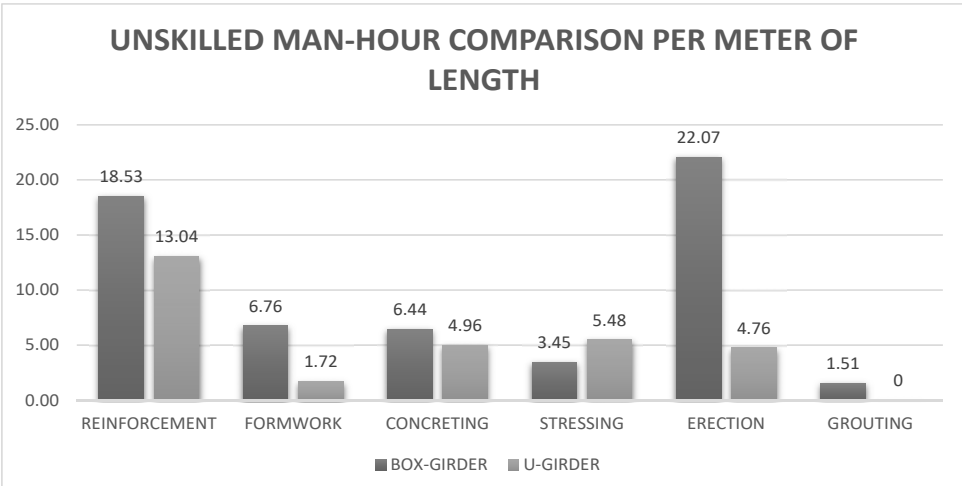


Chart 8: Unskilled Man-Hours Comparison between Box-Girder and U-Girder

The skilled man-hours required for Box-girder per meter of length **= 58.76 man-hours**
The skilled man-hours required for U-girder per meter of length **= 29.96 man-hours**

Thus, in terms of workmanship the U-girder requires less skilled and unskilled man-hours as compared to Box-girder and thus, U-girder is better in terms of workmanship.

The major activity which requires high skill is the erection of segments by launching girder in Box-girder. Activities like Auto-Launching of Launching Girder, Lifting of segments, vertical and horizontal stressing, gluing and span lowering requires very high skill. While on the other hand, the U-girder is lifted by Cranes and thus it is easier and requires less skill workers in executing the task. Thus, U-girder is a better option as compared to Box-girder in terms of workmanship.

CONCLUSION

After a thorough comparison between the Box-girder and U-girder typically used as super-structure elements for Indian metro railways on the aspects of Ease of constructability, Cost, Time, Safety, Quality and Workmanship the U-girder has emerged out to be the better option on each and every aspects discussed above. The major difference that makes U-girder the better option is its erection procedure, the erection of U-girder is done by the cranes where the erection of the Box-girder is done by launching girder. Now, major cost and time differences arise out this different erection methods. Launching girder system is costly and the workers required to operate it must be highly skilled, whereas the crane operations are not as difficult as compared to the launching girder. This affects the time, cost, productivity, ease of constructability. Another major point in the comparison is the shape and design of both the girders, U-girder uses lesser materials and is easy to construct while box-girder has complex structure, uses more materials as compared to U-girder and is difficult to construct in segments and launch. Thus, based on all these major and minor points, it can be concluded that U-girder is a better option than the Box-girder.

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A Detailed Study on Industry 4.0 & Automotive 4.0 in Context of Opportunities & Challenges for Electric Vehicles Industry

Jayesh Ramnani
MBA Student,
School of Petroleum Management,
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: Jayesh.rpgp19@spm.pdpu.ac.in/ ramnanijayesh56@gmail.com

Abstract—In the 21st century, the automotive industry has seen different phases. Today this industry is moving towards using technologies like Electric Vehicles, Hybrid vehicles, etc. which can give them an upper edge in the competitive market. In doing so, companies will require a new revolution of customized products from mass production. In this phase of the automotive sector, Industry 4.0 can play a huge role in developing customized Electric Vehicles and at a faster pace to sustain in this competitive market. During this journey the companies will also need to develop the ecosystem like efficient chemical Energy Fuel cell chargers, fast charging of Electric Vehicles, etc. which must be acceptable by the consumers. This will give a boost to the energy sector across the country, as the market will see a major shift from petrol and diesel engine to new technologies like electric engines. Today, where two-wheeler manufacturers are also moving towards Electric Vehicles, Industry 4.0 with the help of machine learning, big data, cloud computing, etc. can help automotive sector for entering in the new market and leverage the technology of fully Artificial Intelligence-based techniques for the production of Fuel cell charging systems and fast charging. The argument of this paper is how Industry 4.0 can give birth to a fully automated Electric Vehicle sector. The objective of the paper is to analyze the challenges faced by the manufacturer of Electric Vehicle and what all can be the opportunities for them with the help of Industry 4.0. During this process, the primary data will be collected from companies manufacturing Electric Vehicles and secondary data will be collected from various sources and research papers. The focus of this paper is on how Industry 4.0 will help automotive companies to develop and boost their growth.

Keywords: Electric Vehicles, Manufacturing, Industry 4.0, Fuel Cell

INTRODUCTION

The term 'Industry 4.0' denotes an era of the cyber-physical system, machine learning and Artificial Intelligence (AI). In this era of smart factories and warehouses, Industry 4.0 plays a key role because of the rapid change in the production system. Industry 4.0 is the big buzzword that is flying around us. It means the technology which has changed the Industry. It has smart factories which are equipped with connected machines and robots which talks to each other and give results accordingly, it generates huge data which can be stored in big data and with the help of machine learning and AI it can make sense out of that data and we can implement the necessary changes. In this new era, we need to change from Industry 3.0 to Industry 4.0 for which we need to rethink our business or and shape our business as it can give the desired outcome out of it, otherwise, we will be left behind from the market. (Rojko, 2017)

The First Industrial Revolution utilized water and steam. The Second utilized electric capacity to make large scale manufacturing. The Third utilized gadgets and data innovation to computerize generation. Presently a Fourth Industrial Revolution is expanding on the Third, the computerized unrest that has been happening since the center of the only remaining century. It is portrayed by a combination of advancements that are obscuring the lines between the physical and computerized systems. (Schwab, 2016)

Automotive Industry includes producing, designing, developing, advertising and selling of motor vehicles. In India automotive industry is on a verge of change because of the introduction of BS-VI engines as well as Electric vehicles (EVs). In this revolution of the Automotive Industry, Industry 4.0 can bring huge opportunities for the Automotive Industry in the adoption of rapid changes with the trend in the industry

which can help to bring the EVs in the market with mass customization and changing in consumer demand. Industry 4.0 can change the production line of vehicles from muscle production to mechanical production which can bring new opportunities and trends in the Industry.

Electric Vehicles are vehicles that run on electricity instead of Petrol or Diesel normally lithium-ion is used as fuel in EVs. EVs are emerging in the Indian market for the revolution in the Automotive Industry. EVs market in India may face problems because of inadequate facilities available for charging of vehicles, the high price of EVs currently, inadequate electricity supply in some parts of India, inadequate technology for production and charging and automotive industry downwards trend in India. In the production of EVs innovation of changing production processes to Industry 4.0 may give a new upfront curve to the market. Also, it required a huge investment which may be difficult for the market players on the other hand BS-VI engine also needs innovation which requires investments.

THE PRESENT STUDY

The present study was designed to find an answer to the following questions:

1. Is Industry 4.0 relevant to adopt in Automotive Industry for the production of EVs in the current market position?
2. What may be the various opportunities & challenges in the production of EVs in India?
3. Do we have sufficient energy available for the revolution in the Automotive Industry?

The automotive industry is on the verge of another revolution in our country (India). Electric vehicles (EVs) are to be introduced in the market and producers are also rapidly moving with market demand of EVs as well as BS-VI engines which may give Automotive Industry a new upfront as compared to the current market position. Also, consumer demand is changing day by day industry is moving towards customized production from mass production for enhancing customer experience. This change from making to stock to make to order has driven the Automotive Industry towards Industry 4.0 where Artificial Intelligence and machine learning can play a huge role in the value chain. (Yin, 2018) Production of EVs can give a boost to the energy sector also as its fuel is lithium-ion batteries but our country lacks such important raw material for production so it must be dependent on imports. Also, we must discuss other factors like charging durations of batteries and payload issues in EVs. This can give a major shift to Auto Industry from petrol and diesel vehicles to EVs but producers, as well as the government, needs to work on certain factors for this technological revolution in Auto Sector. Industry 4.0 in this situation can give a major shift to the EVs sector by producing vehicles with the help of big data, IoT, etc.

Industry 4.0 has been long been cheered in manufacturing sector for inventory management, smart production, reducing costs of production, customized production, etc. various books, papers, magazines, and newspapers have suggested numerous ways of application of Industry 4.0 in manufacturing sector but talking about Automotive sector where mass customization is needed in current market position, Industry 4.0 can play an important role in manufacturing auto parts as well as electric vehicles. Industry 4.0 is watching the whole network of machines instead of individual computerized machines, we have smart machines that can talk to each other with the help of sensors in them so they can diagnose their problem. Industry 4.0 is a new trend towards automation and smart manufacturing which includes Cyber-Physical Systems (CPS), the Internet of Things (IoT), Big Data, Cloud Computing, Artificial Intelligence (AI), etc. (Y.M. Goh, 2016)

Promoting Industry 4.0 in theory and implementing it in real life has many differences in production. EVs production will need a major shift in production lines which will increase cost of production So that will affect the price of EVs in that context our eyes must be on cost reduction because the cost can drive the market in totally different directions. However, we could find answers by using a quantitative approach.

To find the answers, we decided to survey Mechanical graduates and industry people. (Cheng, Liu, Qiang, & Liu, 2016). In India two-wheelers market is also on the verge of change in current market scenario best two-wheelers run for 150 kilometers after a full change of battery also costs high as compared to normal two-wheelers on other is to tackle this problem government is coming with new policies and subsidies for the buyers of EVs. So, in two-wheelers EVs market cost is something that is challenging the players and infrastructure may be seen as the second challenge for them too. (Automotive, 2018)

In certain great driven businesses like the automobile, whenever there is a change to an assembling procedure there are leaps around client endorsements. The EVs has very low maintenance cost as compared to normal petrol or diesel car. Radio Frequency Identification (RFID) is a widespread technology used in the automation Industry. Also, after implementation of RFID the industry has faced certain challenges. With the integration of RFID and Industry 4.0, it can create a different environment for the players. Automotive Industry may face certain challenges when it comes to the Industry 4.0 application like they face problems in supply chain management and also the security of the data may be in danger because of an open-loop of connections between machines and that can lead to cyber security threats.

With the adaptation of Industry 4.0, the working efficiency is expected to increase also in production producers may use mass customization as production type which is need of current market by the help of Industry 4.0 machines get to connect and learn from each other and generate data from which the decisions can be backed in automotive industry which will give grate connectivity to the production line. In production line will give a linear structure that will be more responsive and will operate independently. (Sweeney, 2019) Cost may also be declining per production of cars because continues production with machines and improving with data collected from the production. To address the issues of every client without blowing past their financial limit, partners all through the car store network can use Industry 4.0. More noteworthy understanding into the most mainstream mix of highlights makes it simpler to designate assets appropriately. If, for instance, another route framework alongside a particular arrangement of wheels see a critical spike in deals, partners can invest more energy and cash on keeping those highlights in stock as opposed to creating different determinations. If a client wishes to buy a component that doesn't occur to be among the top vendors, Industry 4.0 innovations like 3D printing can cut generation costs. (Farish, 2016)

METHODOLOGY

The Experiment

The type of method used for this study is a quantitative method. The experiment was done to find the answers to the questions regarding the opportunities and challenges of EVs in current market conditions. In this experiment, 38 people (Males = 38, Age group = 19-28 years, mean = 22.72) were given a survey form to fill which was based on this study. The form consists of distinct questions regarding the performance of EVs in the market as well as the preference of the surveyors regarding the market conditions. Surveyors were selected specifically from the background of mechanical engineering or Automobile industry personnel. The questionnaire was designed by the author of this paper and was circulated to Automobile background personnel specifically. The questionnaire was mainly divided into 11 questions relating to EVs in India. The questionnaire was prepared based on two parameters:

1. Challenges and opportunities for EVs in India.
2. Current market condition of Automotive Industry.

In this paper, we tried to research and document measurable social trends and focused on data collection and analysis of a trend in the market. Therefore the type of method used here is a quantitative method. The questionnaire was based on various questions like:

- Is the infrastructure of our country ready for EVs?
- What are the effects of EVs launch announcement on the Automotive Industry?
- Will AI, Industry 4.0, etc. helpful concept for EVs production?

LIMITATIONS

The present study has a few impediments that could be tended to in future investigations. The present study had little example size and consequently, representativeness is significant worries of the present study. The present investigation utilized a quantitative methodology. A subjective or blended technique approach might be attempted. The present study utilized restricted factors such as non-technical background of the author and no prior knowledge about the research papers.

DEMOGRAPHICS

It is important in a survey to know your audience and characteristic of the surveyors filling the survey form. The term demographics refers to the characteristics of the sample. The form consists of 5 questions about the demographics of the surveyors. The demographics are reported here.

Age			
		Frequency	**Percentage**
Valid	<20 Years	1	1.63
	20-25 Years	56	91.80
	25-28 Years	4	6.55
	Total	**61**	**100**

Most of the respondents are in the age group of 20 to 25 years it might be because most of the respondents were from under-graduation or post-graduation backgrounds. I have sent the form in various colleges where we can find mechanical background students and Automobile background personnel.

Gender			
		Frequency	**Percentage**
Valid	Male	57	93.44
	Female	4	6.66
	Total	**61**	**100**

Most of the respondents are Male. From this, we can infer that Mechanical Engineering is mostly done by Male and the ratio of males is to females is high. So that male respondents are more than female.

Education Attainment			
		Frequency	**Percentage**
Valid	High School	1	1.63
	Graduation	43	70.49
	Post-graduation	16	26.23
	Doctorate	1	1.64
	Total	**61**	**100**

Most of the respondent's education attainment is graduation as I mentioned earlier in the analysis.

Background			
		Frequency	**Percentage**
Valid	Mechanical	42	68.85
	Electrical	5	8.19
	Automobile	2	3.27
	Others	12	19.67
	Total	**61**	**100**

Most of the Respondents are from Mechanical Background as I mentioned earlier that the survey form was distributed in Mechanical Engineering colleges for the reliability of the data collected.

Occupation			
		Frequency	**Percentage**
Valid	Students	40	65.57
	Employed	16	26.23
	Unemployed	2	3.28
	Businessman	3	4.92
	Total	**61**	**100**

Most of the respondents are students as mentioned earlier.

MEASURES

MEASUREMENTS OF THE SURVEY CONDUCTED

In this survey, we generated data from the background of the surveyor and then asking them their point of view about this particular topic with the help of 11 questions followed by suggestions on this particular topic for the future aspects. We calculated different options given in the survey for the given question for coming as close as possible to the conclusion.

Each survey form indicating the answers given by each participant was assessed by the author. The answers to the distinct questions are very subjective when it comes to a particular individual and evaluating the answers carefully. In this survey we found out that the majority of the sample prefers petrol as a fuel of the vehicle evaluating this we must find out why is it so? From which hypothesis comes into the picture. For that matter, we need to further study and identify why this particular sample of the population prefers petrol as a fuel of vehicles rather than Electricity, CNG and Diesel.

DATA ANALYSIS

In this paper, we are focusing on quantitative data and interpretations derived from that data. As I have mentioned earlier about a survey conducted for analyzing the depth of the topic from that we classified that surveyors hope to see Industry 4.0 in production of vehicles and take this concept as interesting in production of EVs as well but also on other hand thinks the electricity in India is not available in many rural areas also in some cities of India. For that matter how can we build infrastructure suitable for the EVs? This is one of the challenges which we must through a light in the coming future not only by government but by private entities as well.

We must also think about the affordability of the EVs in the Indian markets if we launched EVs and built the infrastructure after so much of researches and spending billions of money but if EVs are not so much affordable then it may collapse the EVs market but again coming to the Research and development part we

need to think with the layman's perspective and for that, we asked about this in our survey form from which people think it is not so affordable to the middle-class people. Then we can come to the use of Industry 4.0 in the production of affordable EVs with the help of economic of scale in production. The majority of the sample thinks Industry 4.0 is a relevant concept to adopt for the production of EVs and charging of EVs but the majority of the sample also agree to a point that it will be a challenging task for the Industry.

RESULTS

Analysis of Responses Generated from the Survey

Table 1a, 2b, and 3c given responses from the survey in which most of the responses are from Mechanical or Automobile background surveyors. As we can see in table 1a six-question of yes and no option are allotted and described with the percentage of yes and no in question 1 we can infer that our country's infrastructure is not read according to data collected as their as almost 64% people selected no as an option.

In question 2 we can see almost 56% of people believe that there is a lack of sufficient resources available in India. Hence, we can say resources are also one of the challenges we must count in challenges for EVs in the Indian market. In question 3 as 66% of people have selected no as an option. Hence, we can deduce that EVs are not affordable for middle-class people which adds one more challenge in challenges part of EVs in India. The 4th question is about Industry 4.0 concept's adoptability for production of EVs and it has been given almost 82% of yes by surveyors which means it is a relevant concept to adopt in the Automobile sector. In question 5 we can see almost 62% of the sample believes that manufacturers are ready for the BS-VI engine in India. Question 6th got almost 59% of no which was about the government's target of 100% EVs till 2030.

In table 2b people gave almost 57% to Industry 3.0 as the concept adopted currently in the automotive sector by the players in India. Hence, from the knowledge of the surveyors, we can say most of the players use the concept of Industry 3.0 in the manufacturing of vehicles in India.

In table 3c is about the surveyors preferences of the vehicles in which almost 56% people marked as a petrol vehicle this is because in India most of the people use vehicles running on petrol and EVs are not so affordable to the middle-class population but if EVs may be affordable in India the answer may change because fuel of EVs which is Lithium-ion batteries is also more affordable then petrol as well and the maintenance cost of EVs is also less as compared to petrol cars.

In table 4d I have described the statistical analysis of the questions and gave 1 as minimum and 5 as a maximum of the frequencies collected in data. In this table first I have plotted about the adaptation of Industry 4.0 is a challenging task for EVs scale between strongly disagree to strongly agree in which strongly disagree is 1 as weight in frequency, 2 as disagree, 3 as neutral, 4 as agree and lastly 5 as agree strongly in which we got mean 3.74 which is near to 4. From this, we can conclude that surveyors agree that Industry 4.0 is a challenging task for the manufacturing of EVs for the Automobile Industry.

Descriptive Statistics

Table 1a: Descriptive Statistics

	Yes	Percentage	No	Percentage
Are there sufficient resources available for EVs	27	44.26	34	55.73
Affordability of EVs for middle class people of India	21	34.43	40	65.57
Industry 4.0 concept to adopt for production of EVs	50	81.97	11	18.03
Manufacturer's readiness for BS-VI engines	38	62.03	23	37.07
Achievement of 100% EVs till 2030	25	40.98	36	59.02

Table 2b: Descriptive Statistics

Automotive Industry Carries Out which Type of Production		
Valid	**Frequency**	**Percentage**
Industry 4.0	17	27.87
Industry 3.0	35	57.38
Industry 2.0	9	14.75
Total	**61**	**100**

Table 3c: Analysis of the Survey Responses

Type of Vehicle Prefer			
		Frequency	**Percentage**
Valid	Electric	14	22.95
	Petrol	34	55.74
	Diesel	7	11.47
	CNG	6	9.83
	Total	61	100

Table 4d: Descriptive Statistics

	N	**Min**	**Max**	**Mean**	**Standard Deviation**
Adaptation of Industry 4.0 - a challenging task for EVs	61	1	5	3.74	0.8398
Effect in markets by the news of launch of EVs and BS-VI engines	61	1	5	2.85	0.8826
AI, Machine Learning, Industry 4.0, etc. can help the production of Vehicles	61	1	5	4.02	0.8258

Effects in markets by the news of launch of EVs in BS-VI engines is the second question in scale of 1 to 5 in which I have assumed downturned sharply as 1, downturned slowly as 2, Neutral as 3, upturned slowly as 4 and upturned sharply as 4 and here mean is 2.85 which is near to 3. Hence, we can say the market is neutral after the news in the market that EVs will be launch it may be because of the affordability of the EVs in Indian markets.

In the third question, we have given the simple scale of 1 to 5 asking about the relevance of the AI, Machine learning, Industry 4.0, etc. in production of vehicles and we got mean 4.02 which is near to 4.So, surveyors find this concept as relevant enough to produce EVs in India.

DISCUSSION

We started this discussion with three questions to ourselves: 1) Is Industry 4.0 relevant to adopt in the Automotive Industry for production of EVs in the current market position? 2) What may be the various opportunities & challenges in the production of EVs in India? 3) Do we have sufficient energy available for the revolution in the Automotive Industry? To find answers to these questions, we decided to adopt a quantitative approach; and we decided to conduct a survey in which most of the people must be of Automobile related background for the accuracy of the data generated from this survey. We asked them questions relating to their demography as well as eleven questions related to the topic I have to decide to do research on and from that we can say we are still on the verge of growth in this sector.

The findings of this study suggest us to consider some results to be redefined in future studies: 1) India's infrastructure is not up to the mark for production of EVs 2) The concept of Industry 4.0 can be helpful in

production of EVs 3) It we be difficult for this sector to adopt the concept of Industry 4.0 4) Cost will be factor that can divert the market. (Vaidya, Ambad, & Bhosle, 2018) In the current global market driverless are being introduced and that can change the global market.

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Technological Options for Clean Energy Production: Advances in CO_2 Capture & Utilization

Riya S. Parikh[1], Dr. Sukanta Kumar Dash[2] and Dr. Daya Shankar Kaul[3]
[1]PG Student, (Environmental Engineering), Civil Department, SOT, PDPU
[2]Assistant Professor, Department of Chemical Engineering, SOT, PDPU
[3]Assistant Professor, (Environmental Engineering), Civil Department, SOT, PDPU
E-mail: [1]riya.pmten18@sot.pdpu.ac.in, [2]sk.dash@sot.pdpu.ac.in, [3]dayashankar.kaul@sot.pdpu.ac.in

Abstract—Global warming and rapid climate change have concerned us to take steps for industrial emission reduction. The major scientific reason for global warming is the rise in the concentration of CO_2 in the atmosphere. Large point sources of CO_2 emission are Thermal power plant, Iron and Steel industry, Cement industry and, Fertilizer industry. Emitted CO_2 can be separated from the flue gas stream by applying the concept of CCS (carbon capture and storage). CCS technology consists of CO_2 capture, separation, storage, and transportation, in which the capture part is crucial. The regenerative chemical absorption process is normally used for capturing CO_2 in which the capturing fluid (solvent) plays an important role. In this review paper, various technologies for carbon capture and the techno-economic feasibility of the capture methods are discussed. Various solvents such as first-generation, second generation, third generation used for CO_2 separation has also been discussed. The captured CO_2 can either be utilized for chemical production or it can be stored as ocean storage, geological storage, etc. Along with CO_2 capture technology this paper will also review CO_2 utilization such as the production of methanol synthesis from the captured CO_2 and its techno-economic feasibility.

INTRODUCTION

With rapid economic growth, the energy demand increases and this energy comes from renewable and non-renewable sources. Using non-renewable sources such as coal, oil, gas; environmental sustainability should be adopted, this is achieved by a suitable technology for carbon reduction. The Intergovernmental Panel on Climate Change (IPCC) under the Kyoto protocol introduced a scheme of Carbon Credit. A recent IPCC advisory said that, to stabilize the global temperature for an increase of 1.5°C scenario, CCS should be adopted along with other carbon reduction options (Myles R. Allen (UK), Opha Pauline Dube (Botswana) & Lead, 2018).

Coal is a major energy source for thermal power plants, emitting 50-60% of CO_2, and this CO_2 emission is being reduced by technologies like post-combustion, pre-combustion and, oxyfuel combustion. Separation of CO_2 from flue gases uses technologies like Absorption (Chemical and Physical), Adsorption, Cryogenic Distillation and, Membrane Separation. Separated CO_2 is transported via pipelines and it can either be stored in an Aquifer, Geological storage, Enhanced Oil Recovery (EOR), Deep ocean storage; or it can be utilized for production of Urea, Methanol, Syngas, Dimethyl ether (DME) etc.

To demonstrate these technologies two expert meetings on financing demonstrating CCS projects were organized in London and New York in 2007 and 2008 respectively by International Energy Agency (IEA) Green House Gas R&D Program and the IEA Clean Coal Centre. These meeting were attended by the insurance, banking and other financial sectors for potential investment opportunities.

FINANCING CARBON CAPTURE

United Nations Framework Convention on Climate Change (UNFCCC) did a study in 2007 and reviewed, present and planned investment flows to develop and identify an effective global response for the mitigation of greenhouse gas emission. A supplementary investment of around US$200-210 billion to return to the level of 2007, half of it heading for developing countries. Among many ways to mitigate

climate change, approximately US$63 billion would be an investment in CCS according to the UNFCCC. Depending on the type of CCS technology additional power station costs can range from US$250-$500 million (UNFCCC, 2007).

Conclusions drawn from the two financial meetings held in London (2007) and New York (2008) (Kessels & Beck, 2009)

- Investment form private and financial sectors in CCS will be required.
- CCS projects will have a high initial cost, particularly capture costs which is unlikely to be met by market instruments alone.
- Barriers to the deployment of CCS are increasing commodity, material and labor costs.
- If large demonstration projects are operated successfully then it will be helpful for reducing the costs of commercial-scale plants.

To accelerate the deployment of CCS, a long term high carbon price (US$80-100) would be needed as well as a regulatory and policy framework that encourages IGCC plants in the short term (Kessels & Beck, 2009).

COST AND PERFORMANCE OF CARBON CAPTURE

The present cost and performance idea related to CCS from power generation is estimated from various engineering studies and experimental plants. The price varies according to the type of fuel used and the category of a power plant. For clean energy policymaking and beginning the energy scenarios, the cost and performance of carbon capture are required. Different costs such as maintenance cost, fuel cost, non-operating fuel cost, and capital cost is used for calculating primary year wages of electricity. For installation of the plants, expenses are expected from buying equipment and also calculated via the equipment's cost database. CO_2 capture additional cost ranges from 2-70% currently (Warren, 2019) which involve public finance and the leveraging of private finance. A large proportion of climate finance is Official Development Assistance (ODA. This cost varies from different nations due to local conditions and the sectors where CCUS is applied. (Bank, 2015) estimates additional cost of around US$500 million to power plant construction (for CO_2 capture, transportation, and storage), whereas, in India, the CO_2 capture and usage from industrial plants are to be the US $20-40/t CO_2 (Bank, 2015)

The economic data used are converted to the US dollar (USD). The Technical performance of power plants with CO_2 capture is usually summarized in terms of the plant efficiencies, power out and CO_2 emissions. CO_2 capture and the techno-economic data are for the following:-

- Post-combustion CO_2 capture from coal-fired power generation using amines
- Pre-combustion CO_2 capture from integrated gasification combined cycle
- Oxy-combustion CO_2 capture from pulverized coal power generation

Regions for the cost estimation considered are the United States, Europe, and China. Fuel is coal and grade of coal is bituminous, sub-bituminous and lignite.

CO_2 CAPTURE TECHNOLOGIES

Technologies for CO_2 capture is shown in the figure 5-1

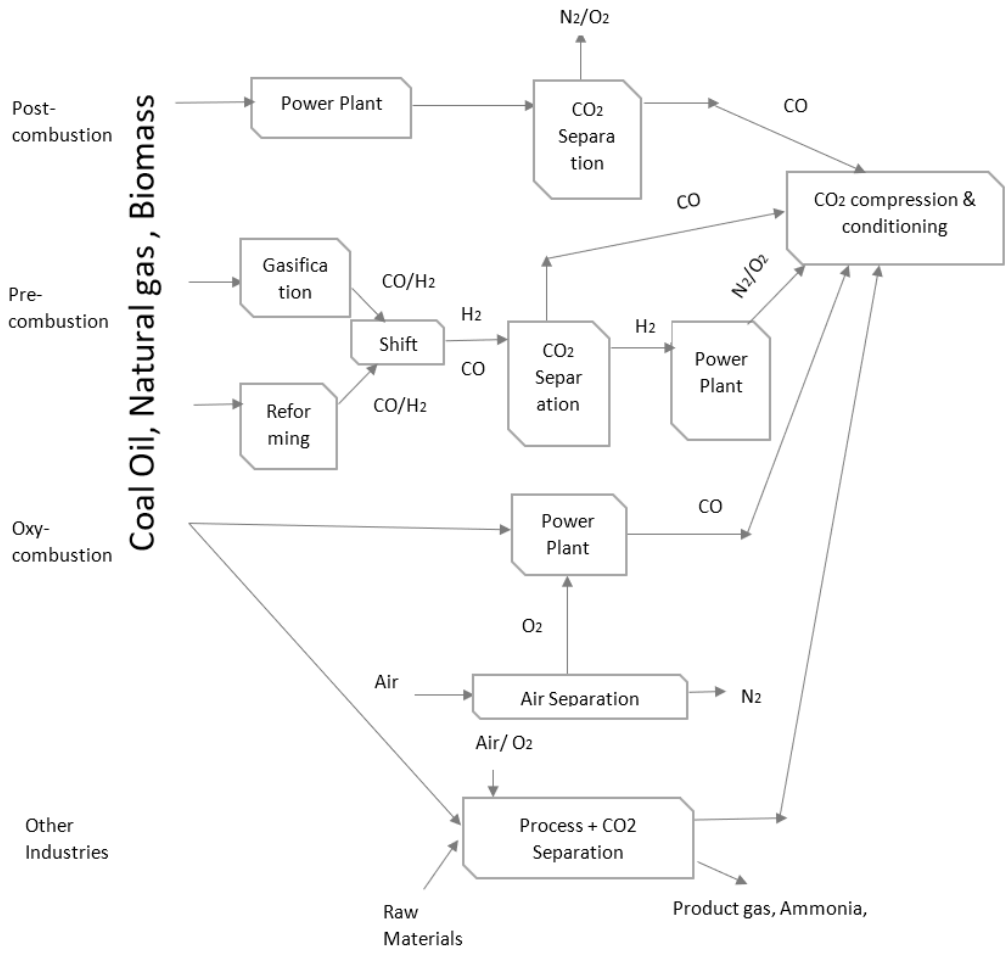

Fig. 5-1: Various Technologies for Carbon Capture

POST-COMBUSTION CO_2 CAPTURE

Post-combustion CO_2 capture (PCC), captures CO_2 from flue gas streams after combustion of fossil fuels. The major leaders for the flue gas exhaust are the Thermal power plants and the Refinery industries. In PCC instead of directly discharging flue gas to the atmosphere, flue gas is first sent to the equipment which separates most of CO_2. A well-known method for PCC is amine absorption technology. Since, CO_2 level in flue gas is low, the cost is elevated for the capture and storage. The leading commercial post-combustion CO_2 capture technologies are Fluor Econamine FG plus (USA), Mitsubishi Heavy Industries (Japan), Alstom (USA/France), Cansolv/Shell Global solutions (Canada/Netherlands), Aker Clean Carbon (Norway), SARGAS (Norway), CCS (UK, India)

PRE-COMBUSTION CO_2 CAPTURE

Fuel is treated before combustion process. For coal, gasification process is involved, the gasification occurs in a gasifier with a low oxygen level forming a syngas (a mixture of CO and H_2). Formed syngas will undergo shift reaction with steam reforming. More H_2 will be formed while the CO gas will be converted to CO_2. Pre-combustion technology is available for Coal based and oil-based power plant. The following equations show the reaction:

Coal→CO+H_2 (gasification reaction)

$CO + H_2O \rightarrow H_2 + CO_2$ *(water-gas shift reaction)*

$CH_4 + H_2O \rightarrow CO + H_2$ *(reforming reaction)*

The concentration of CO_2 in input to the CO/H_2 separation can be 15-60% on dry basis (Panel & Change, 2013). 0.1% of the total installed capacity worldwide used are Integrated gasification combined cycles (IGCC) (Panel & Change, 2013). Oxy-fuel Combustion

For coal combustion process O_2 is used; if we don't use pure O_2, N_2 needs to be separated after the combustion process adding cost to the process. To decrease the cost, process of using pure O_2 instead of air for combustion is called oxy-fuel process. This pure oxygen is obtained from cryogenic distillation. When pure oxygen is used, the flue gas consists of CO_2, water particles and SO_2. Electrostatic precipitator and desulphurization units are used for the removal of the particulates and SO_2. CO_2 concentration will be around 80-98% depending on the type of fuel used (Leung, Caramanna, & Maroto-Valer, 2014). Oxy-fuel process is feasible but it consumes large amount of oxygen coming from the energy-intensive air separation unit (Pfaff & Kather, 2009), resulting into high cost and the energy penalty may reach as high as 7 % in comparison to a plant without CCS (Burdyny & Struchtrup, 2010; Leung *et al.,* 2014). No full-scale plant for the oxy-fuel combustion is present, but some sub-scale commercial plant with capacity of 1000-2000MW and 25-250MW are under development. In about 7 years large scale production for oxy-fuel combustion will be available once the industrial demonstration is completed (Leung *et al.,* 2014).

Table 5-1: Advantages and Challenges of Various Technologies Available for the Carbon Capture (Leung *et al.,* 2014)

Type of Technology	Advantages	Challenges
Post-Combustion	Retrofitting is easy for the existing plants, it's a mature technology	Less CO_2 concentration affects the capture efficiency.
Pre-Combustion	High CO_2 concentration that enhances the sorption efficiency, it's a fully developed technology, in some industries its deployed at the required scale, retrofitting is possible in this technology.	Temperature related heat transfer problems and efficiency reduction with the use of hydrogen-rich gas turbines fuel, more power required for the regeneration of the sorbent, high capital cost and high operating cost for current sorption systems
Oxy-fuel Combustion	Very high CO_2 concentration that enhances absorption efficiency, it's a mature air separation technology, reduced volume to gas to be treated, it needs a smaller size of boilers and equipment.	Cryogenic technology for the production of pure O_2 which is costly, the problem of corrosion arises.

Table 5-2: Existing and the Future Technologies for the Various Carbon Capture Process

Type of Technology	Existing Technology	Future Technology
Post- Combustion	• Absorption process, should be used with flue gas pretreatment.	• Adsorption process • Membranes • Solid sorbents
Pre-Combustion	• Steam reforming of gas and light hydrocarbon. • Partial oxidation of gas and light hydrocarbons. • Auto-thermal reforming of gas and light hydrocarbon. • Gas heated reformers. • Gasification of coal, petroleum or biomass. • Integrated gasification combined cycle (IGCC) for power generation.	• Sorption enhanced reaction. • Membrane reactors for hydrogen production with CO_2 capture. • Microchannel reformer. • Technologies based on calcium oxide.
Oxy-fuel combustion	• Oxy-fuel indirect heating-steam cycle. • Oxy-fuel direct heating- gas turbine cycle. • Oxy-fuel direct heating- steam turbine cycle.	

Cost Comparison for the Different Capture Process

By comparing mentioned technologies, pre-combustion for coal-fired based plants has lowest cost of per ton CO_2 avoided, while post-combustion and oxyfuel technologies cost are almost similar (Ã & Chalmers, 2015). For a gas-fired plant, CO_2 cost per ton avoided was 50% low for post-combustion capture than the pre-combustion and oxy-fuel combustion capture technologies. CO_2 capture by the post-combustion method is the least efficient option, considering the energy penalty of about 8% and 6% for the coal-fired and gas-fired plants, respectively (Leung *et al.,* 2014).

Table 5-3: Cost Comparison for Different Capture Process, Costs Include CO_2 Compression to 110 Bar but Excluding Storage and Transport Cost (Usubharatana *et al.,* 2006)

Fuel Type	Parameter	Capture Technology			
		No Capture	Post-combustion	Pre-Combustion	Ox y-fuel
Coal-fired	Thermal efficiency (%LHV)	44.0	34.8	31.5	35.4
	Capital Cost ($/KW)	1410	1980	1820	2210
	Electricity cost (c/KW)	5.4	7.5	6.9	7.8
	Cost of CO_2 avoided ($/t CO_2)	-	3.4	23	36
Gas-fired	Thermal efficiency (%LHV)	55.6	47.4	41.5	44.7
	Capital Cost ($/KW)	500	870	1180	1530
	Electricity cost (c/KW)	6.2	8.0	9.7	10.0
	Cost of CO_2 avoided ($/t CO_2)	-	58	112	102

Table 5-4: Various Costs for Different Technologies (Finkenrath, 2011) 2010

Type of Technology	Net Power Output (MW)	Average Net Efficiency, LHV (%)	Capital Cost (USD/KW)	CO_2 Emission (kg/MWh)	Overnight Cost with CO_2 (USD/KW)	Cost of CO_2 Avoided (USD/t CO_2)
Post-combustion	493–676	30.9	1572–4279	73–126	1838–4657	40–74
Pre-combustion	497–730	41.4	1471–3940	90–152	1721–5150	18–86
Oxy-combustion	500–673	31.9	1900–3985	0–105	1481–4665	27–66

Table 5-5: Various Costs for Different Type of Coal and Technologies (Finkenrath, 2011) 2010

Type of Technology	Net Power Output (MW)		Capital Cost (USD/KW)		CO_2 Emission (kg/MWh)		Overnight Cost with CO_2 (USD/KW)		Cost of CO_2 Avoided (USD/t CO_2)	
Coal Type	Bituminous Coal	Sub-bituminous and Lignite	Bituminous Coal	Sub-bituminous and Lignite	Bituminous Coal	Sub-bituminous and Lignite	Bituminous Coal	Sub-bituminous and Lignite	Bituminous Coal	Sub-bituminous and Lignite
Post-combustion	631–553	500–550	3767–3610	2270–3485	101–121	121–141	3166–4195	3404–4657	51–69	40–61
Pre-combustion	553	482	3049	4221	112	141	3555	5150	43	45
Oxy-combustion	533–541	549–550	2894–3095	3114–3656	35–42	67–102	3419–3500	4161–4885	45–50	49–69

CURRENT TECHNOLOGY: CO_2 CAPTURE BY CHEMICAL ABSORPTION

The absorption process makes use of the reversible nature of the chemical reaction of an aqueous alkaline solvent with an acid or sour gas. The flue gas from the industry is at high temperature around 250°C, it is cooled by a suitable cooling method up to the temperature of 40-60°. The cooled flue gas is sent to the absorber, it's a packed tower generally of the structured packing. CO_2 transfer from a gas phase to the solvent phase, while two phases are moving in the counter-current direction, the exhaust from the absorber is mostly clean N2 gas. The rich solvent is sent to the heat exchanger where the temperature is increased to 100-140°C, where there will be four-stream; one will be fresh makeup solvent; one will go to the stripper; one to the absorber; and one will come from reboiler. The ideal temperature for stripper operation is 120°C but for the different solvents the temperature varies and the pressure will be 2 bar. The stripped CO_2 will be in gas phase which will be condensed and transferred to knock out drum where the gas will be separated from the top and the bottom product will be introduced as reflux back to the stripper. The bottom of the stripper has an arrangement of the reboiler where the solvent wastes are discarded. Alkanolamine is used as solvent.

Amine is classified into first generations, second generation and tertiary generation. Mono-ethanolamine (MEA)- a first generation amine, lacks in CO_2 loading and has maximum loading upto 0.5. Due to the lack of carbon capture second generations amines are researched and various researchers investigated and recommended the usage of 2-amino-2-methyl-1-propanol (AMP) with different blending of two solvents to overcome limitation observed by conventional amines in PCC (Post-combustion Carbon Capture) unit. To improve the reaction kinetics, the third generation amines were introduced which are activators like piperazine, which are less corrosive and less degradative. Most desirable properties of the solvents are described in figure 2.

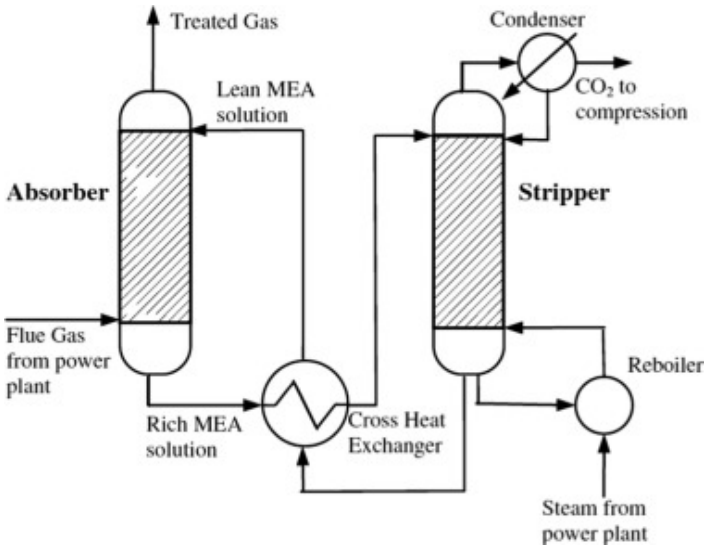

Fig. 6-1: Capture of CO_2 by Absorption Method

Solvents like piperazine and anion-functionalized ionic liquid are some third generation researchable solvents (Gurkan *et al.,* 2010). Piperazine is more reactive than the MEA, but its high volatility creates a problem. To operate a plant, physical properties of solvents are needed and few researches are going on the AMP+PZ, the temperature and the mass fraction plays an important role. The temperature range is 25-100°C and the mass fraction of AMP 0.2-0.4 and PZ 0.05-0.1 (Fu, Li, & Liu, 2013), for a temperature range of 40-120°C and mass fraction of Amp and PZ are 3-4 and 1-1.5 respectively is done (Grimstvedt, Mejdell, Svendsen, & Bru, 2011) for a temperature range of 25-100°C and AMP and PZ mass fraction 0.22-0.3 and 0.02-0.08 respectively (Samanta & Bandyopadhyay, 2009). Very few literature is available for the CO_2 loading of mass fraction 0-0.6 (Fu *et al.,* 2013) and 0.1-1.0 (Grimstvedt *et al.,* 2011).

	Heat of absorption	Absorption Rate	CO_2 capacity	Degradation tendency
Primary Amines	●	●	○	●
Secondary Amines	●	○	○	○
Tertiary Amines	○	○	●	○
Sterically hindered amines	●	○	●	○
Polyamines	●	●	○	○
Alkali Salts	○	○	●	○
Ammonia	○	○	●	○

● High ○ Medium ○ Low

Fig. 6-2: Desirable Properties of a Solvent

N-(3-Aminopropyl)-1,3-propanediamine (APDA) is a polyamine having three amino groups one secondary group and two primary amine group, is an activator for the removal of CO_2 (Das, Deogam, Agrawal, & Mandal, 2016). It has high pKa value with low vapor pressure, high reaction rate, and absorption capacity. Kinetics of APDA-CO_2 was investigated (Das, Deogam, & Mandal, 2017) and concluded that it has a high loading capacity with the single and blended solvent system. Despite its potential for the removal of the CO_2 very few solubility data are available for the APDA-CO_2. (Kumar, Bandyopadhyay, & Nath, 2017) showed it has a high CO_2 loading capacity, up to three times higher than MEA at the 15 KPa. This desirable property encourages the research, and at present studies are going on the thermally induced properties.

The Challenge for absorption is solvent loss, equipment corrosion, degradation of the solvent and generation of volatile degradative compounds (Fredriksen & Jens, 2013; Rochelle, n.d.). Amines can be degraded into nitroimines and nitrammites (Leung *et al.,* 2014), which are potentially harmful to human health and the environment.

UTILIZATION OF CO_2

Although the capture CO_2 has many uses, it's used for industrial purposes like urea production, methanol production. Conversion of CO_2 to methane or methanol by photocatalytic conversion has a scientific and technical challenge when its planned on a large scale and keeping economic consideration (Roy, Varghese, Paulose, & Grimes, 2010). A recent study in this particular area is to find a novel catalyst with the help of nanotechnology (Liu & Maroto-valer, 2012; Tan *et al.,* 2012). Emerging technology like photocatalytic reactors, using ultraviolet for CO_2 reduction are being tested (Usubharatana *et al.,* 2006), and these are generally batch operated process (Tseng, Chang, & Wu, 2002), with limited studies published in solar reactors (De, Roca, & Yebra, 2012; Huang, Yao, T-raissi, & Muradov, 2011).

METHANOL PRODUCTION

Methanol is used in several industries, and the main derivatives of the methanol are dimethyl ether (DME) and the tertiary-butyl ether (MTBE). The demand for the ethanol will increase if it is encouraged for direct gasoline blending, for the production of DME and/or biodiesel. Production of methanol is done by the Frischer-Tropsch process; pressurized synthesis gas (or syngas, a mixture of mainly H_2, CO, CO_2) reacts in the presence of the catalyst (Pérez-Fortes, Schöneberger, Boulamanti, & Tzimas, 2016):-

$$CO + 2H_2 \rightarrow CH_3OH$$

The above reaction mentioned is an exothermic reaction with a major challenge of removing excess heat, to shift the equilibrium towards methanol production and minimize side reactions (Van-dal & Bouallou, 2013). The catalyst used for the production can be $CuO/ZnO/Al_2O_3$. The hydrogen used for the methanol production must be produced by less or minimal amount of carbon to reduce the life cycle of

CO_2 emissions. It is either done by electrolytic method which is considered to be a renewable energy for example proton exchange membrane electrolysis (PEM) or by steam electrolysis which uses solid oxide electrolyser cell (SOEC).

If we use conventional methanol synthesis; water shortage and the GHG emission problems arises. Therefore, we need to have alternate ways to synthesis methanol without using fossil fuel as raw-material. By two different ways we can synthesis methanol from carbon dioxide. Firstly, Hydrogenenation of carbon dioxide with hydrogen and secondly, carbon dioxide conversion into carbon monoxide and further the hydrogenation of carbon monoxide. Economic feasibility of producing methanol through CO_2 hydrogenation mainly depends on the feedstocks prices (Pontzen, Liebner, Gronemann, Rothaemel, & Ahlers, 2011). Out of two raw materials, hydrogen has a more significant cost effect than CO_2, if hydrogen is produced via electrolysis (Goeppert, Czaun, Jones, Prakash, & Olah, 2014). It was found that CO_2 based methanol costs 500-600 €/t while from conventional method methanol costs 300-400 €/t. The production cost of methanol via water electrolysis depends on the price of electricity.

CONCLUSION

Temperature rise, sea level increment, reduction of arctic ice are some issues related to the global warming. One of the way to reduce the global warming is carbon emission reduction pathway which is the most suitable one. CCS is a viable option for the reduction of CO_2. PCC is a suitable option for carbon capture from large point sources like fuel-based power plant. Regeneration chemical absorption technology is used for carbon capture with different novel solvents. More research needs to be done on the solvent, so the cost can be reduced and the desirable properties of the solvent can be achieved. But by adopting all this the cost is likely to be increased and an understanding of the financial expense is necessary. Good infrastructures will tend to decrease the cost. While capturing this CO_2 more energy should not be used and it should not contribute excess emission to the environment as the only main objective of using the CCS system is to reduce the emissions.

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A Qualitative Study on Evolution of Electric Vehicles in India

Mrunal Thaker[1] and Dr. Vivek Pandya[2]
[1](B.Tech-Electrical Engineering),
School of Technology (SOT-PDPU),
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
[2]Professor,
School of Technology (SOT-EED),
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]mrunal.tee16@sot.pdpu.ac.in/ mrunalthaker28@gmail.com
[2]Vivek.Pandya@sot.pdpu.ac.in

Abstract—Electric Vehicles are marking a revolution all around the world owing to their environmental and socio-economical benefits. They are going to revolutionalize the vehicle market and automobile industry along with efficient and user preferred updates. From the utilities point of view, the adoption of plug in electric vehicles (PEV) to distribution network brings challenges as well as opportunities. One of thebiggest challenges that the EV will pose to existing Electrical Infrastructures and Supply networks is the quantity and the pattern of the supply.

This paper gives a brief overview about evolution, current trends and future prospects of EV in India.Keeping in view the next five to ten year plan regarding EV by government of India, the paper also discusses the challenges ahead with respect to accommodating EV demand in the existing electricity grid and the roadmap for meeting the same.

Keywords: Electric Vehicle (EV), Grid Impacts, Energy Storage, Grid Stability, Demand-Supply Balance

EVOLUTION OF ELECTRIC VEHICLES IN INDIA

- India's journey in electric vehicle started almost two decades ago with the launch of an electric three wheeler Vikram SAFA developed by Scooters India Ltd. The company could sell around 400 vehicles that ran on a 72 V lead acid battery. Mahindra and Mahindra Ltd. launched its first electric-three wheeler in 2001 in the name of 'Bijlee'.[1]
- Bharat Heavy Electricals Limited (BHEL) also introduced an electric bus using 96 V lead acid battery pack, however the project didn't pick up due to the product quality inconsistency and cost. In 2001, a Bangalore based company 'REVA' entered the Indian EV sector in the four wheel segment and could sell more than 1500 vehicles.[1]
- In the 4 wheel segment, Mahindra & Mahindra, launched E2O couple of years ago, with a two battery variants of 48 V and 72 V, and later launched the Mahindra Verito in the sedan segment. Tata Motors also entered in the electric car segment with the introduction of the Tata Tigor with a battery capacity of 72 V and a maximum power of 30 KW. In the commercial vehicle segment there have been recent introduction of electric buses in existing public transport fleet in selected states.[1]
- Himachal Pradesh has been the first state in India to operate electric buses on selected routes. Cities like Ahmedabad, Bengaluru, Mumbai, Hyderabad and Kolkata among others have already floated tenders for procurement of buses which would be in operations soon.[1]

INDIAN GOVERNMENT 5 TO 10 YEAR POLICY ON ELECTRIC VEHICLES IN INDIA

- The government of India has demonstrated a strong commitment in introducing electric mobility in India and announced a very ambitious plan of making India a primarily electric car driven nation by 2030.[3]

- The government in this regard launched a scheme for the Faster Adoption and Manufacturing of (hybrid &) Electric Vehicles in India (FAME India) under the National Electric Mobility Mission (NEMM) in 2015. The scheme was successful in increasing the share of hybrid and electric passenger vehicles sales from almost zero percent in 2012 to 1.3 percent by 2016.[3]
- The government plans to introduce 6–7 million electric vehicles (EVs) /hybrid vehicles on Indian roads by the year 2020. In order to accelerate penetration of these vehicles, the government had earlier declared certain measures that included placement of battery based electric (BEVs) drive trains in a low Goods & Services Tax (GST) slab of 12 percent, as compared to 28 percent for petrol and diesel cars and hybrid vehicles, and procurement of 10,000 BEVs for its own use.[3]
- Under the FAME II scheme which is expected to span 5 years with an objective of boosting faster adoption of energy efficiency in the automotive sector in India, a financial support of more than INR 8730 crore (Euro 1100 million) is awaiting final approval from the government. Given this strong emphasis of the Indian government on EVs, the country has a huge potential of becoming one of the largest electric vehicle markets in the world.[3]
- While it is Mahindra's E2O, the only domestically manufactured battery electric vehicle (BEV) that is sold in Indian market, companies like Maruti Suzuki, Tata Motors, Nissan, Toyota, have expressed their strong willingness to introduce EVs in Indian market. Tata Motors have recently started manufacturing electric vehicles in India.[3]
- There are other economic and environmental benefits linked to growth of EV sector that include reduction in physical imports of oil and depletion of foreign exchange reserves through reduced import bill, promotion of energy security, creation of better investment opportunity in generation of clean energy, and a lower cost of integrating renewables through "smart charging", etc.[3]

THE CHALLENGES FACED BY UTILITIES TO INCORPORATE EV'S IN ELECTRICAL GRID

- Finally, EVs use power-electronics extensively. India had an early start of its power-electronics industry. However, the industry has not kept pace with new developments that have seen digitization of power-electronics over the last decade.[2]
- India would need a new power-electronics industry which can help develop and produce high-efficiency sub-systems for EV industries. A special thrust is needed to promote such industries.[2]
- Indian power industry needs to be prepared for the EV roll-out. The network must be geared to minimizing impacts. Some key actions to prepare for greater EV penetration are demand-side management, dynamic electricity pricing, and vehicle-to-grid technology for use of EVs as active loads and generators for power demand shaping.[2]
- Global experience suggests that the distribution systems are generally quite loaded and enough spare capacity is not available to support charging infrastructure required for EVs. A similar situation exists in Indian cities where adding banks of chargers is possible only with upgrading of distribution networks. Managing distribution transformer upgrades may beless expensive and easier.[2]

CHARGING INFRASTRUCTURE FOR ELECTRIC VEHICLES IN INDIA

- Charging Infrastructure is one of the key components of developing an effective ecosystem, as potential consumers may face 'range anxiety' and are concerned about where they might charge their EV.

- In order to develop public charging infrastructure cost and scale are two critical factors as setting up charging infrastructure is expensive and consumer demand is unknown.
- Three prevalent business models around managing the charging infrastructure are talked about:

PUBLIC INFRASTRUCTURE MODEL

Providing Charging Points in public parking spaces. This involves reserving spots at which a charging point is provided in the electric vehicle at public parking spaces. Since, Ev's are only allowed to park in these spaces they likely to act as an incentive to consumers in urban areas. These method should be implemented with the help of infrastructure providers and local municipalities. It seeks to provide access to charging for those consumers that lack home charging[4].

PRIVATE INFRASTRUCTURE MODEL

This is a preferable model in early stages of EV adoption as it corresponds to direct consumer demand. It involves installing charging points for EV-adopters at their residence or at private sites such as malls, office parking etc [4].

END TO END SOLUTION

This Model involves close partnerships between OEMs, Infrastructure facility providers, maintenance service providers and local governments to provide consumers with integrated package of end to end value added services thereby minimizing the number of interfaces that the consumer has to manage. These could evolve as a subscription service that provides where the EV adopters have to pay monthly fees which include charging, vehicle maintenance and free parking managed by local municipal authorities [4].

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Suneel Pandey (Advisor)
M.K. Bineesan (Secretarial Assistance)
The Energy and Resource Institute (TERI), New Delhi

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Independent Contributor
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Government of India

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Samir Kamik, Nitin Sukh (Responsible Banking Team –Yes Bank)

A Qualitative Study of Unlocking LNG Potential in Indian Heavy Transport Sector

Anirudh Kumar Singh
Ph.D. Scholar from Jyoti Vidyapeeth Women's University, Jaipur, India
E-mail: anirudhsingh@ddn.upes.ac.in

Abstract—Natural gas is a colourless, odourless, environment friendly energy source. It is cleanest of all the fuels are traditionally use in India. Natural Gas is highly flammable hydrocarbon gas chiefly consisting of methane (CH4). It may also include other gases such as oxygen, hydrogen, nitrogen, ethane, ethylene propane, and even some helium. Natural gas converted into a liquid state by cooling it to −162 °C, is termed as LNG. LNG is more compact than natural gas and occupies 1/600th of its gaseous volume. Natural gas, when compressed at a pressure of 250 bars, is termed as compressed natural gas (CNG). Since natural gas is not a pure product, when non-associated gas is extracted from a field under superficial conditions, it may partially condense upon isothermic depressurizing - an effect called retrograde condensation.

LNG as a cost-effective and environmentally friendly alternative to diesel. This study focused on alternative Transportation cleaner fuel segments to grow and helped immensely to drive natural gas penetration in the future via setting up of Small scale LNG Fulling station in the country. It is highly efficient, with a low Volume easy to fill up; LNG could play an important role in a clean energy future for Indian Transport sector. Liquefied natural gas (LNG) use as a fuel in Heavy road traffic has increased rapidly, and it is slowly entering railroad traffic as well as in Marine traffic. LNG as a cost-effective and environmentally friendly alternative to diesel. Different infrastructural projects for the widespread use of LNG in transport have been launch around the world. The main goal of this article was to analyse use of LNG as a fuel for heavy trucks. Different aspects of LNG chain were analysed along with economic and ecological benefits of LNG application. Filling stations network for LNG were describe for the purpose of comparative analysis of diesel and LNG heavy trucks. Conclusion has shown that using LNG as propellant fuel has numerous advantages over the use of conventional fuels. The higher initial investment of the LNG road vehicles could be amortized in their lifetime use, and in the long-term, they are more affordable than the classic diesel vehicles. In addition to cost-effectiveness, LNG road vehicles reduce CO_2 emissions. This study has been perform to assess the potential of LNG as a transportation fuel in India follow-up focusing on road transport for large trucks (Heavy Goods Vehicles - HGVs) and Buses. To identify the benefits of adopting LNG as a fuel in Transportation sector with an insightful approach. In this study, I have done major Secondary research. The main goal of this paper was to analyse use of LNG as a fuel for heavy trucks.

Keywords: LNG, Heavy Transportation, CO_2 Emissions, Infrastructure

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Static Bi-Directional Pile Load Test: A Case Study

Saurabh Dugad[1], Dr. Devanshu Pandit[2] and Snehal Patel[3]
[1]Assistant Engineer,
Shapoorji Pallonji & Co. Ltd., India
[2]Professor,
Faculty of Technology, CEPT University, India
[3]CEO & Director,
Satt Engineering, Canada
E-mail: [1]saurabhdugad1@gmail.com, [3]snehal.patel@sattengg.com

Abstract—Piles are widely used in bridge foundations. Designers require initial pile load test to determine capacity of piles before commencement of work. Subsequently routine pile tests are carried out on working piles on alternative bridge foundations. The objectives for doing the load testing must be clear so as to utilise it best. The testing requirements must follow the requirement of the respective regulations and prevailing practices instead of promoting "best practice".

The criteria used for the various types of pile tests are the duration required to carry out the pile tests, application of load to the pile and induction of strain in the pile. Pile load capacity is assessed by static load tests, by applying large forces for longer period of time. Pile Integrity tests are done by applying small energy low strain tests. In high strain dynamic and rapid load tests, although the force is comparable in magnitude to a static test, it is applied over a much shorter period than in a static load test. Careful consideration is therefore needed in the interpretation of the dynamic effects in order to derive static load capacities. (Handley, Ball, Bell, & Suckling, 2006)

US DOT, FHWA GEC 012 – Volume II says static pile load tests are the most precise method for the determination of load capacity. The static load testing of piles is performed during the design development or execution stage. The types of conventional pile load tests are axial compression, axial tension and lateral load tests are the types of conventional pile load tests. The static load testing as per AASHTO guidelines, resistance factor for determination of the nominal resistance is one load test per site.

A mid 1994 survey by the US FHWA recognised that the engineers and contractors appreciated the O cell method "the method of choice" and after this recognition its use had risen rapidly, it contributes to 65% of testing done all bored piles (Baker, 1994). This trend has continued and the usage probably now exceed 90% in the USA. Bi-directional loading tests using Osterberg cells are now common (with over 300 tests performed per year) around the world, particularly for loads >10MN or where traditional top-down loading tests are not convenient to execute (England, 2006).

BDSLT method of pile load test utilizes hydraulically operated super-cells which are embedded inside the pile before the concreting activity of bored pile is performed on site. It is a system, allows the end bearing and skin friction portions of the pile to act against each other, to provide reaction load for the test. This process therefore alleviates the need for expensive reaction piles, the need to build a testing beam arrangement or the risk of building test kentledge. The supercell is expanded with the use of hydraulic oil, water or air and required load applied to the pile. With the use of displacement wires and strain gauges the whole pile reaction to the load at various pre-determined depths can be accurately measured and thus provide detailed information regarding the load bearing capacity of various soils types along the shaft of the pile. The results can then be used in conjunction with the geotechnical report. It helps in substantial cost savings in the large construction projects which involves friction piles leading to reduction in the estimated pile lengths.

Case Study: Initial pile load test was performed for optimizing the design of pile foundation for this project. A maximum bidirectional load of 8750 KN applied to the pile above and below the Supercell. Once the maximum load achieved, unloading of pile was started as plan. Pile capacity calculations for test piles are carried out; there is a possibility of carrying out both ultimate skin friction and end bearing resistance separately with biaxial pile load test at various depths which proves to be useful in design optimization, which is not possible in conventional pile load test method.

The factors considered for comparison are cost, time, space required to perform the pile load test. The site condition in which the test can be performed, requirement of reaction system, maximum test load that can be performed with the reaction system, technique for data collection.

The case study examines the application of static pile load test reaction system, kentledge as opposed to bi-directional load cell (super cell) by replacing kentledge reaction system with bi-directional load cell. Kentledge reaction system. The total cost required for undergoing initial static pile load test with kentledge reaction system was ₹ 2.63 million whereas with reaction system of Bi-directional load cell amounts to ₹ 2.10 million. For complete procedure of test with kentledge reaction system thirty six days were required whereas with bi-directional load cell reaction system sixteen days were required. By such intervention it was observed, there was cost saving of ₹ 0.53 million (20%) and time saving of 20 days.

Keywords: Static Pile Load Test, Bi-Directional Tests, Value Engineering

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Electric Vehicle (EV) Charging Station Infrastructure Scenario in India

Ketan Srivastav[1], Harsh Patel[2] and Monish Thakkar[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deendayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: [1]ketan.spgp19@spm.pdpu.ac.in,
[2]harsh.ppgp19@spm.pdpu.ac.in,
[3]monish.tpgp19@spm.pdpu.ac.in

Abstract—Indian government wants to convert all petrol & diesel vehicles in Electric Vehicles (EV) from 2030 onwards. Development of EV charging infrastructure is challenge in this mission. This paper discusses about potential need for EV charging stations (CS) & how charging infrastructure develop in India.

Availability of adequate charging infrastructure is acknowledged as a key requirement for accelerated EV adoption in country. To meet target of 2030, we have to increase EV charging station progress at least three-fold. We also discuss about faster adoption of EV in India by ensuring safe, reliable & affordable charging infrastructure.

With increase in liberalization, privatization and expansion of distributed and renewable power generation of Indian electricity market, transmission and distribution, as well as market processes related to the allocation of energy and energy mix are undergoing an evolutionary development with improved efficiency and reliability.

The discussion on management challenges face by EV charging infrastructure development in India.

1. Standardization for charging stations in India
2. Governmental support for rollout
3. Regulatory issues on safety
4. Availability of electricity at sufficient level in the planned locations

Also discuss technical challenges such as charging speed & charging frequency for EV charging stations.

Since EV cars, battery technologies, charging station standards are still under various stages of evolution we are looking at an infrastructure which would be future ready.

Keywords: Electric Vehicles, Charging Stations, Energy & Infrastructure

Evaluating the Performance of Transportation Sector in India in Last Decade (2009–2019)

Jay Joshi[1] and Jugal Soni[2]
[1,2]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]jay.jpgp19@spm.pdpu.ac.in/ jayjoshi041@gmail.com,
[2]jugal.spgp19@spm.pdpu.ac.in/ jugalsoni.06021997@gmail.com

Abstract—Economic development of any country is not only the result of production factors such as capital and labour, but also of infrastructure. Infrastructure development is an important component to encourage the economic development of the country. In which a related effect is that there will be changes in transport cost for Transport-infrastructure investments. So, they may affect trade relationships and also the location of production factors. This implies transformed growth of regions and countries. Due to this transformation, plays a major role in the political agenda many countries. The economic impacts of the infrastructure are discussed at various levels: urban, regional, national and international. Specific issues play a role in each of spatial category. At urban level important issues are the consequence of public transport infrastructure on spatial development and local development. At the regional level, infrastructure has always been considered as a policy tool to stimulate backward areas. The balance between private and public investment is an important issue to reach the path of best growth at the national level. Like any developed countries, Indian government is putting their maximum efforts to develop in transportation sector. It has been evaluating that, Indian economy has achieved tremendous growth in last decade in the sector of transportation infrastructure in all the mode of transportation.

Furthermore, Development in the particularly Road transportation, it is able to generate huge employment in the country as it can create a good number work opportunities to ordinary workers. As in India, 66.46% of the population is leaving in the rural area, which is defined by National Statistical offices; therefore it is the basic requirement to develop connectivity in the rural area by road transportation. Road transportation is very important for agriculture sector of the country as well as for modern and giant industry sectors. Basically it connects door to door, villages to village and road to rail transportation. It is also observed that Rail transportation is also as much as important sector is Road transportation. Indian Rail network is fourth largest network in the world. By providing fast and reliable transport medium, Indian Railways is also helping Indian economy. Apart from the biggest employer in the country Railways provide most economic infrastructure of the National economy. It has been accepted that Railways play a major role to run smooth and sustainable economy.

The recent announcement of the new vision by the government of India that to become $5 trillion economy by 2025, gives a new direction and new scope to overall transportation sector and particularly Road-ways and Rail-ways mode of the transportation. It is observed that, to achieve this vision government of India took steps in that direction. It can be seen from the budget allocation earlier and after the announcement of this vision to these sectors by the current government of India.

Therefore, this proposed work has been made to analyse the road transportation and rail transportation in India during last decade (2009-2019). This study is attempting to discuss about the contribution of transportation sector in overall economy of India, various efforts put in by government through many development programs and skims to strengthen the overall economy by developing transportation sectors and further it discuss, how it will contribute further to achieve $5 trillion economy.

Keywords: Transportation Sector, Road Infrastructure, Rail Infrastructure, Economic Growth, $5 Trillion Economy

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Analysis of Ecosystem of Electric Vehicles in India: Challenges and Opportunities

Ayushi Tiwari[1] and Wael Sawan[2]
[1]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
[2]M. Tech. (Electrical Engineering Student),
School of Technology,
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]ayushi.tpgp18@spm.pdpu.ac.in, [2]wael.smtee18@sot.pdpu.ac.in

Abstract—Electric mobility is expanding rapidly. The global electric car fleet exceeded 5.1 million in 2018 in comparison to 2 million in 2017. China is currently the world's largest electric car market, followed by Europe and the United States. Norway has the largest market share in electric vehicles. India is also on its way to turn its clean energy policy towards pushing the electric vehicles. Electric mobility can be a major game changer in attaining energy security in India. India is heavily dependent on imports to fulfill its demand of Oil. India's import dependence has raised from 83.8% in 2018 to 85.2% in 2019. India is now striving towards being a major exporter and hence, reduce the energy dependence on imports. India imports most of the lithium-ion batteries from China which constitutes the 40% of the total cost of an electric vehicle. Therefore, govt. is now supporting R&D in battery technology to reduce the total cost of an electric vehicle which is currently high acting as an entry barrier for EVs in the market. Indian government has come up with a suite of fiscal and non- fiscal measures to support electric mobility. India also lacks supportive infrastructure for EVs which is in the development phase by private players, OMCs and through mergers and acquisitions (RIL-BP- 2019). Private sector companies have a major role to play in collaboration with the public sector companies and the govt to accelerate the growth of EVs which is discussed in the paper. This paper aims to discuss the journey of EV in Indian market covering recent developments, policies and initiatives by the Indian govt., market scenario and major players, challenges, opportunities, growth drivers and its impact on economy and other sectors. India is also a part of EV30@30 campaign to reach a 30% market share for EVs in all modes except two-wheelers by 2030 with countries like China, US, Canada etc. Therefore, EV ecosystem in India and other nations in EV30@30 campaign has been compared and gaps found are evaluated. We are aware of the Oil war but with the increasing need of Lithium, there exists a geo-political war on Lithium which will play a crucial role in deciding the world leaders in electric mobility. Chinese state-owned firms secure lithium mine concessions in countries such as Bolivia, Argentina and Chile, which forms the so-called lithium triangle putting other nations at a disadvantage. This paper also describes the status of India in this geo-political situation and how it may impact the growth of EVs in India. India's automobile industry and market are at the cusp of change. The disruptive technologies and reduced import dependence on energy can change the Indian market massively. This paper attempts to capture all the aspects of Electric Mobility future of India.

Keywords: Challenges, Market Scenario, Lithium War, Opportunities, Growth Drivers, Policies & Initiatives

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The Role of Disruptive Technologies in Indian Power Sector

Chirag Vanpariya[1] and Jill Shah[2]
[1,2]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]chirag.vpgp18@spm.pdpu.ac.in, [2]jill.spgp18@spm.pdpu.ac.in

Abstract—India is the 3rd largest primary energy consumer country in the world after U.S. and China. The primary energy consumption in the world seems to be increasing considering the increase in population, economic development, increasing urbanization and increasing vehicle demand. The global primary energy consumption was 13864.9 mtoe in 2018 in which India's share was 5.84%. The most rising energy demand is met by electricity and petroleum sector. The world's electricity consumption 26614.8 Terawatt-hours in which India's contribution is 5.86%. In 2018, the electricity generation growth in India was 6.2% which expected to be increasing considering several favorable factors. India has 360.456 GW installed power generation capacity out of which 56% share is from coal-based power plants. Renewable energy comes 2nd with 22% share in total installed power generation capacity. Indian power sector faces many challenges like transmission and distribution losses, demand side management, grid stability, understanding customers' consumption pattern, power theft, supply fluctuation, safety, health concerns etc. To manage these difficulties, the sector is involving the use of latest technologies. Indian power sector sees huge potential in advance technology implementation in coming years. The policy changes, inclination towards renewable energy, steps taken to reduce the losses are the big examples which justifies the bright future of Indian power sector. Various disruptive technologies like Artificial Intelligence, IOT, Robotics, Drone technology, Battery storage, Data analytics, Utility-scale wind and solar, Distributed generation, Smart grids, and Energy efficiency. These innovations are already implemented or are under implementation worldwide. In India, power sector is mainly operated traditionally and very few technologies are implemented so far. Smart meter can provide flexibility by understanding consumer consumption patterns and accordingly tailoring the supply. AI can be used for energy storage and supply related decision making. AI can assist in analysis and interpretation of data analysis and can provide solutions by using consumer consumption pattern data. AI and ML can be used for predictive maintenance which can revolutionize the operation in power sector. Drone can be used for surveillance and supervision as a part of predictive maintenance. IOT can be used to connect all the devices to predict the consumption of electricity and patterns for each consumer which helps to serve consumer by tailoring the supply. IOT can be used to get real time integrated data collection. Battery technology is very essential for future as renewable power generation share is expected to increase which needs huge battery storage for grid stability. As roof top solar power generation is growing, needs better battery technology for sustainable power supply. Data analytics can be used to analyze the data collected from various IOT devices, smart meters and sensors. This can be used to demand forecast and prediction of immediate response to demand fluctuations. Smart grid is improving the demand-supply relations by connecting the customers with utility providers. Smart meter can improve the connection of individual supply by connecting them with smart grid. Such more disruptive technologies are expected in coming years which can change the whole power sector scenario. A study conducted by Sunil Upadhyay (2013) on role of information technology in Indian power sector for efficient operation, distribution and automation, power management, load forecasting and consumer relationship management. A blog posted on IEEMA (2019) mentions about growing digitalization and automation in power sector and how technological advancement will change the scenario in generation, transmission and distribution segments. An article written by Pravin Chopade, B E Kushare and D G Bharadwaj (2005) contains that how power industries are transforming from being energy suppliers to becoming energy service companies. Another literature by Franklin Wolfe and Kimia Mavon (28th Aug 2017) on Harvard University blog reveals the impact of artificial intelligence on energy industry. This paper contains Indian aspect of scope of various disruptive technologies and possible consequences on generation, transmission and distribution sectors in power industry.

Keywords: Power Sector, Disruptive Technology, Energy Efficiency

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Charging Electric Vehicles with Solar Power

Mansi Rai[1], Arpita Jain[2] and Ayushi Tiwari[3]
[1,2]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management,
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]mansi.rpgp18@spm.pdpu.ac.in,
[2]arpita.jpgp18@spm.pdpu.ac.in,
[3]ayushi.tpgp18@spm.pdpu.ac.in

Abstract—Electric Vehicles are appearing more and more in our roads. But an insufficient charging infrastructure is causing problems. And more often than not, Electric Vehicles are being charged with unclean electricity from coal and nuclear power plants. So, to charge the electric vehicles with something that is environmentally friendly and within reason, we have majorly three options. First, plugging into a power point and using electricity from grid. In this case, we are not using green energy, it is expensive and slow. Also, standard household electric power points are not designed to be used over such a long period of time with so much power. Second, recharging at public charging stations. In many cases, it is quite expensive, have different payment systems and is often impractical because there aren't enough charging stations and is not located everywhere that is convenient for you. But this option can be made a green source of energy by making the charging station powered by solar energy. Finally, charging at home with a solar power system. With this, we use one hundred percent renewable energy, it is independent from power companies & price increases and the power costs are way cheaper than the power that an electric grid would cost.

Solar panels can be very easily installed at house roof/ garage roof/ car parking which is possible for roofs with various orientations and inclinations. Also, to address the current inadequate charging infrastructure, major companies should adopt solar powered charging stations. The solar powered charging stations can be located in parking lots to produce electricity and thus charge electric vehicles. The development of solar powered charging stations will reduce the amount of greenhouse gases emitted into the atmosphere and health issues.

Since solar has great potential to generate electricity from PV panel, the charging of EVs from solar PV would be a sustainable step towards the environment. This paper presents a comprehensive study of solar PV-EV charging station. This paper will also include the EV charging behavior, modes of charging station in operation, location of charging station users and battery swapping model pros and cons.

Keywords: Solar Power, Electric Vehicles, Sustainability

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Lean Approach for Overcoming the Losses in Profit Ratio Due to Delayed Projects

Dr. Abhay P. Bhuva[1] and Kamlesh R. Damdoo[2]
[1,2]Assistant Professor,
U.V. Patel College of Engineering,
Ganpat University, Mahesana, Gujarat, India
E-mail: [1]apb02@ganpatuniversity.ac.in/ abhay10001011@gmail.com,
[2]krd01@ganpatuniversity.ac.in

Abstract—In any project, the role of contract in project execution is of prime importance. Since uncertainty lies in every project, contract document becomes one of the key feature to resolve any dispute that may arise in project execution. In most of the projects, the major criteria of successful projects follows the cost management and time management and so cost and time overrun are the major issue for major contract. The time overrun drive towards penalties for the delay which results in reduction of profit ratio which is estimated earlier. To compensate the penalties, the quality of the project seeks to be distorted. A better contract management formwork can help to reduce risk of quality loss. The lean approach can be help to develop the relation between quality and contact penalties. In this paper based on lean approach a new contracting condition and its likelihood were considers over the existing contract conditions. The new relation are tested and analyzed which lead to result in a relation between penalties and its minimal damage to project execution which allows contractor to complete project without any quality issue. The new conditions are in favor of both contractor and client though indirect loss occur in the contractor side most of them prefer the new conditions.

Keywords: Lean Management, Project Delay, Quality Loss

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SECTION–V

PRODUCTION & OPERATIONS MANAGEMENT

Small E&P Operators Need to Develop Risk Analytics Engine and Maintain Risk Registers to Avert Financial Shock in Oil & Gas Business

Mahendra Pratap[1] and Dr. Sudhir Yadav[2]
[1]Ph.D. Student,
School of Petroleum Management,
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India
Senior Reservoir Engineer (Badarivishal Oil Company) Led by Ramayna Ispat Limited,
New Delhi, India
[2]Professor, School of Petroleum Management,
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: [1]mahendra.pphd19@spm.pdpu.ac.in/ mpratap@bocindia.in,
[2]sudhiryadav66@gmail.com/ sudhir.yadav@spm.pdpu.ac.in

Abstract—Oil and gas enterprises world over implement ERM (Enterprise Risk Management) as a compliance requirement. They develop risk registers and governance framework which they keep updating continuously. The ultimate objective of an ERM framework is the readiness to address and mitigate risk before it happens and identify some of the uncontrollable risks. Indian NOCs in general lack a well laid decision support enabled risk framework like MNOCs such EXXON-MOBIL, TOTAL, BP, SHELL, CONOCO PHILLIPS, CHEVERON and OXY. As a result, senior technical executives of these NOCs are not well exposed to risk analysis and management framework unlike other International NOCs who work as partner with reputed MNOCs. Due to absence of MNOCs in India and general lack of cognitive awareness of the comprehensive taxonomy across five areas of risk i.e. strategic, operational, compliance, financial and legal risks among these NOC executives, there is dearth of such technical experts in Indian Oil Industry.

The pragmatic shift from PSC (Production Sharing Contract) to RSC (Revenue Sharing Contract) paved the way for ease of doing business with relaxed norms in Indian Oil & Gas sector. Many new but small players from diversified fields have been awarded small oil and gas fields under DSF-I & DSF-II rounds of bidding for Discovered Small Fields (DSF) in 2016 and 2018 respectively. Most of these new entrants have no prior experience of E & P operations. They have hired retired/experienced senior executives from NOCs to manage their new business who themselves are not well trained in risk assessment and management. As a result, the work culture of these new companies is not much different than that of the NOCs of which they were part of few years back.

It is important here to emphasize that many of the risks that they heeded least attention while working with their parent NOCs have become so important for them while managing these small and private E& P companies as they do not have support on demand from a well laid Legal, Finance and Well Service Departments which they enjoyed while working with NOCs. Unfortunately, the management of these new small oil companies have few from disciplines such as Legal and Finance as they have hired mostly technically sound senior executives who were hardly exposed to the concept of ERM processes.

This paper introduces and presents an overview of ERM process and signifies the importance of developing and maintaining Risk Registers by these small companies to succeed in their new venture by taking calculated risk commensurate with their risk appetite. Through case histories of workover jobs undertaken to revive production in two of the sick wells, the need of the same has been emphasized to avert financial losses that have potential of even failing of these small companies. It has been demonstrated how un-attending to a risk at the onset of a problem led to significant financial loss as well as loss of the well in one of the cases which could have been averted had the RACI chart that fixes responsibility and accountability of an individual been evolved and followed by the company.

Through this case study, the authors want to emphasize the burning need of adopting proactive approach by these companies to evolve their risk registers and governance framework to avoid sudden off-budget financial shock which they are incapable of handling. They can do so by developing inter-relationships between various risk drivers across different risk domains, namely strategic, compliance, operational, financial and legal. In nut shell, these small new E&P players in Indian Oil and Gas sector need to develop a risk analytics engine with robust day to day monitoring and integrated reporting and alerts framework by deploying expert from International Oil and Gas sectors to help them in formulating risk registers with proper risk assessment and management of their high-risk venture of exploration and production of oil and gas.

Keywords: NOC, PSC, RSC, GOI, E&P, Risk Register

INTRODUCTION

Inherent risks in oil business involve both oil and gas industry-specific risks and the business specific risks applicable to all industries. There is no risk-free business and therefore, some business risks that are managed properly can be accepted by the company if acceptance of such risks creates value. An oil company needs to adopt an Enterprise Risk Management (ERM) framework and avoid any adhocism in its high-risk potential oil and gas business through effective management of the risks. ERM consists of Company's organizational structure with clear roles, responsibilities and accountabilities aimed at risk identification, risk assessment, risk treatment and risk monitoring and reporting as well as the policies and the procedures.

THE KEY OBJECTIVES OF THE ERM

It ensures that the significant business risks to which the company is exposed are systematically identified, assessed and managed to acceptable levels based on risk tolerance and appetite levels as approved by the board and to ensure that risk management is embedded in all decision-making processes.

THE ERM PROCESS

It typically involves the following:

- Establishing context i.e. establishing strategic, organizational and risk management process by considering the environment within which the risks are present.
- Undertaking regular exercise (Quarterly every year) of Risk Identification, Risk assessment, Risk treatment through communication and consultations between stake holders.
- Evolving, updating and maintaining the Corporate Risk Register as well as Department Risk Registers through regular Risk Monitoring and Reporting.
- Regular review of risk status, including changes to the risk environment and implementation process against agreed actions. Risk reporting is the creation of useful management information that can be used to inform business decision making and prioritization of resources.
- Semiannual reporting to executive committee about the status and changes if any in the Department Risk Registers and the Corporate Risk Register.
- Annual reporting to the audit committee/board and the need of changes if any in the Corporate Risk Register is ensured by the ERM.
- The Board is ultimately responsible for adherence to risk management in accordance with corporate governance requirements and providing an oversight of the strategic direction of the business.
- It is the responsibility of the Board to ensure that its approved Business plans have well defined operational targets with associated risks to delivery.
- To manage risks and embed these into business activities and process a Corporate Risk Register, comprising key Group level risks, and the Department Risk Registers, dealing with key activity risks, are created and reviewed periodically.
- The CEO is the Group Risk Owner for the significant risks at corporate level, along with the COO as the Risk Sponsor, is responsible for ensuring that each department completes an assessment of their risks, for challenging the robustness and completeness of the risk profile, for performing in-depth reviews of the key risks and monitoring the planned improvements.

A designated risk manager (Thomas H. Stanton, 2017) assists all Department Risk Owners in the ERM process to ensure that risk management complies with the relevant standards and that it is working effectively covering all aspects of business.

The Group adopts risk management strategies based on the nature and type of risks categorizing them into Strategic, Operational, Financial and Compliance risks. Risks identified in the preceding year are reviewed in the current operating environment and updated in risk registers at corporate and department levels. The review of department risks arising from the risk assessment are focused on the critical risks that were considered in depth for mitigating measures.

The focus is finally embedding the ERM in the strategy and planning processes through a series of communication and consultation meetings across the Group and evolving a RACI (Responsible, Accountable, Consulted, Informed) chart for smooth and safe execution of business of the Company involving both technical and non-technical risks (Adebanji Adekoya *et al.,* 2016 and McKeeman *et al.,* 2012).

PRINCIPAL RISKS

Risk Owners assess the risks and evaluate the mitigating factors and progress of planned improvements quarterly while reporting to the Executive Committee at department level semi-annually. They are responsible and accountable for overall management of risks in their respective areas of responsibilities. Significant risks are identified, assessed, monitored and reported to the Executive Committee and are ultimately reviewed by the Audit Committee. Mitigating factors and planned improvements are discussed and implemented to manage these risks.

To be consistent with Industry best practices, the Control Framework document of the company is reviewed periodically to ensure the relevancy of key elements of controls. Policies and procedures aimed at managing the risks inherent in Oil business are developed. The application and consistency of these policies and procedures are regularly reviewed by the Group's Internal Audit function and are then overseen by and reported to the Audit Committee, who are ultimately responsible for reporting on the same to the Board.

RISK REGISTER

A Risk Register is a master document which is created during the early stages of the project. It is a tool that plays an important part in the Risk Management Plan, helping the company to track issues and address problems as they arise. It contains information about identified project risks, analysis of risk severity and evaluations of the possible solutions to be applied. Presenting this in a spreadsheet (Figure 1) is often the easiest way to manage things, so that key information can be found and applied quickly and easily.

Description of Risk	Impact on Project	Assessment of Likelihood	Assessment of Impact	Resulting Grade (Combined Likelihood and Impact)	Change in Grade Since Last Review	Date of Last Review	Mitigation Actions	Person Responsible	Cost	Date Required for Completion	Timeline for Mitigation Actions	Work Breakdown Structure Reference
Volatile oil and gas prices	Massive impact to margins on oil and gas and the success of the project at large highly, highly impact	High	High	A	Gotten worse	06/03/2018	Try to sing longer term price lock-in contracts with major buyers. Assume the lower end of the market price will prevail and plan the project accordingly Manage costs more effectively Have a team of economists on retainer to warn of increased volatility	Joseph	$200,000	09/02/2018	6 weeks	No selection
Regulatory and legislative changes and increased cost of compliance	Increases the cost of the project workers are not trained and informed aboutnew practices Not abiding by rules and regulations can result in large penalties or the project being shut down	Medium	High	B	No change	04/01/2018	Maintain a strong relationship with the regulatory bodies invest in a document and permit management system which is more flexible and adaptable to change setup new training workshop to be include with new inductions	Rebecca	$100,000	10/10/2018	6 months	No selection

Fig. 1 (Contd.)...

...Fig. 1 (Contd.)

Description of Risk	Impact on Project	Assessment of Likelihood	Assessment of Impact	Resulting Grade (Combined Likelihood and Impact)	Change in Grade Since Last Review	Date of Last Review	Mitigation Actions	Person Responsible	Cost	Date Required for Completion	Timeline for Mitigation Actions	Work Breakdown Structure Reference
Enviromental restrications and regulations	Can cause project start failure or close down Massive PR and branding issues with enviromental concerns. Political relationship concernsimpacts cleanup costs are more than preventative measures	Medium	High	B	No change	03/04/2018	Ensure permitting workflows are followed expand the enviro team (typically under-resourced) Enviro inspection training Regular environmental audits scheduled	Dave	$100,000	06/02/2018	3 months	Activity 1: Inspection of ring
Operational hazards: Blow outs, spills and personal	Impact can be all over the spectrum. Large scale operational hazards can cost billions of dollars.	Low	High	A	Improved	11/06/2017	Ensure hazard reporting training is implemented Hazard reporting and tracking software maintain strict inspection procedures and schedule	Dorian	Unknown	09/10/2018	3 months	Activity 3: Setup mainline valve
Natural disaster and extreme weather conditions	Bad weather can impact and inhibit project progress. Natural disasters can ruin or seriously impact the project.	High	High	A	No change	31/07/2017	Improve evacuation procedure in the event of bad weather Inspect platfom rigging before any weather event	Joe	$10,000	09/03/2018	4 weeks	Activity 1: Inspection of ring

Fig. 1: Typical Risk Register Format

The Risk Register will generally be shared between project stakeholders, allowing those involved in the project to be kept aware of issues and providing a means of tracking the response to issues. It can be used to flag new project risks and to make suggestions on what course of action to take to resolve any issues.

All corporate and organizational projects face risk at one time or another. Having a Risk Register in place simply provides a better means of responding to problems as they arise. The Risk Register is there to help with the decisions making process and enables managers and project stakeholders (Rodriguez, Roberto, 2014). to handle risk in the most appropriate way. A risk needn't be a threat to the project, it is simply an issue that can arise during the project; if effectively managed, it shouldn't prevent project from attaining its goals and objectives.

The following is a brief guide on how to get started and create a Risk Register in just a few steps:

Create the Risk Register - this step will be undertaken when the project plan is approved, and the Risk Section of the project plan should serve as the basis for the document.

Record active risks - keep track of active risks by recording them in the Risk Register along with the date identified, date updated, target date and closure date. Other useful information to include is the risk identification number, a description of the risk, type and severity of risk, its impact, possible response action and the current status of risk.

Assign a unique number to each risk element - this helps to identify each unique risk and its severity based on its Likelihood (Probability) & Impact ranking as shown in Figure 2, so that required mitigation plan is effectively taken as and when that risk eventuates during the project execution. Keeping this number consistent throughout the project will make it easy to see how this risk links into the Project Status Report, Risk Identification and Risk Impact Form.

		Likelihood		
		1	**2**	**3**
Impact	1	Low	Low	Medium
	2	Low	Medium	High
	3	Medium	High	High

Fig. 2: P-I Matrix for Categorising Risk Severity

The Risk Register addresses risk management in four key steps: (1) identifying the risk, (2) evaluating the severity of any identified risks, (3) applying possible solutions to those risks and (4) monitoring and analysing the effectiveness of any subsequent steps taken.

Any issues that are likely to impact upon the success and the speedy completion of the project is categorised as risk. Implementing strategies to handle this, such as a risk register helps to prevent risk from becoming an issue that may cause significant delays or even lead to the project failing.

THE RISK MANAGEMENT PLAN

The Risk Management Plan supports risk management. It sets out the organisation's risk management policy, roles and responsibilities for managing risk, any budgetary considerations and the tools, techniques and templates that must be used.

The contents vary between organisations but should address the following areas: Risk Strategy - the high-level approach to risk management, the processes and procedures for managing risk and the organisation's risk tolerance or appetite for a certain level of risk. For example, risk of budget overruns may be more acceptable than delivery delays. Some risk areas may have much lower tolerances than others, for example the risk of not meeting DDA guidelines may have very low tolerance for a government website. Organisation - any roles and responsibilities associated with managing risk. The Project Manager will have main responsibility, but there may be other responsibilities perhaps for the project office or specialist risk consultants for example an Asbestos Consultant on a construction project. Risk Budgets - the money and resource that will be set aside to manage risk. Tools and techniques - the techniques that will be used to manage risk. Risk Management Templates - the templates that should be used e.g. a risk register template and a Risk Management Strategy

THE RISK MANAGEMENT PROCESS

The risk management process (Figure 3) starts with identification of risks, analysis of the impact and probability of those risks (risk assessment), selection of suitable responses, planning responses and monitoring and controlling the process as shown below.

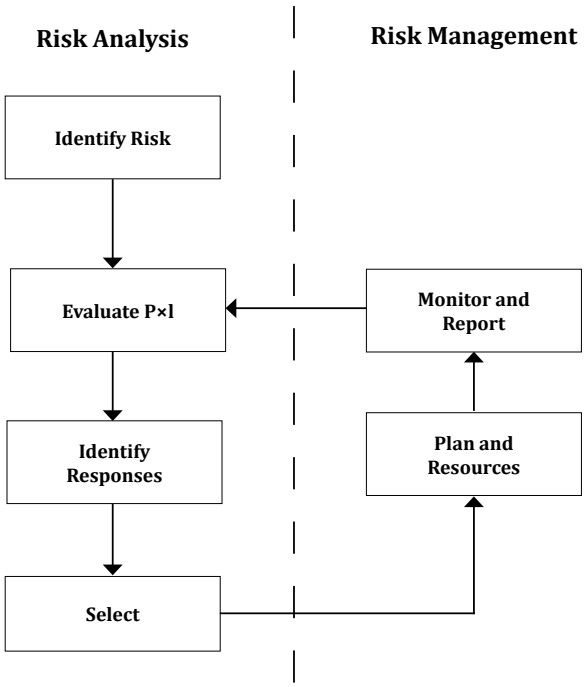

Fig. 3: Risk Management Process

Figure 4 shows the pyramid of ERM framework followed by an IOC Courtesy Enterprise Risk Management (ERM) framework (2012), Annual Report- Dragon Oil Company.

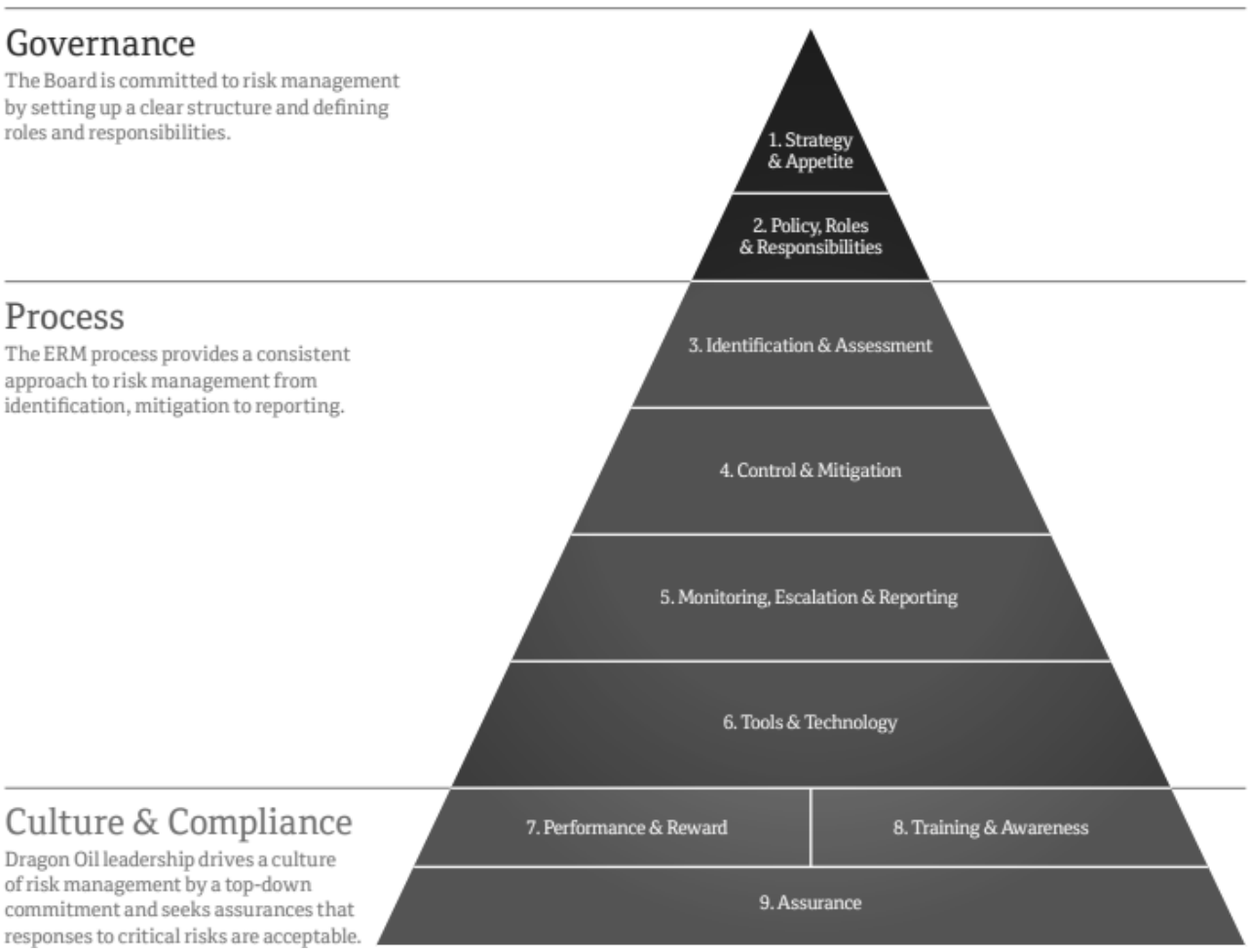

Fig. 4: Pyramid of ERM Framework, Courtesy Dragon Oil Company (2012)- Annual Report

NOCS VS SMALL OIL COMPANIES

NOCs do, indeed, have many advantages relative to private corporations, most notably the political muscle of their parent government. Also, they usually at least have greater access to capital and the potential to take greater risks without fear of "betting the company". However, they are not necessarily disciplined by the marketplace and, therefore, relative to IOCs, tend to make economically inefficient decisions (Saud M. Al-Fattah, 2013). They also have the tendency to tolerate underproductive labor and staff bloating or, potentially, graft and other abuses on the part of national leadership. IOCs can bring new technologies, critical expertise and international experience that may not be as readily available within NOCs. It is therefore obvious that these small Oil Companies need to evolve its Corporate Governance & ERM framework in line with established IOCs tailored made to domestic conditions. Experts that have international experience of working with small companies can be hired to develop ERM framework for domestic small players to minimize the inherent risks in oil business as they have limited risk appetite as compared to NOCs in terms of access to both capital and other resources.

CASE HISTORIES

Following two case histories emphasize the need of ERM framework and Risk Register for a small company.

Workover Operation in Well A

This well was a producer which ceased to flow due to high GOR and water cut and was left in closed condition since then. It was producing from a deep reservoir in a small discovered field that was acquired recently by a small oil player with no prior experience of oil business. The technical team of the company evaluated the remaining production potential of the well based on simulation model and the performance history of the well. To mitigate data gaps and have improved understanding of formation fluids around the well, the latest suite of Pulsar log in the cased hole was recorded by Schlumberger that helped identifying gas cap overlying the oil rim which in turn is underlain by a thick aquifer. Upside potential was also established by Pulsar log that was recorded first time in India in an Onshore field. The suspected entry point of water in the well was confirmed and accordingly the well was planned for both water and gas shut off job encouraged by results from Pulsar log.

The well entry met with a surprise when 5-1/2" Production Casing obstruction at 2683 m prevented further entry of 4-1/2 " bit to reach to the target reservoir that was approximately 700 m down. Lead Impression Block (LIB) impression confirmed off centered casing joint suggesting thereby casing parting. After milling operation, the well was cleared with great difficulty using smaller bit till bottom and Pulsar log was recorded successfully. This was perhaps due to comparatively free upper casing at 2683 m level against which cement bond was poor. During the casing milling operation, the return mud showed black shale with occasional sand with evidences of iron cuttings indicating that the sandy shale against the damaged casing was getting caved and produced. This in turn offered more play for the parted upper casing to oscillate.

The Pressure and Temperature logs recorded by Schlumberger during recording of Pulsar log confirmed reopening of the lower 2m perforation that was used for block cementation job to repair poor primary cement against the casing to stop water incursion from underlying aquifer. This was in accordance with the analysis of the technical team based on sudden rise in water cut observed in the well post cement repair.

The well had now three distinct intervals from where the fluid could enter into the production casing from various zones, namely, the lower most 3354-56 m which had reopened post block cementation job, middle 3342-3345 m perforated interval in the producing Oligocene reservoir and the top most parted casing zone at 2683 m depth in the Miocene formation.

After a long deliberation, as recording of previously planned CBL/USIT was not possible due to restriction at 2683 m, blind cement squeeze job was carried out to squeeze the lower two intervals with cement top in the casing at 3250 m. The cement inside the casing was re-drilled only till 3350 m well above the possible water entry interval of 3354-56 m. No cement repair job for the parted casing interval was attempted despite raising alarm by Reservoir and Production section. The severity of risk was not assessed in terms of the following:

1. With the time, the entry diameter at the casing parting depth had reduced and possibility of losing the well was inherent due to oscillating nature of the upper parted casing.
2. The cost of second cement squeeze at 2683 m, putting a cement plug against it and finally re-drilling the column of cement inside casing from 2600 m to 3350 m vs the benefits of repairing casing damage as follows were not examined.
    i. The cement repair job at parted casing depth would have not resulted in access to the reservoir through tubing only.

ii. The possibility of falling of debris from the caved zone at 2683 m depth would have been ruled out.

iii. Accessing the reservoir through tubing only would increase the dependency on resources like CTU which is not only costly but difficult as well to mobilise on demand given the limited resources, capital access and risk appetite of a small company

iv. Safety compliance would have been ensured after casing repair job.

v. The installation of suitable artificial lift in a damaged casing well would not have been so challenging.

Completion of the Well A

The well was finally completed with casing parting unattended at the depth of 2683 m by running in tubing through the damaged casing with great difficulty necessitating frequent pulling out and running in operation which took almost two weeks. Unproven jugar technology was used to mill the tubing joints to pass through the damaged casing.

The well was perforated through tubing in the interval 3343-3346 m leaving slightly more than a meter margin from the gas cap based on the fluid type identified by the pulsar tool and completed with packer in unset condition at 2683 m as it could not pass through the damaged casing section. The orifice valve was set at 2000 m depth for unloading the well during activation.

Activation using Nitrogen Injection through Orifice Valve

The well was subjected to high drawdown of 2000 m by unloading through orifice valve during the process of activation. The well occasionally flowed mostly clean oil into the tank but sustained flow has so far eluded. An attempt to reperforate the well was not successful as the strip gun could not be lowered below 2700 m depth. Prior to running in the perforation gun, the dummy was lowered till 3344 m only indicating some debris against the perforation. Debris cleaning through tubing required costly CTU operation and hence it was not considered a viable and efficient preposition.

Of late, the SGS could not be recorded as dummy did not pass below 2683 m. With the passage of time, the THP has refused to build up beyond 150 psi while the CHP goes as high as 600 psi and the worst fear of losing the well looms large. The well has so far produced about 70 barrels of oil in the tank with very low water cut.

Workover Operation in Well B

This well is only 2 km apart from well A in the same field, but it targeted deeper Eocene reservoir for exploration. Previous operator tested all promising lower zones and concluded them to be water bearing. They finally put a BP above the last tested zone and capped the well. Our technical team reviewed the testing results of all the zones tested in Eocene and re-evaluated one potential zone above the BP that was not tested and recommended it for testing.

Again, as we entered the well, there was slight obstruction to the bit at a shallower depth of less than 300 m which was overcome with ease as compared to well A. Thereafter, we rapidly reached to the top of BP and tagged its depth at 4642 m which was shallower than reported by previous operator. Tried several times to overcome the hard tag and wash down further from 4642 m but could not succeed. Casing hermatical test failed. The 5-1/2" production casing was scrapped thoroughly, and second hermatical test was conducted which also failed. SLB recorded CCL -GR from 4649 to 4325 m and set a BP at 4648 m. BP was pressure tested twice but did not pass pressure testing. Run in packer and set it at 4596 m depth and retested BP successfully at 500 psi and was found holding the pressure.

As planned, to create 1500 m under-balance before perforation, N2 was injected through orifice valve but despite significant increase in injection pressure, no unloading was taking place after initial unloading of 40 barrels against the required 100 barrels. Opened the annulus between 5-1/2 and 9-5/8 inch and found release of N2 from the annulus. The casing damage at shallower depth was confirmed. As with well A, the red alert was flagged by Reservoir and Production team to repair the casing by identifying the damage and undertaking cement squeeze job. However, decision was taken to complete the well by perforating the untested zone using TCP gun without achieving planned under balance condition and isolating the damaged casing by completing the well with tubing and packer assembly.

Taking casing repair measures either by a casing patch or a cement squeeze job, the additional cost incurred would have been significantly low compared to the cost of frequent requirement of costly CTU operations required for well unloading. By not mitigating the risk at the onset, the company could cut cost for the time being, but it later costed huge and did not create any value. Instead, it has invited greater compliance risks for production operation. By restricting reservoir access through tubing only, many of the future operations for well stimulation and artificial lift cannot be taken effectively and efficiently. For example, the efficient stim frac and installation of jet pump have been ruled out in well B which is completed in a tight reservoir and needs unconventional stimulation technique for commercial production.

Recently Pressure & Temperature (P-T) Gradient Survey was carried out for both the wells. In well A, the operation was not successful as the dummy could not be lowered inside tubing below the casing damaged zone at 2683 m most likely due to buckling of tubing. In well B, the SGS results clearly indicate that the most promising lower perforation interval is filled with high density mud/debris that fell from damaged casing zone at shallower level and has blocked the perforation interval to the extent that almost negligible flow is seen from the lower two perforation intervals that pertain to petrophysically superior zones (Figure 5). To remove debris against the more permeable lower perforation zone, costly CTU operation must be planned.

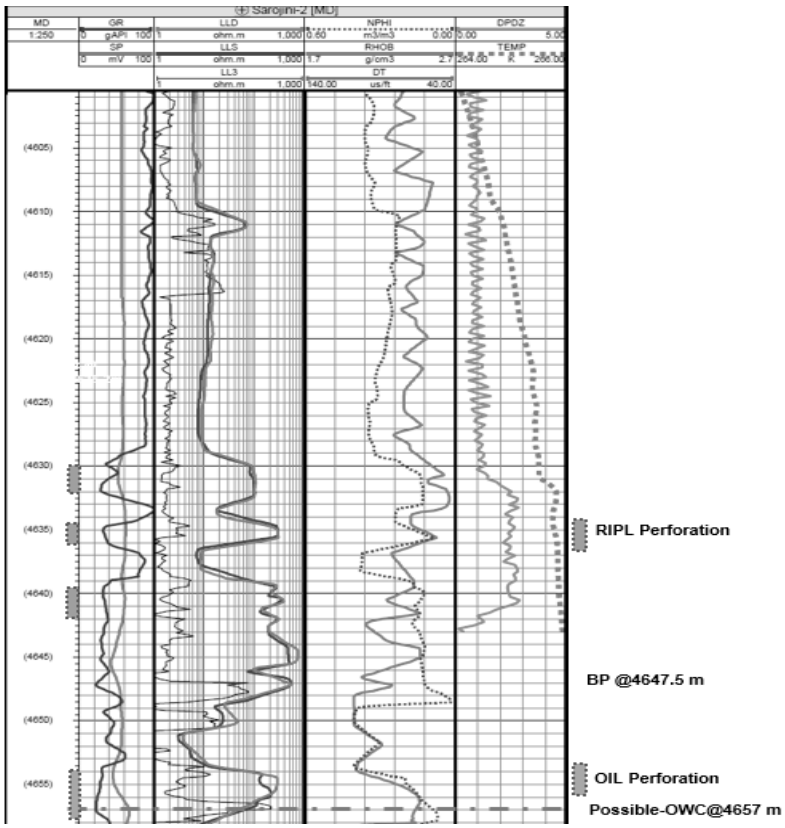

Fig. 5: P-T Gradient Survey in Well B Shows Mud/Debris Against Most Prolific Zone

LESSON LEARNED

Proper risk assessment was necessary before deciding not to squeeze cement and put a plug and re-drill the same to repair damaged casing zone. By not having a risk register and ERM framework, the small oil companies are exposing themselves to greater risk though adhocism in decision making process as the roles and responsibilities of the stake holders are not defined and the severity of a risk are not assessed and mitigated properly for adverse consequence. There is no need to invent the wheel, all they need is to hire consultant to develop form international learning an ERM, Risk Register and RACI chart for their oil business that are commensurate with their risk appetite and capital constraint. Lesson Learned documents must be prepared and the finding be incorporated in the ERM framework on continuous basis so that similar mistakes are not repeated.

CONCLUSIONS

- Risk appetite of small Oil company is limited as compared to NOCs.
- ERM framework and Risk Registers must be developed to avoid financial shocks and chances of failing all together due to low capital access and limited resources available to small domestic oil companies.
- Risk identified from Lesson Learned documents must be included/updated in Risk Registers for their severity and mitigative actions.
- International Expert with working experience in IOCs and small private oil companies across the globe should be hired to evolve ERM and Risk registers by small domestic oil companies to minimize business risk.

ACKNOWLEDGEMENTS

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Operational and Financial Perspective of Carbon Capture and Storage

Shalini Kumari[1], Sasadhar Bera[2] and Rahul Kumar[3]
[1,2,3]Indian Institute of Management Ranchi, India
E-mail: [1]shalini.kumari18fpm@iimranchi.ac.in,
[2]sbera@iimranchi.ac.in,
[3]rahul.kumar18fpm@iimranchi.ac.in

Abstract—The increasing industrialization since its inception has drawn attention towards the impact of industrial activities on the global environment. The increasing concern of global warming and rising earth's temperature has driven the institution of the Paris Agreement to examine the threshold limit of emission of carbon dioxide, which is the major component of greenhouse gases (GHG). Carbon capture and storage (CCS) technologies play a vital role in achieving net-zero carbon emission. The motivation behind this paper is to review the execution of CCS innovation in thermal power plants with the help of a financial and optimization model. The result presented here demonstrate the cost and benefit of installing CCS technology in a thermal power plant.

Keywords: CCS, GHG, CBA, MINLP, Carbon Emission, Climate Change

INTRODUCTION

The biggest challenging problem of the world from pre-industrial to the current era is the emission of carbon. Carbon dioxide (CO_2) is currently present in the atmosphere at a concentration of 0.04 percent, i.e., 1 in 2500 molecules. Before the beginning of the Industrial Revolution, the percentage CO_2 of concentration in the atmosphere was lower at 0.028 percent or 1 in 3500 molecules (*Riebeek, 2011)*. The carbon cycle of the planet is now out of balance. If the emission of carbon will not get controlled then 9 to 10 billion people would be exposed to heatwave, 85 million people would be affected by river flooding, 500 million people would be affected by increase in water stress and 3 million square kilometre cropland doesn't remain viable for agriculture every year (*Wise et al., 2014*).

According to the Paris agreement (*Paris Agreement, 2015*), there are three goals needed to be achieved. The short-term goal is to remove the peak carbon emission from the atmosphere as soon as possible. The long-term goals are to limit the increase in global average temperature and to achieve a neutral balance for carbon into the atmosphere after 2050. To control global emission by 2050, Carbon Capture and Storage (CCS) has the most securable technology to deliver 20% of the greenhouse gas (GHG) reductions. CCS is the "process of capturing the carbon dioxide from stationary sources such as power plants, cement industry, steel industry, or any other energy-related sources and then transport it to the storage location to remove the carbon from the atmosphere." CCS helps to contribute to mitigating climate change. It involves three stages, namely, capture, transport, and storage (*Mathieu, P., 2006*). The capture of carbon is feasible from the abundant point sources rather than mobile or small point sources. The next consecutive paragraphs describe the three methods that capture the carbon from the significant point sources.

POST-COMBUSTION CAPTURE

The coal and air react in the power plant which generates CO_2 and other gases. The gases then pass through the equipment (amine, ammonia, membrane) which separate most of CO_2 and other pollutants from the flue gases before entering the atmosphere.

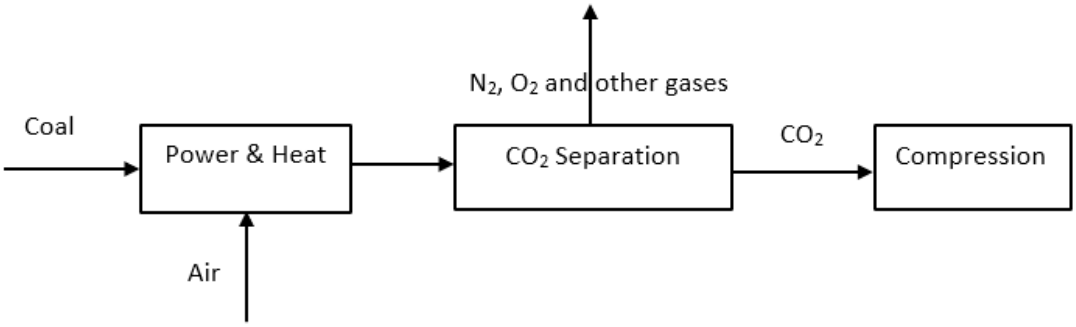

Fig. 1: Capture of Carbon Dioxide by the Post-combustion Method

PRE-COMBUSTION CAPTURE

In this method, coal reacts with air or limited oxygen to give carbon monoxide and water, which is known as synthesis gas, and then the gas passed with catalytic reactor where carbon monoxide gets converted to carbon dioxide and hydrogen gas. Carbon dioxide gets captured and compressed. The remaining gases which are released to the atmosphere are rich in hydrogen.

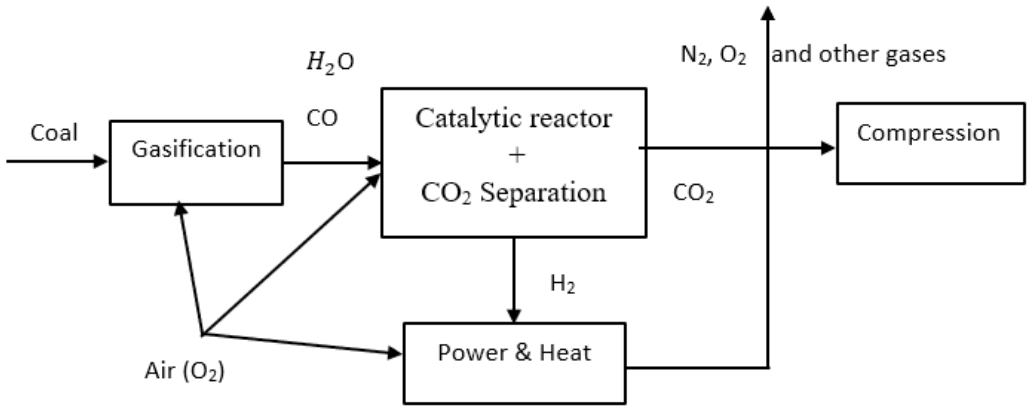

Fig. 2: Capture of Carbon Dioxide by the Pre-combustion Method

OXY-FUEL COMBUSTION CAPTURE

Coal is reacted with pure oxygen in the oxy-fuel combustion capture method. Pure oxygen is obtained by passing air through the air separator. Due to the pure oxygen the percentage of CO_2 in the flue gases is more, and then the gas passed with CO_2 separator (Chemical looping cycle) before entering the atmosphere.

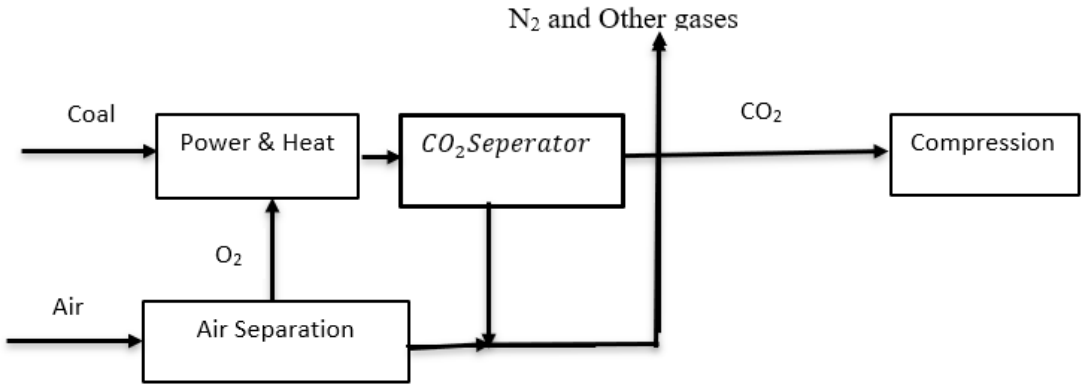

Fig. 3: Capture of Carbon Dioxide by Oxy-fuel Combustion Method

Transport is the next step in the CCS, which connects the source and sink. The source is the sizeable stationary emission point, while the sink is the storage site. Transportation step is not the new step as the transfer of natural gas, and petroleum is routinely transported from one point to another via various means like pipeline or marine. CO_2 can be transported in gas, liquid, and solid states. CO_2 in gaseous form can be transported close to atmospheric pressure, but it occupies high volume. Thus, it is compressed so that it occupies less volume and can be transported through the pipeline. Liquified CO_2 occupies less volume and can be transported through ships. Solidification of CO_2 generally not occur because it requires a large amount of energy and hence increases the overall cost. After capturing and transporting carbon dioxide, the last step in CCS is the storage of carbon dioxide, which can be done to isolate the carbon to enter the atmosphere and help to balance the temperature on the earth. The storage of carbon dioxide can be done geologically or in the ocean. In this paper, we are more focusing on the capturing of carbon dioxide than on transportation and storage.

In this article, the first objective is to evaluate the financial perspective of CCS technology in the context of thermal power plants as one of the abundant point sources of carbon emission with the help of cost-benefit analysis. The other objective is to compare the power plant with and without CCS technology to see the impact of the levelized cost of electricity and emission rate of carbon dioxide from the plant with the help of the optimization model.

LITERATURE REVIEW

The management of energy is the art and science of the optimum utilization of energy, which helps in reducing the cost, reducing the emission of carbon, and reducing the risk (*Johnson, 2010*). To solve the issues of climate change, increasing earth temperature, CCS is one of the viable approaches for reducing carbon emission from the atmosphere (*Ashworth, Boughe, Mayhe, & Milla, 2010; L'Orange Seigo, Dohle, & Siegrist, 2014*).

In the early 19th Century, the use of cost-benefit analysis initially found in Europe. Later it was gaining popularity in different countries in Europe and developing countries. In 1970 some countries like Germany used an alternative method that is multicriteria analysis. In their analysis, the project is evaluated in qualitative & quantitative both ways. But even these methods were used, but the importance of CBA didn't fade away. Many European directives encourage the use of CBA to evaluate different projects. *Amartya Sen* (*2000*) states there are some ethical problems associated with CBA. So, he advised taking individual capabilities while evaluating any project using CBA. CBA also evaluates the non-monetary attributes of the project, such as time (*El-Hifnawi, 2002*), noise (*Saelensminde, 2004*), and life of a human (*Kamerud, 1983*), which is not directly related to the economic values of any project. Evaluating environmental impact is also a non-monetary attribute where CBA can be applied. CBA widely used in transportation projects evaluation in Europe as well as across the world. CBA also used for evaluating many projects based on the societal problem, health program (*Wiseman, 1963*), environmental issues (*Markandya, 2004*) and government policies, etc.

Snyder, B., & Kaiser, M. J. (2009) analyzed the costs and benefits relating to the installation of conventional electricity generation, offshore and onshore wind power plant. In the Mexican power sector *(Islas, J., Manzini, F., & Martínez, M., 2003),* CBA was used to analyze different scenarios of economic conditions. The cost-benefit ratio can be found out by changing three economic indicators. These are average fuel costs, discount rates, capital budgeting costs, which used as a metric in the dynamic technological world. According to *Simpson, D., & Walker, J. (1987*), in every investment, CBA attempt to give all the analysis in economic values. The researcher suggested that CBA should also consider dimensions like environment, technology, and level of risk.

S. Jebaraj (2004) described various energy modelling techniques with different panorama. The model in energy systems such as the optimization model, energy demand-supply model, the renewable energy model is discussed in his article. *Cuellar et al.* (*2015*) compare the environmental impact of CCS and CCU (carbon capture and utilization) technologies. The environmental impact depends on the type of plant-like IGCC (Integrated gasification combined cycle) and type of methods (pre, post, and oxyfuel) in case of CCS, but in case of CCU, environmental impact depends on its utilization.

Pang, M., Zhang, L., Liang, S., Liu, G., Wang, C., Hao, Y., … Xu, M. (2017) integrated CCS with a biomass power plant to reduce carbon emission, and this integrated plant is called BioCCS. The study tries to analyze the benefit of carbon reduction and the cost of the environmental performance of installing CCS to the power plant. The decision-maker must take all costs and benefits into consideration while deciding the development of the BioCCS system. The CCS cannot be deployed on a large scale due to the fear of the public on environmental and health issues related to carbon storage and the potential threat of leakage of carbon from geological storage. The problem solved by storing carbon in the ocean. The paper (*van der Zwaan, B., & Gerlagh, R., 2016*) highlights evidence that carbon is stored in seabed safely. This paper studies the impact of leakage of carbon if occur in terms of an increase in temperature and ocean acidification at the global level and success the relative role of onshore and offshore CCS in pursuit of mitigation of climate change. Probabilistic Monte-Carlo cost-benefit is used for the analysis. The geological storage cost varies from site to site depending upon geological complexity of storage formation and risk of leakage. Generally, like in business economies of scale, benefit, the carbon capture storage system as a large plant may have a lower cost per tonne storage. The unit cost of geological storage is higher than ocean storage as there is higher operating cost in the case of geological storage, as shown in separate studies for Europe (*Hendricks at al., 2002*) and Australia (*Allinson et al., 2003*).

Arnette (2017) developed a model and compared the CCS with renewable energy to achieve maximum reduction of GHG. *Santibanez-Gonzalez* (*2017*) used a stochastic model to compare carbon pricing versus CCS. They use a mixed-integer linear optimization model to find out the solution. *Agrali et al. (2018)* studied the coal-fired power plants in turkey and use a mixed integer programming method to decide the capacity of capture units. They also suggested that whether it is optimal to install or not.

METHODOLOGY

In this section, we present the different types of costs involved in CBA in the context of CCS technology. These costs are useful for the formulation of optimization problem. The CBA is a highly elaborative and analytical procedure in evaluating this type of technology and public policy related to it in today's complex business environment. The broader usage of CBA is to help in decision making related to society. It also helps in the efficient allocation of resources to the citizen. CBA is a very time consuming, a skill-oriented technique which adds on to the firm's cost. We try to evaluate the CCS technology with the use of CBA analysis in which we assess a project's economic, social costs, and benefits. Thus, the cost involves in capturing the carbon is capital cost, incremental product cost, cost of carbon avoided, cost of carbon captured, or removed.

CAPITAL COST

The cost of capital refers to the cost of installation of technology or investment cost or fixed cost. It does not change with the change in output to a specific range of production. It can denote as cost per kWh in normalized form. In a capture unit of carbon, the capital cost associated with capital expenditure incurred to design, procure, and set up the carbon capture system. If any cost arises due to presence or adding on the carbon capture system in power plants, it will be treated as capital cost. The incremental capital cost of carbon capture can be measured by taking the difference in producing electricity with or without a carbon capture unit. The impact of uncertainty can also be included in the calculation of capital cost for taking consideration of the risk and uncertainty of the dynamic business environment.

Incremental Product Cost

Electricity is one of the products from the power plant. The incremental product cost can be estimated by making a difference in the cost of electricity with and without the carbon capture system. Power plants are the major contributor to carbon emission in the environment. Hence, it is needed to see how carbon capture systems impact the cost of electricity in power plants. The incremental cost can be influenced by the operating life of a plant, unit fuel cost, variable operating cost, cost of electricity, which may vary from year to year. Generally, the levelized cost of electricity calculated for making CBA study simple. The cost which remains constant over the working period of the power plant and will help in estimating the same NPV even if there is yearly variation is called the levelized cost of electricity.

Cost of Carbon Avoided

$$Cost\ of\ CO_2\ avoided = \frac{LCOE_{with\ capture} - LCOE_{without\ Capture}}{Emission\ of\ CO_{2\ with\ capture} - Emission\ of\ CO_{2\ without\ Capture}}$$

The cost of carbon avoided is calculated when the levelized cost of electricity (LCOE) includes the cost of capturing, transportation, and storage. The cost of carbon avoided also influences the incremental cost of carbon capture to a specific type of plant.

Cost of Carbon Captured or Removed

$$Cost\ of\ CO_2\ \ captured\ /\ removed = \frac{LCOE_{with\ capture} - LCOE_{without\ Capture}}{CO_{2\ removed}}$$

The cost of carbon captured or removed is another cost metric in a carbon capture system. If the carbon is traded in the market like other industrial commodities, the cost of carbon capture act as a yardstick for analysing the economic viability of the carbon capture system. If the selling price of carbon captured in the market is the same as the incremental cost of producing electricity under the carbon capture system, then it is better to go for a carbon capture system as it generates electricity at the same price as the reference plant, but the emission of carbon is quite low.

After capturing the carbon, it needs to be transported, and that involves transportation cost. Transportation occurs either by pipeline or by marine. So, the cost of pipeline transportation involves construction cost, operation, and maintenance cost, and some other cost.

Construction Costs

The pipeline material cost can influence by many things such as the amount of carbon to be transported, distance of carbon capture system to a storage area, and the nature of carbon. The material cost also depends on pipe coating, cathodic protection, telecommunication equipment, etc. Labour cost is the prime cost of construction costs.

Operation and Maintenance Costs

It includes the monitoring cost, which consists of the installation of proper mechanism or labour force that can regularly monitor the working of the pipeline transport to avoid unfortunate circumstances in the future. Another cost that may influence the transportation of carbon is maintenance cost, which may occur due to normal wear and tear arises due to some regular business operation, or it may occur due to some unavoidable events like earthquakes. These are the cost which incurred to keep pipeline transportation in suitable conditions.

OTHER COSTS

As transportation through the pipeline is risky, it is much needed to insure from unfortunate events in the future through insurance products. The project management & design cost, right to way costs, contingencies allowances, and cost related to regulatory filling are some of the additional costs required in implementing the pipeline transportation system.

Pipeline transportation can be Onshore or Offshore. The onshore pipeline is the pipeline that laid on the land. Due to heavy congestion and populated areas, the onshore pipeline costs may increase by 50% -100%. The onshore pipeline cost may increase due to the presence of mountains, rivers, heavily urbanized areas, which lead to investing in additional safety measures and accessibility for the development of pipeline transport. The offshore pipeline is the pipeline that laid on the seabed. The offshore pipeline is expensive to develop as the offshore pipeline can work with higher pressure & lower temperature than the onshore pipeline. The smaller project will incur high costs as compared to a large project. The cost of the pipeline is the function of distance. Another mode of transportation of carbon is through ships.

The cost of marine transportation includes mainly investment in ships for transportation, development of loading and unloading facilities near the port, creation of intermediate storage to safeguard from any anticipated or unanticipated disruptions in the transport system, and the development of liquification unit. Apart from this, many recurring costs may incur like labour cost, fuel cost (ships), cost of electricity, port fee, and maintenance. The port fee may change in different geographical boundaries. The marine transportation system is cost-effective as compared to pipeline transportation over larger distances. It is not only due to distance, but the other factors include loading terminal, construction cost, water depth, fuel cost, security, different operating costs in a different location.

After transportation of carbon, it needs to be stored in the sink, which can be geological or ocean. The ocean storage cost includes the cost of transport and handling carbon offshore and doesn't cover the cost of inland transportation. The ocean storage can be done in two ways Dispersion from moving ship and dispersion by pipeline. The cost involves in geological storage are capital costs, operating costs, and monitoring costs.

CAPITAL COSTS FOR GEOLOGICAL STORAGE

Capital cost includes the cost of designing and development of geological storage site, which includes drilling of wells and its infrastructure, cost of project management, and cost of development infield pipeline. The pipeline is needed to distribute and deliver carbon accrued from a centralized plant that is present within the site. An additional facility is to be developed for other storage options like enhanced oil, gas, and coalbed methane (CBM).

OPERATING COSTS FOR GEOLOGICAL STORAGE

It is a recurring nature cost, which includes labour cost, power & fuel cost, maintenance cost, and licensing fee. For the selection of geological storage sites, feasibility studies should be done, which include geological, geophysical, engineering, and financial viability studies.

MONITORING COSTS FOR GEOLOGICAL STORAGE

It is the cost that enhanced or added to the cost of geological storage. It arises due to regulatory requirements, and it depends upon the total time of monitoring and legal obligation. Over time, the additional cost of monitoring may decline.

After estimating the cost, the next step is to estimate the benefit. It can be divided into two broad categories, non-financial benefits, and financial benefits. Non-financial benefits are:

Greenhouse Gas Reduction: The CCS is one way to achieve negative emission, which needed for achieving the Paris Agreement carbon level target in the environment up to 2050. The CCS project must be evaluated on this metric too. The power plant is one of the contributors to carbon emission in the environment. So, CCS help in reducing the emission of carbon by power plants. Carbon is also the prime reason for global warming.

Sustainable Development: For the long-run sustainable development, it is necessary to adopt technology like CCS. The power plant with ccs has lower emission than power plants without ccs, which lead to sustainable development and clean, green, as well as less carbon environment.

The Welfare of Citizen: Every government has the responsibility of safeguard the interest of citizens, and now a day pollution-free environment is one of the fundamental rights that are right to live. So, every government should subsidize technology for the welfare of their citizen.

Climate Change Mitigation Control: Now a day climate change is one of the problems that every country is facing. Global warming adds to this problem. The prime reason for this problem is pollution, and the carbon is one or other form one of the crucial components of it. Decarbonization of the environment, which ultimately leads to a reduction in climate change, is possible with the help of ccs technology. These are some non-financial benefits, and the financial benefits are discussed in the next paragraph.

CCS helps in sustainable growth in the business of power plants. According to all stakeholder's benefit, it is viable to implement CCS technology. If the power plant exceeds the emission limit, then the operation of a power plant must stop. Hence, it led to a decline in revenue of the power plant. It is challenging to implement CCS technology without the help of government incentives due to its high costs and energy requirement. The government provides some tax benefits to the firm who are implementing CCS technology in many countries. Also, the government provides a cheaper source of funds to the firms to implement CCS, as investors are reluctant to provide funds for the same.

Trading of Carbon: With the increase in demand for carbon, which is highest in EOR (Enhanced Oil Recovery), the prices of carbon are rising in the market. There is a discussion going on across the globe for the development of a proper carbon trading market. Beverages industry, carbon-based fuel, mineral carbonization is the other purpose of the carbon demand in the present as well as in the future with limitation. Reduced cost of electricity: Initially, all new technology comes with a high cost. With the advancement of technology, the passage of time, and discovering more generic technology, the cost declines over time. Similarly, CCS is a new technology that has initial cost and energy requirement is high, but over time its cost of installation and the cost of electricity will decline. Hence, it will be widely accepted. The next section describes problem formulation based on the cost that is discussed above.

PROBLEM FORMULATION

In this work, a mathematical optimization model is developed to minimize the levelized cost of electricity and emission rate with a load balance constraint and upper bound of emission value. We have considered the post-combustion carbon-capturing approach in a coal-fired boiler. Four different scenarios can be observed, which can be subcritical or supercritical thermal power plant with or without CCS technology, as shown in Figure 4 below.

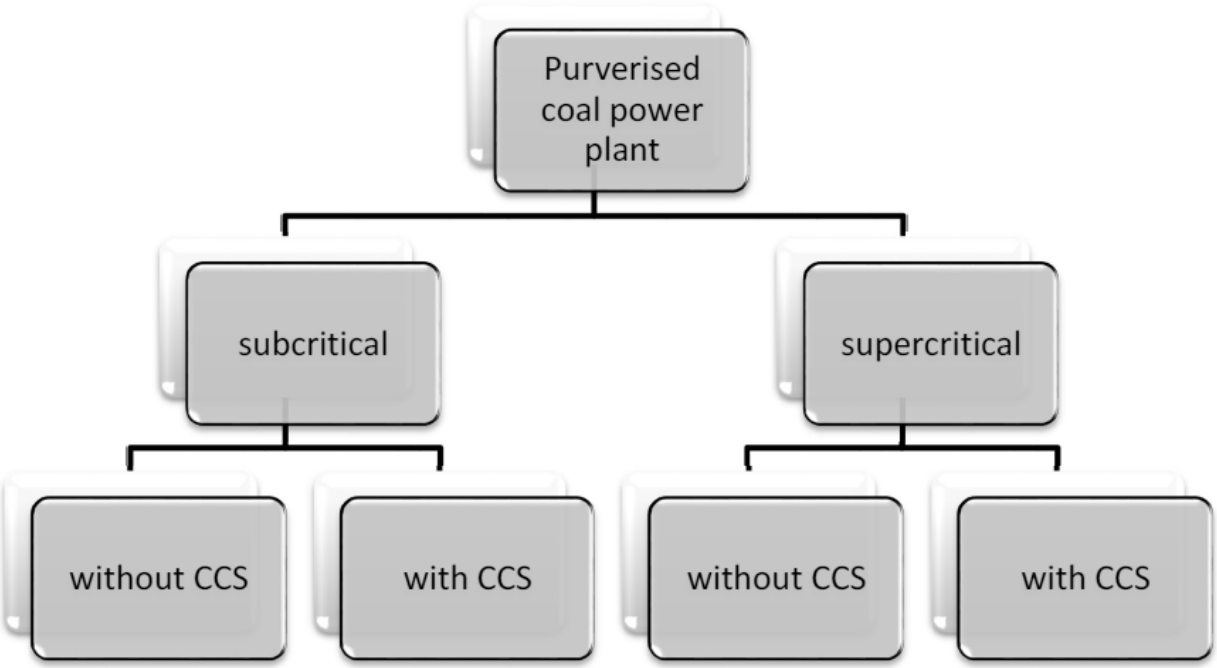

Fig. 4: Disintegration of Power Plants

We have used the following notation (provided in Table 1) to formulate the optimization model.

Table 1: Notation Used in Problem Formulation

Variable	Description
CO_{2Abs}	Absolute carbon dioxide emission of the power plant in a year
CO_{2Total}	Specific carbon dioxide emission of the power plant in a year
P_i	The net power generated from the i^{th} thermal power plant
f_c	Amount of fuel consumed in a year
t_i	Plant working hours in a year
CRF	Capital recovery factor
EF	Emission Factor
ELV	Emission limit value of carbon dioxide
FC	Cost of the fuel
FOC	Fixed operating and maintenance cost
G	Number of thermal units
g	No of thermal power plant
GCV	Gross calorific value
LCOE	Levelized cost of electricity
LD	Load demand at t^{th} hours.
Oxid	Oxidation factor of the fuel
PCF	Plant capacity factor
RR	Revenue required
TCI	Total capital investment or total plant cost
VFR	Volumetric flow rate
VOC	Variable operating and maintenance cost

The objective and constraint designed in the mathematical formulation are convex functions. The problem formulation is presented below.

$$\begin{aligned} &Min\left\{LCOE\left(x,y,z\right),CO_{2,Total}\left(x,y,z\right)\right\} \\ &s.t.\ \ U\left(x,y,z\right)=0 \\ &\qquad G\left(x,y,z\right)\le 0 \\ &where\ x \in R, y,z \in \{0,1\} \end{aligned} \tag{1}$$

In the above formulation, x is a set of continuous variables, y is a binary variable used to select a subcritical or supercritical operating condition. Similarly, z is used to select with or without CCS technology. Both the objective functions are minimization type. We have used the revenue required model, as described in the methodology section. Each objective function is described below.

LCOE is an economic objective function and represents the levelized cost of electricity. It is the revenue generated in ($/kWh) assuming the cost of electricity (COE) remains constant for the life period of the power plant. The formula to determine LCOE is given below:

$$LCOE\sum_{i=1}^{g}\left(\frac{\left(CRF*TCI_i\right)+FOC}{PCF_i*t_i*P_i}+VOC_i+FC_i\right) \tag{2}$$

where g represents the number of power plants. CRF is a capital recovery factor per year. TCI is total capital investment ($/kWh) or cost of a thermal power plant, which includes the cost of coal & sorbent handling, coal and sorbent preparation and feed, feed water & miscellaneous BOP systems, PC boiler, flue gas clean up, combustion turbine/accessories, ducting & stack, steam turbine generator, cooling water system, ash sorbent handling system, accessory electric plant, instrumentation & control, improvement to site, buildings & structures.

FOC is an annual fixed operating cost ($/kW-net year), which includes operating labour cost, maintenance labour cost, and administrative & support labour. PCF is the plant capacity factor. For the new plant, the capacity is equal to the availability, i.e., the plant can generate maximum capacity initially. To determine plant capacity factor, there is an assumption that there is always a demand for the output, and for the pulverized coal power plant, it is generally assumed to be 85%. It also assumed that the addition of the capture unit in the power plant does not affect the capacity factor because if the capacity factor is further decreased, it will increase the LCOE in the case of carbon capture. is the no of hours a thermal power plant work in a year (hour/year), and P_i is the net power generated (kW) by the i^{th} power plant.

VOC is variable operating cost ($/kWh-net) maintenance material cost, water, chemicals, other, waste disposal, by-products, and emissions of a power plant. FC is the cost of fuel consumed ($/kWh-net) by each power plant.

The second objective function focuses on emission reduction model where the objective is to minimize the emission of CO_2. It is known as the environmental objective function. CO_2 emission of a thermal power plant per year is calculated using the formula as given below:

$$CO_{2_{Abs}} = (f_c * GCV * EF * Oxid) \tag{3}$$

$CO_{2_{Abs}}$ is the absolute carbon dioxide emission from a power plant in a year for each power plant. is the annual amount of fuel consumed by a power plant. GCV is the gross calorific value of the fuel (i.e., coal). Oxid is the oxidation factor of the fuel, which can be calculated on the unburnt fuel. EF is the emission factor of the fuel, which can be derived in four different ways.

$$\text{Weighted Average} = \frac{Absolute\ CO_2\ Emission\ of\ all\ power\ stations\ in\ the\ region}{Region\ total\ Net\ Generation\ which\ includes\ all\ the\ sources\ (\ hydro\ or\ nuclear\ )}$$

$$\text{Simple Operating Margin} = \frac{Absolute\ CO_2\ emission\ of\ all\ power\ station\ in\ a\ region}{Region\ total\ Net\ gen\ excluding\ low\ cost\ energy\ sources(hydro)}$$

Build Margin = Average carbon dioxide intensity of newly build power stations.

Combined Margin = Weighted Average of Simple Operating Margin and Build Margin.

$$CO_{2Total} = \sum_{i=1}^{g} \left(\frac{\left(CO_{2\,Abs}\right)_i}{P_i} \right) \tag{4}$$

CO_{2Total} is the total carbon dioxide emission of the power plants is obtained by summation of absolute carbon dioxide emission of the power plant divided by the net power generated in a year.

Two types of constraints are used in this formulation, namely load-balanced constraint and emission limit constraint, as described below.

Load Balance constraint: The summations of the power generated from all the thermal plants is equal to the load demand in a year.

$$\sum_{i=1}^{g} P_i = LD \tag{5}$$

Emission Bound: The emission of carbon dioxide should be less than the emission limit value (ELV) of the power plant set up by a country. In this constraint, VFR represents the volumetric flow rate of the released gas into the atmosphere.

$$\sum_{i=1}^{g} \frac{\left(f_c\right)_i 10^6 * t_i}{VFR_i} \leq ELV \tag{6}$$

Thus, our formulation is a multi-objective mixed-integer non-linear programming model that aims to minimize the Levelized cost of electricity and emission rate with various constraints in all the four cases.

DISCUSSION

According to the literature of CBA, the CCS is found not a suitable technology for the current time because of its high cost and high energy requirement. It is not suitable if we take only economic factors for evaluation as we can't foregone the environmental & social benefit. It also provides certain advantages like co capture of other air pollutants, increases in calorific value of fuel, etc. CCS technology must improve to become more effective and cost competitive. Long term and more stable storage facilities must be developed. An interdisciplinary approach must be taken to tackle issues related to CCS like technological aspects, economic factors, timing issues, carbon cycle dynamics, and unstable and uncertain sustainability. It had to widely accepted that the government incentives are needed as well as other stakeholders must support the power plant firm. Government incentives can provide incentives in many ways like giving tax incentives, provide funds at a cheaper rate for installation, can provide funds for research and development of advancement in CCS to reduce its cost, and increase operational efficiency as well as lower energy requirement. The optimization model and CBA developed above are if empirically tested, it will provide the actual data of LCOE. But to calculate cost of CO_2 avoided or captured the storage and transportation cost need to be included. In this paper our approach is to study the difference between supercritical and subcritical situation in power plant with and without CCS.

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Major Areas of Costs and Improvement Strategies in Supply Chain Management for the Oil and Gas Industry

Tanzim Thobhani and Sachit Vasudeva
Pandit Deenadayal Petroleum University, India

Abstract—The main objective of this paper is to exemplify and investigate the role of Supply Chain Management in the oil and gas industry. It also discusses the application of the Uniform Commercial Code (UCC) for the issues related to the supply chain management. Also, several strategies are examined for improving the quality of management in the oil and gas industry. It includes Employs Interpretive Paradigm where it will guide towards rigor Qualitative Methodology. This study also provides rich and thick description of the dynamic supply chain capabilities where the outcome will contribute to the managerial and theoretical perspective of supply chain management in oil and gas industry. It incorporates the development of Channel Spanning Performance Measures and also creates operational innovation. This method also involves the application of Strategic Sourcing and adapting the wide technological perspectives in connection with the supply chain. The industry offers a classic model for implementing supply-chain management techniques. In a supply-chain, a company is linked to its upstream suppliers and downstream distributors as materials, information, and capital flow through the supply-chain. It covers the mid stream suppliers and the entire chain from the exploration till the end consumer. Also, vertical integration and outsourcing are discussed involving key management decisions in the global capital investments and cost effective Energy Management. It customizes the logistics network and plans according to the market signals. The novelty of the new classic model is in the ability to understand and rectify the future undertakings in practical terms of economics and management related to oil and gas industry and minimize the fluctuations and risks associated with it.

Keywords: Paradigm, Vertical Integration, Outsourcing, Spanning

INTRODUCTION

The key factors in determining the status of world economy for petroleum and crude oil products are the the logistics of its demand and supply. Due to the competative nature of Petroleum industry, it is a major challenge to be in the market due to the oscillating demand for crude oil and petroleum products. This industry satisfies more than 70 percent of the world's energy demand and crude oil has been the largest energy source with around 39 percent of fossil energy, followed by coal and natural gas at 33 and 28 percent, respectively [Fossil fuels- Hannah Ritchie, Max Roser]. Its contribution in powering vehicles, electricity generation to construction, the manufacture of plastics and other synthetics makes it as one of the major area's which has contributed to the world's technological, industrial and economic development and depends on a supply chain (SC) made up of integrated and complex processes.

Supply- chain management (SCM) defined as the coordination, configuration and continuous improvement of a consecutively sorted out arrangements of tasks with intent to provide best customer service at the east cost. A customer is anyone who uses the result of a process and thus, for any organization is major area of focus where he is linked to its upstream suppliers and downstream distributorsfor customer delight. Usually, information, materials, technology, labour, capital, financial assets and other resources flow through the supply-chain. Cost reduction and enhancing benefits along this cahin. Since the main aim of the industry is to maximize the profits, the firm must minimize costs and maximize benefits along the supply-chain with important analysis of benefits versus the costs of various decisions taken along its supply-chain management.

Since, the petroleum industry requires very high investments, one has to explore the possibilities of cheap, efficient and safe options of meeting customers' needs while ensuring that the tasks are done right, the first time. The errors occurred in the intial satge can prove to be very expensive later on depending

upon the stage of the project they are detected and also can result in damage to environment damage along with raising several safety concerns. Integrating operations management with similar operational functions allows all functions to be involved in the supply-chain management decisions and improve overall efficiency and effectiveness.

Historically, there has been a tremendous focus on ownership of business supply-chains but typically, it is common to manage capital intensive operations from labour intensive operations and high-tech operations separately from low-tech operations by considering scale economies. Hence, it is possible to differentiate operations that produce standardized products and services in large quantities from those that produce a great variety of customized products in smaller quantities. To have a homogeneous mix of customers and products, it is prudent to focus on general operations in supply chain.

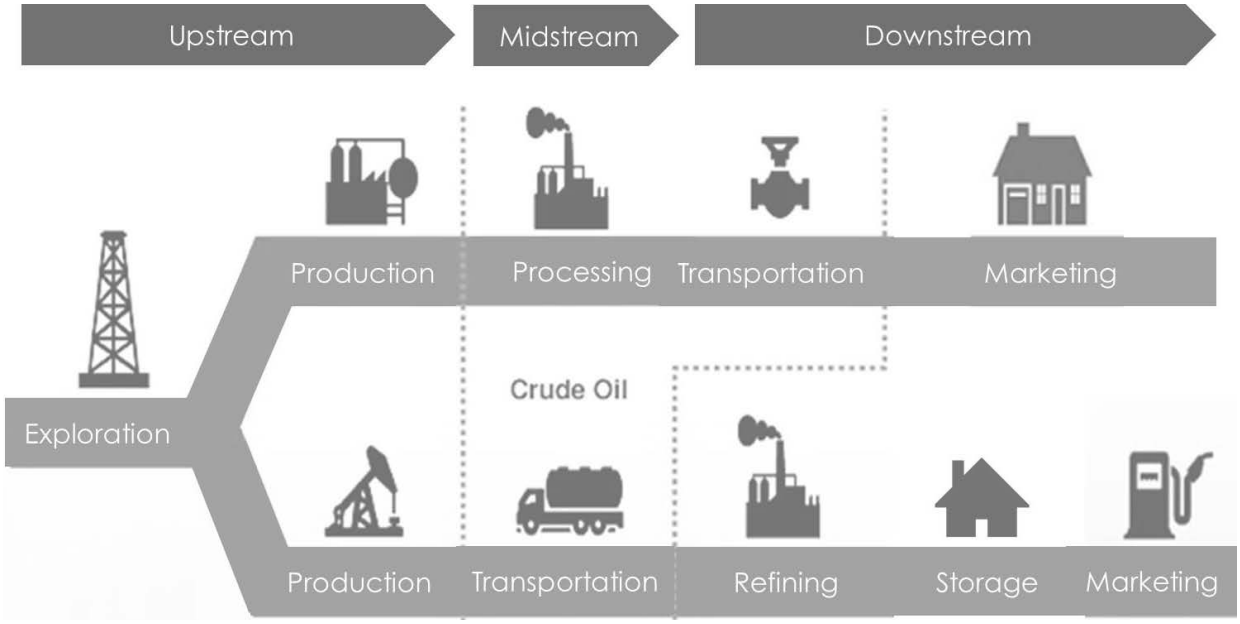

Fig. 1: Global Gas and Oil Value Chain

Due to the interdependent and complex nature of supply chains in oil and gas industry, vulnerability and uncertainity including risks of demand, price fluctuation and supply are quite evident. Overcoming these risks require new techniques and innovations which effect the quality of service by improving customer satisfaction, optimizing the inventory costs and total costs.

Upstream, Midstream, and Downstream are the three different sectors which are related to global supply chain. The upstream industry finds and produces crude oil and natural gas also known as exploration and production (E&P) sector. The midstream industry is involved in the storage and transportation of commodities like crude oil, natural gas, natural gas liquids (NGLs) and sulphur and provides the vital link between the remote petroleum producing areas to the consumers.

The downstream industry includes oil refineries, petrochemical plants, petroleum products distributors, retail markets and natural gas distribution companies. The downstream industry reaches wherever the consumer is present, providing products such as gasoline, diesel, jet fuel, heating oil, lubricants, plastics, synthetic rubber etc. The supply chain links and provides vital contribution in overall process and is absolutely necessary to have proper supply chain management in order to reduce and optimize operational and maintenance costs.

The oil and gas business is reliant on many internal and external factors. Enhancement and viable administration of the chain are important. As supply chain cost adds up to 40% of total distribution and refining cost. Therefore after lot of research, there are many proposed assembly of research and various

quantitative models and scientific programming systems have been created, the utilization of which has fundamentally expanded associations' and capacity to design and create industry exercises and increment benefits which are of utmost importance during the ongoing financial falldown, which has restricted many organizations to leave or quit the business. So, an elaborate planning of the networks connecting oil industry is very important for it to be powerful enough to deal with oscillations and adaptable enough to acclimate internal and external changes in the petroleum industry.

However, from the last decades onward, the attention of researchers focused on planning a part of petroleum supply chain and logistics under uncertainty, using analysis of major costs areas and optimizing it though different programming models.

UPSTREAM SECTOR-COST CONTRIBUTOR

Well productivity, well site location, its type and regulations are some elements that effect the overall cost. Due to the uncertainty involved in the drilling process due to unknown lowering and raising, drilling site conditions change and has a significant effect on the cost.

Whether the oil or natural gas shall be the end product from the well is based on the data given by geologists before drilling a new well. Since over half of wells produce both oil and natural gas, the objective resource isn't normally a primary consideration in deciding the cost of a well. Since, based on the usage, the transportation of oil and natural gas are done in different way, the final cost is known only after the extraction is done.

Many factors like land acquisition; capitalized drilling, completion, and facilities costs; lease operating expenses; and gathering processing and transport costs including location of the well site cumulatively add to the toal project cost and are mainlyclassified in Upstream Sector under two categories: Onshore and Offshore.

ONSHORE COSTS

1. ***Drilling:*** These costs consist of activities associated with utilizing of a rig to drill the well to total depth and include:

    a. Tangible Costs, which have to be depreciated and capitalized over time, such as liner and well casing.Method of depreciation has to be decided by company which will define their profitability in short or long term.

    b. Intangible Costs, which include logging and other services, cement, mud and drilling fluids, and fuel costs, drill bits, rig hire fees.These costs can vary depending upon the size and quantum of worl involved.

2. ***Completion:*** Well perforations, fracking, water supply and disposal are part of this cost. Typically, this work is performed using specialized frack crews and a workover rig or coiled tubing which include:

    a. Tangible Costs such as tubing, liners, Christmas trees and packers.

    b. Intangible Costs include frack-proppants of various types and grades, frack fluids which may contain chemicals and gels along with large amounts of water, fees pertaining to use of several large frack pumping units and frack crews, perforating crews and equipment and water disposal. These costs can vary drastically depending upin the quantum and quality of services utilized and can be a sizeable one in overall cost structure.

3. ***Facilities:*** These costs include:
   a. Separators, dehydrators and hook –up to gathering systems, storage tanks as surface equipment.
   b. Road construction and site preparation and artificial lift installations. Which can be mechanized or semi automatic.
4. ***Operation:*** Lease operating cost which are highly variable, depending on product, well size, location and well productivity are included in this and include:
   a. Fixed lease costs including artificial lift, well maintenance and minor workover activities. These costs can be varyng form time to time and has to be streamlined for overall effectiveness and control of splan over the useful life of the facility.
   b. Variable operating costs of delivery of oil and gas products to a purchase point or pricing hub. As, the facilities for these services are owned by third party midstream companies, the upstream producer generally pays a fee based on the volume of oil or natural gas.

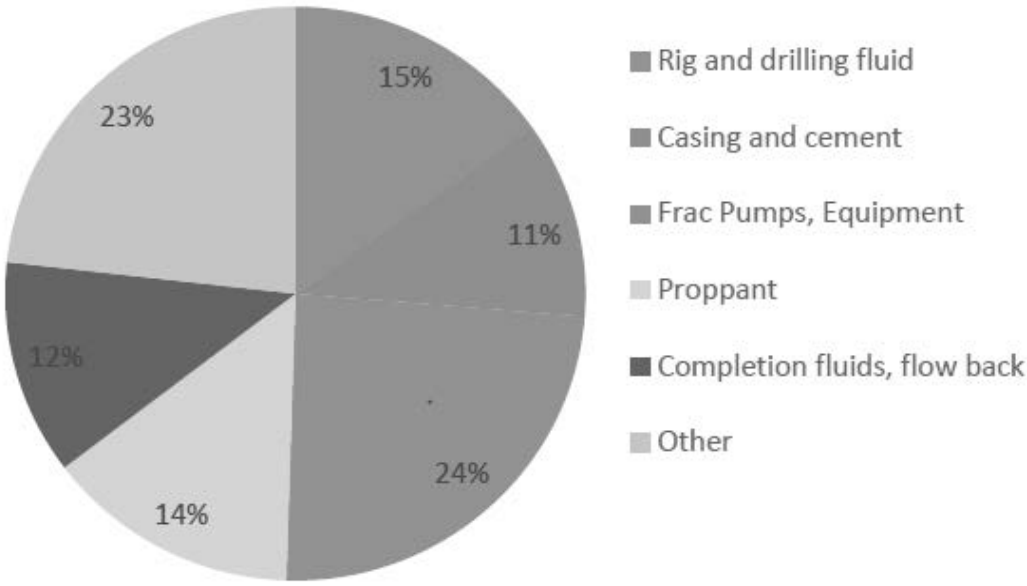

Fig. 2: Trends in U.S. Onshore Costs of Drilling and Completions

As shown in the figure below, it is an example of Percentage breakdown of cost shares for U.S. onshore oil and natural gas drilling and completion which explains the principle distribution of various factors where the costs is applied.

Overall, 77% of the cost of a well, armed with latest technologies is comprised of just five key cost categories:

- ***Drilling Related Costs:*** (1) rig related costs (rig rates and drilling fluids), and (2) casing and cement.
- ***Completion Related Costs:*** (3) hydraulic fracture pump units and equipment (horsepower), (4) completion fluids and flow back disposal, and (5) proppants.
  - Rig related costs are dependent on drilling efficiency, well depths, rig day rates, mud use and diesel fuel rates. Rig day rates and diesel costs are related to larger market conditions and overall drilling activity rather than well design.

- Casing markets set the casing costs and are related to steel prices, the dimensions of the well, and by the formations or pressures that affect the number of casing strings.
- Frack pumping costs are highly variable and are dependent on horsepower needed and number of frack stages the by determining combining formation pressure, rock hardness or brittleness and the maximum injection rate.
- Completion fluid costs are driven by water amounts, chemicals used and frack fluid type (such as gel, cross-linked gel or slick water), which is determined by play production type, with oil plays primarily using gel and natural gas plays primarily using slick water.
- Market rates for proppant, the relative mix of natural, coated and artificial proppant and the total amount of proppant determine proppant costs.

OFFSHORE COSTS

Well depth, reservoir pressure, water depth and field size, temperature, and distance from shore are few key factors which are required to be considered for deciding the cost of offshore drilling. Day rate of utilizing drilling ship or a semi-submersible drilling rig for drilling, completing the well, and all other rig related costs, such as drilling crew,logging,helicopters fuel, consumables, support vessels, shore base supplies, cementing etc.can be for almost 90-95% of total well costs, for both drilling and completion.

1. ***Drilling:*** These costs from drilling the well to total depth and include drilling bits, rig hire fees, casings, logging, liners and other services, cement, mud and drilling fluids, fuel costs, offshore support services and other services are included in this.These costs at times can become very high depending upon the productivity of oil and gas form these wells and needs to monitored accordingly.
2. ***Completion:*** Well perforations and testing, completion rig hiring, completion fluid, well head equipment, transportation/logistics, well stimulation and sand control are the components for this cost.Thes eocsts are generally high in nature and are one time in general.
3. ***Injection Wells:*** Additional wells are drilled to reinject produced water and/or gas for maintaining reservoir pressure are part of this cost.Number of additional wells to eb drilled need to be optimized to lower the cost under this head.
4. ***Facilities:*** Production facilities are another of the major expenses and may include
   a. Floating facilities, such as tension leg platforms (TLP), Spars or Semisubmersible platforms. These facilities may include topsides, production equipment, such as compressors, separators and processing units, and capabilities to drill additional wells.Thes efacilities can be hired or bought and will determine the cost in terms of overall usage and span of control over the total facility.
   b. Sub-sea tiebacks to production facilities with riser connecting platforms and customized sea floor platforms.

ONSHORE *VS.* OFFSHORE

Post shale drilling, the cost of rigs in the gulf gets reduced up to certain extent in view of expanding cost and aggressiveness else where in USA. Due to number of impacting factors like water depth and distance from the shore and have costs running into billions but has advantage to operate over a longer period of time. The expenses of offshore drilling projects vary more than those of onshore projects. On premise of higher oil costs in the future, the projects are less vulnerable against momentary changes in cost.There are linked advanages of drilling with offshore projects like I radically increase the total oil production and create a distinct habitat in the ocean.

DIFFERENT FACTORS WHICH ARE IMPORTANT FOR THE REDUCTION OF COSTS IN ONSHORE AND OFFSHORE SITES

Drilling Portfolio

Based on the latest insights and developments on which the wells design depend, plans can be changed. Hence, drilling teams are often unable to plan in advance for rig allocation and manging logistics. Optimizing rig allocation, rig movement, the logistics for specialized equipment and how a company manages its rigs along with Clustering of similar wells in order to create repetitive jobs for drilling crews, locking in the drilling plans can be done.

Contrasted with ordinary groups, selected groups ought to have the option to get up to speed quicker and subsequently at lower cost - contrasted with ordinary groups.

Standardization and Simplification of Wells

Reduction in costs by 10-15 % through several mechanisms has a proven improvements in several other related areas such as:

- Through several mechanisms, less number of items for use in well resulting in short-term savings in procurement, mid-term maintenance, and long-term plugging and abandonment (P&A) can be achieved.Companies can also have a tie up with tohers to have a common inventory system for all critical and expensive insurance spares.
- Post drilling, perhaps unpredictable standardization leads to more flexibility and quickness. For example, the warehouse will have the necessary and sufficient parts available when operators encounter a different geology than they expected, and they need to alter the well's trajectory. Also, at times, tie up for quick delivery of spares can also be planned instead of buying them upfront even if one has to pay a bit more as this will be much cheaper than carrying an invenroy at higher cost.

Measures to Reduce Non-productive Time (NPT) and Improve Efficiency

Through collection of many smaller efforts, total well delivery cost can be reduced by 5 to 10%. By applying a normal lean toolkit to prevent reduce waiting time, Rework, eliminate contingencies and enable processes, NPT should be executed in parallel. To add value to the bottom line, and reduce NPT, a large part of the costs of a well are time related and hence are to be redued.

Supply Chain Management (SCM) and Procurement

Contracting for the ongoing and emergency services play an important role in cost reduction. 90% of the industry's capital spending and 70% of its operational expenses are for contracted services and products and is a key driver of cost reduction. Operator can reduce the procurement costs through fundamental rethink of commercial models by already available or devising the new one's based on the operating experience and an aggressive approach to taking advantage of the current market downturn. Drilling approaches that remove idle time, working closely with rig operators to develop designs, reduce the use of third-party services and increase drilling speed and expensive down-hole equipment are some more advanced Supply Chain Management practices in vogue. Focusing on time-to-delivery rather than fixed day rated, some operators have successfully used alternative compensation strategies to align service provider incentives with company objectives while others have struggled to sustain the benefits of such strategies.Greater emphasis needs to be given on timely procurement of equipments and completion of services as per agreed plan to increase the well uptime and reduce downtime cost and production.

Rigorous Performance Management

Performance management is not only a tool but it is well proven that 5% to 10% reduction in cost can be achieved through performance drive througha meticulous way. Since, operators perceive each production job as very different, they tend to resist ambitious targets for time improvements as the wells are hard to compare, and with standardized and optimized drilling plans for recurring jobs, it becomes far easier for setting the bold targets.

MAJOR AREAS OF COSTS IN MIDSTREAM AND DOWNSTREAM SECTOR

Transportation of crude oil and gas through pipeline, truck, rail or barge through different parts of the world in order to deliver at the local utilities is the major costs involved in midstream sector. Thes ecosts are generally fixed and do not avry significantly with the price of crude and other proucts and hence have a significant role to pay in overall costing.

Costs involved in the downstream sector is in the refining and distributing the different petroleum products obtained after fractional distillation of crude oil along with the costs in marketing of finished products and delivering it to the local or retail outlets in different parts of the world. In order to minimize the costs and maximize the industrial benefits, optimization and supply chain management are very crucial.Different oil and marketing companies have tie up for the end products for swaping and reducing the cost of transportation from one place to another and vice versa.Companies also tie up for emergency repsonses too in case of any unforeseen failures thru pipelines which reduces their cost significantly by interdependence.

MODEL OF INNOVATIVE TECHNIQUE GENERATION

For generation of steady and radical advancements, the conceptual structure (see figure below) exhibits interactions between buyer and seller in supply chain networks. Several controlling factors which are grouped into two categories to highlight the the link between innovation of new techniques and interactions is highlighted below:

1. Those which can be manged through administrative action on either side and that are internal to the inter-firm purchaser-seller relationship.
2. Those which cannot be controlled single handedly and are external to the relationship.

Adoption of technology and the conventionl relationship factors of responsibilty and faith, which is crucial to the buyer-seller relationships are the internal factors. Applications of information technology, solidity of demand, and network collaborations are three external factors. For undersanding the innovation of new techniques, applications of information technology is important, while the nature of demand explains the agility of the supply chain.

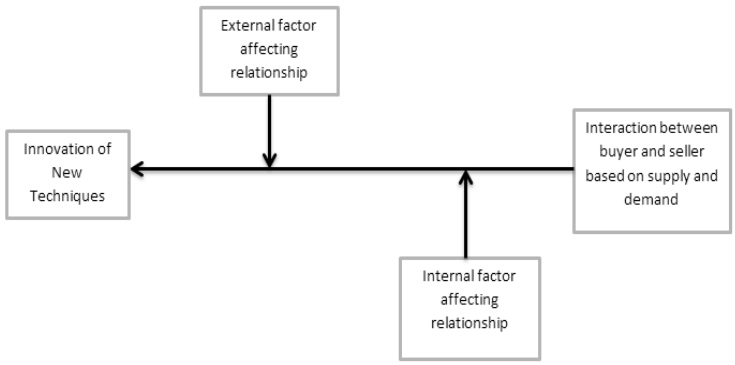

Fig. 3: A Model of Innovation Generation in Supply Chain Relationships

Figure 3 explains the overall process of the innovation of new techniques generated through the interactions between buyer and seller which are highly dependent on internal and external factors which ultimately affects the relationship based on supply and demand in the market.

By further changing exploratory parameters and real-world application of data science, the scientific model proposed in this study has to be verified. While taking lead time into consideration, it's essential to think about which different expenses could be joined for the instance of more prominent vacillation in market demand.

STRATEGIES TO TRANSFORM OIL AND GAS SUPPLY CHAIN

Companies in oil and gas supply chain have gone from bottom to bust in last few years as operators have cut back sharply on supply-chain spending due to abrupt and steady rise of crude oil pricess resulting into the evopration of business for major oil-field service and equipment (OFSE) companies and are forced to cut costs and, in some cases, changed business models in response. However, both operators and OFSE companies have begun to work together in pursuit of sustainable cost reductions and near and long-term profitability. Following strategies, at present are explored by some of the OFSE companies in particular.

VERTICAL INTEGRATION

Vertical integration is a key for better profitability and a successful attempt to reduce the cost .Present developments highlight the need to manage a company's supply-chain in an integrated and cohesive manner to achieve the desired targets of cost reduction and optimization. This can be achieved by integrating the increased demand for better and faster customer service, globalization of the oil and gas business, competition, usage and availability of information technology to facilitate information exchange. This cohesiveness will deduct costs if it leads to a more efficient system and make the supply chain system more viable to increase the bottom line.

Vertical integration decision helps the companies to decide and bifurcate as to what functions to perform in-house by a firm and what functions to contract out in the oil and gas industry. Complexity and a fragmented supplier base results in many services and equipment purchase currently outsourced to a variety of providers thereby creating complexities in tracking and ontime delivery of the same. By bringing these services in house as done by multiple OFSE companies can result in reduced coordination costs leading to a savings of up to 30 percent. For example, Schlumberger's SIS division is offering a software spine based on the Petrel software platform which allows an operator to develop a view of the potential for oil and gas in a reservoir, model the field, plan the wells, and complete the design.

OUTSOURCING

A driving force for many oil and gas companies is in outsourcing finance and accounting functions which has helped them to reduce the costs by 30- 50% that have been calculated based on their offshore gains. Furthermore, outsourcing diminishes headcount and related costs such as salaries, benefits and incurred office space expenses. Simplifying, standardizing, centralizing and automating finance processes through the use of best practices and advanced technology also reduces costs and increases efficiencies. Outsourcing gives benefits of economies of scale to clients by offering similar services to a broad range of customers and result in significant reduction in costs.

STRATEGIC SOURCING

Ability to analyse, identify improvement areas, create new roadmap and take required actions due to global demand & supply fluctuations and market dynamics faced are challenging. To drive the proven performance, scalability and improve supply chain margins, the Strategic sourcing is one of the solutions

from leading system integrators designed for O&G industry customers that enable management of operations, thereby improving business performance.

Specialized vendors add strategic value supply chain operations and help O&G customers to formulate supply chain models that optimizes the diverse business environment by providing supply chain management and strategic sourcing and system services for O&G companies, and bring the stake holders onto a common terminology and an integrated management system.

It also develops channel spanning performance measures. Inefficiencies associated with it will not be eliminated if localized decision making is perpetuated across the chain.

THE UNIFORM COMMERCIAL CODE AND SUPPLY CHAIN MANAGEMENT

To harmonize rules for each of nine transactional areas that pertain to commerce and commercial law was the main purpose of UCC.

The terms dealing with the sales of goods are goverened by UCC along the oil and gas industry supply-chain. Contracts that are primarily for sales of goodsare applied through Article 2 of the UCC. It applies to suppliers of tangible goods to the oil and gas companies. The UCC applies to merchants, as well as to private parties, in the sales of goods.

For the seller of goods when no place of delivery has been agreed upon under the UCC, there are delivery obligations. However, that place is the place of delivery, if both the buyer and seller know that the goods are at a particular place or location.

CASE STUDY

The Supply chain network is made up of individual firms working in alliance to serve customers; therefore, its efficacy is highly dependent on the trust between the individual network partners.Trust plays a pivotal role in the establishment and sustenance of any long term relationship and it also betters the average cycle time, the in-time order fulfilment rate & the supply chain financial performance.

The horizontal position of the last 5,000 ft of the X50 well of ConocoPhillips Ekofisk offshore platform, located nearly 200 miles off the Norwegian coast posed a significant challenge for the supply-chain manager. By employing a Just-in-time (JIT) installed column services provider that was responsible for the tubular-goods preparation,planning, ordering, logistics, and installation, ConocoPhillips was able to complete the well and put it on stream in 30 days.Efficient management of the supply-chain was estimated to have achieved savings of about 25% in procurement and installation costs.

CONCLUSION

Recent devwelopments in oil and gas industry include high demand for more efficient and quicker customer service, increase the availability of technology to smoothen the information exchange and reduce the high costs of equipment which are used for various processes along with the transportation of crude oil and petroleum gas, marketing costs, drilling and completion costs etc. which has a huge impact on the profitability of the company.

Responsible supply chain management can generate value for the company by improving collaboration with suppliers along with Dialogue and cooperation to improve CSR performance to improve productivity, reduced costs and service quality is one of the main advantages of supply chain.

The main aim of supply- chain management is to provide best customer service at the lowest cost possible to whoever is present at receiving end of the service. Thus, excellent service would result in customer satisfaction and faith in service provider thereby strengthening the relationship. It also

requires very effective improvisation of supply chain management to get operation done at very first attempt to reduce cost and stop hazardous environmental effects by analyzing different factors affecting costing in onshore and offshore wells. Majority of cost is spent on drilling and completion operation thus, Innovative techniques are the need of the hour. Swap practicing methodology and vertical integration is another technique to reduce cost and doing business with competitors.Additionally interdepence upon different producers by good networking is another option which is being explored to reduce the cost w.r.t tranporation of raw material, products, services and insurance spares too.

ACKNOWLEDGEMENTS

Authors of this paper sincerely thank and express gratitude to Dr. R.K. Vij, Mr. Netram Singh and Mr. SSP Singh for their technical support. We are also thankful to Mr. Vijay Vasudeva for constantly guiding and motivating us throughout the process.

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Role of Automation in Shaping the Future of Indian Petro Retailing

Prajakta Naik[1], Umang Trivedi[2] and Sumit S. Mehta[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management, Pandit Deendayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: [1]prajkta.npgp18@spm.pdpu.ac.in, [2]umang.tpgp18@spm.pdpu.ac.in,
[3]sumit.mpgp18@spm.pdpu.ac.in

Abstract—Petro retailing companies, commonly known as Oil Marketing Companies, are trying very hard to keep up with the competition to retain their existing customers, convert variable customers to loyal customers and further to attract new customers. The Fleet catering done by Petro Retailing industry has a very low product and quality differentiation. This is also affected by lack of customer loyalty and costless switchover. To attract more customers in fleet business, Automation program has been one of the techniques developed by Petro Retailers in order to stimulate customer loyalty.

In today's scenario, the immense competition from various Petro retailing companies make fleet catering a crucial program of the day-to-day functioning, as it provides a good income to Petro Retailing companies. The study basically focuses on understanding the fleet business catered by Automation through benefits, functioning, visiting Retail Network and Institutional Business set up. The study also focuses on further scope of improvements which can strengthen Petro retailing network by increasing per pump throughput.

Keywords: Petro Retailing, Automation

INTRODUCTION

In today's era, we can say that Indian Oil industry is an oligopoly market which is dominated by some state-owned companies and some private companies compared to few decades back, where the industry had a monopoly of state-owned companies. Today, the increasing competition, fall in crude oil prices and fuel de-regulation has put the Oil Marketing Company's in tough competition. In the present situation where there is intense competition, lack of customer loyalty, costless switchover and less product & quality differentiation has made it difficult for Petro retailing companies to sustain in the market and to retain their existing customers, convert variable customers to loyal customers and further attract new customers.

The commercial benefits of loyal customers are well known by all the brand managers as the cost of acquiring a new customer is always more than retaining an old one. So, loyal customers are very important as they provide the consistency of volume consumption in retail business which helps in increase in sales. The loyal customer is generally a user of various products like Motor Spirit (Petrol), High Speed Diesel (Diesel), Heavy fuel oil, etc. Among all the available products, this study focuses on customers which are using High Speed Diesel (Diesel) particularly for commercial vehicles or for their fleets. These are valuable customers in terms of Retail Sales as these customers' purchase of HSD will be in bulk, giving good amount of revenue to the company (Dugar,2007, pg 57).

To cater to this segment of customers, companies have started fleet programs which give good business. PSUs, being the leader in Petro retailing industry, had started fleet programs to cater to this segment of customers and have been trying hard to retain these customers from switching over to their Private Counterparts. This customer base is often established through the aid of retail outlets and the points of contact between the fleet customers and the company. Hence, the companies are trying to attract more customers and make their experience, better, with the help of automation which can make customers loyal among them, and in turn, is beneficial for the company through the increase in its sales. Service is something that is appreciated by the customers and indirectly helps the company to have loyal customers.

The immense competition in Petro retailing will make the value-added services, non-fuel retailing, ancillary services and loyalty programs as an integral part of the day-to-day functioning of the retail outlets and to achieve this, Automation will play a major role in future Petro retailing. This will increase the importance of services among the consumers and it will be important to see how this integration helps the Petro Retailing Companies to leverage their technology and achieve Customer Loyalty by gaining popularity in delivering special treatment. Ultimately, the success & importance of Automation depends on how well the business uses the data gathered, to further filter and refine it and accordingly mold its policies and loyalty programs (Sudhir Yadav 2012, pg.37). Right now, not much have been seen in terms of Automation programs being run by the Petro-retailers. This will change in upcoming future where Automation will play a major role in Oil Marketing Company retaining share and will lead to strengthen Petro retailing network by increasing per pump throughput.

OBJECTIVE

In Order to understand the role of Automation in Petro Retailing, basic research is needed to understand how the fleet market is catered by various Oil Marketing Company. This will help in better understanding of the project and will give clear idea about the future scenario of Indian Petro-retailing.

The objective was sub-divided as:

- To study the Indian fleet market and its program execution from Oil Marketing Company perspective.
- To study the impact of automation in fleet program execution from Oil Marketing Company and customer perspective.

RETAILING IN INDIA

The Oil Marketing Companies in India have been doing Petro retailing in following ways:

1. ***Retail Sales:*** The Oil Marketing Company caters the customer from their retail outlet located across all India. This service is taken by fleet owner who have their fleet running across India's all corner. This type of customer is catered by loyalty programme.
2. ***Institutional Business:*** The Oil Marketing Company caters this customer by giving them special dispenser setup at their space. The Setup is given for such customers who have fleet working region and requires fuel for long time. This type of customers is catered by deep discounts. Consumer pumps, long term contracts, etc.

FLEET MARKET IN INDIA

The Indian market is completely different market from other countries. We have an unorganized market scenario due to which no proper data on market can be kept and effectively it cannot be used to catered customers. Indian transport industry is developed on many ways consist of rails, road, inland water ways, pipelines, etc. But in the past recent years we can say that the market share of roadways has increased significantly which has led to decreased in rail mode transport. All this is due to development of good road infrastructure in India. This way we can say that the road transportation mode has been increasing day to day in Indian Market, but it has also led to development of unorganized sector affected by ownership pattern in Indian markets. The ownership patterns which have been seen in Indian market is as follow:

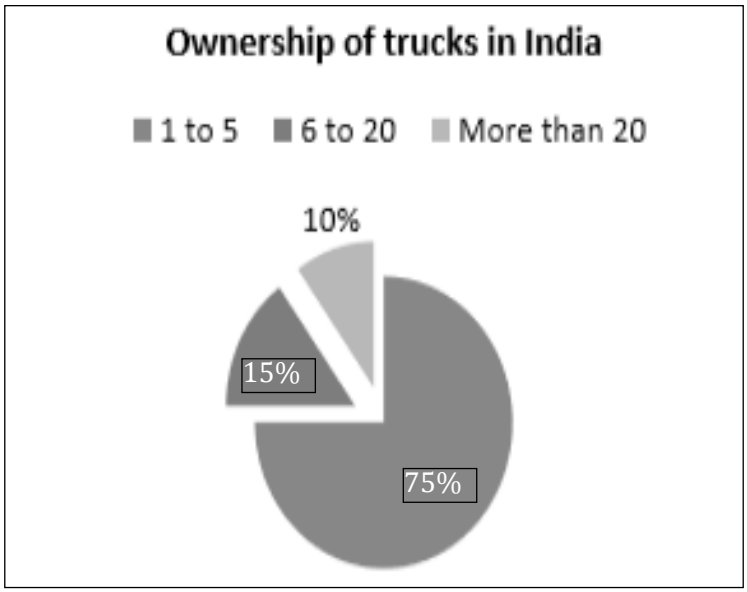

Fig. 1: Indian Truck Ownership

As, we can majority of chunk in transport industry is covered by owner having 1 to 5 trucks, followed by 6to 20 trucks and at the end we can see that Indian market is having less portion of owners having more than 20 trucks in India. So, because we can't keep the track record of the moment done that leads this industry in unorganized sector while international markets have more owner having large fleets due to it that market are more of organized compared to domestic market. The large fleet operators primarily work on a hub and spoke model. Large operators are also able to bid for movement contracts with companies (NTDPC. 2014, pg. 50). They utilize the services of the smaller operators when they need to have additional vehicles. The unique ownership profile has created middlemen who act as liaison agents. Liaison agents runs almost 60% of market in India.

AUTOMATION NEW ERA IN PETRO RETAILING

The Retail Station have been in operations since many decades but with rise of new technology wave like IOT, INDUSTRY 4.0, etc. we are trying to generally imply the integration of machines into a self-governing system. The system will be developed to cope up with future needs to cater customer and increase throughput. In initial years around mid-2000 Indian company has started implementation of automation to make process efficient. The Indian retailing has seen implementation of PHASE I to PHASE VI Automation.

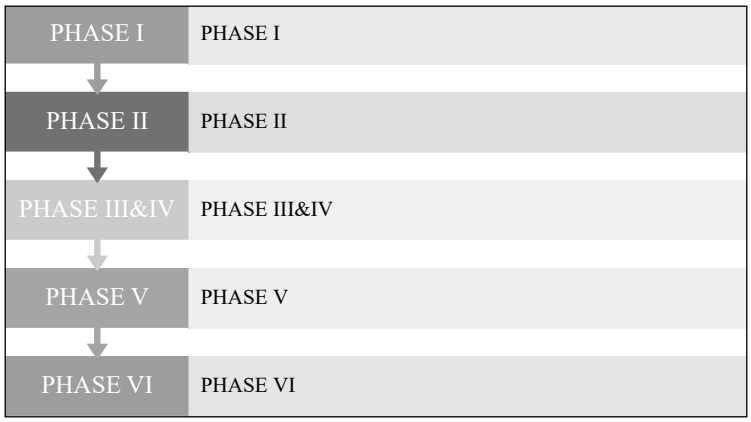

Fig. 2: Automation PHASE Implemented in India

Phase I: It was the initial phase of automation in industry. The India retail outlet where being considered for modernization. The outlets were computerized so that it can be made efficient compared to global standards. It was done in early-2000 so that company get its process efficient.

Phase II: In this time the industry was changing and evolving around in world. The Oil Marketing Company started adapting itself with the change. The industry was using mechanical dispenser which were replaced by computerized dispenser. Modern dispenser was place which connected with computerized machine in RO so that it can be used to give clear quantity of fuel to customers. It was also used to stop adulteration and have a proper amount of quantity generated in invoice by itself.

Phase III & IV: It was in around 2006 where automation was taken to new level. The industry was facing issue of adulteration and lack of proper quantity even modernized dispenser where used but it was lacking from terminal side. So, terminal where made automated in this phase. Due to it the refueling of tankers can be made efficient and each entry were automated for measuring and proper check can be kept in this phase. Apart from it we can say ROs where also automated. Now dispenser where given facility of automated payment. Person can pay from credit cards and have secured process. The process where developed in PHASE IV similar with PHASE III. It was used so that customer can have better experience plus company can have clear idea of sales taking place once its tally with dispenser. For this purpose, various software's company were given contract to automate all things. Example Honeywell was given contract to modernize IOCL and HPCL. For this technical requirement where placed. All process was automated using various technologies.

Phase V: In this stage all Oil Marketing Company have set objective to make ROs automated. In this process Tank storage unit was placed which gives information of how much left with the help of ATG (Automatic Tank Gauges) for that various sensor where used to measure. The payments process where linked with dispenser so as soon as quantity is generated dispenser gives billing to customer and inform computer about quantity given and remaining. In this phase NANO was implemented means "NO AUTOMATION NO OPERATION". As said no operation was performed if RO was not automated. Automated SMS were sent to customer about refueling they have done (Fleet Customers).

Phase VI: In this stage industry has taken a leap forward by connecting all automation system interlinked. So, it can be access from any part and can be seen. For example, regional department can use automation and look any RO located at far distance and see what quantity it has, what sales done at that point. The software's were connected through cloud so that when minimum quantity has reached in RO it will automatically send the signal of material procurement to company. With the help of new technology like IOT we can say all ROs are made connected to Oil Marketing Company office. So, more transparency can be seen, and operation can be made efficient. In this customer were also given facility that they can load money in card and redeem at any point with getting OTP in phone. The process was made hazzle free for FLEET CUSTOMERS. The customer was given tracking option of the fleet and, they can set the amount of refueling they want to have from card. This way customer where given benefits which indirectly increase loyalty towards companies

AUTOMATION'S FUTURE OUTLOOK

In era where time will be important, we will see Automation Playing important role in catering customers. The Automation will be used to next level which can be implemented to make customer touchpoint into trust point.

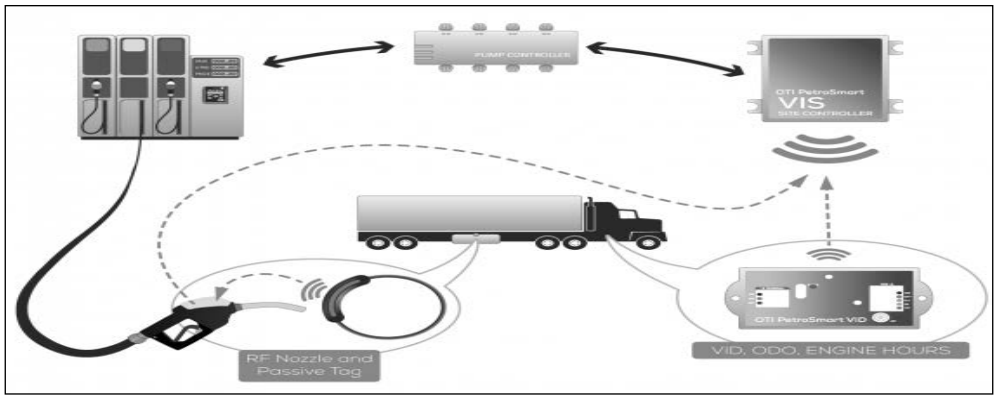

Fig. 3: A Diagram of Automation in Retail

The above figure setup has been developed to understand the role of automation in future Petro Retailing. The automation which we tried to understand with case study will be future strategy used by Petro retailing to make customer experience better and move towards unmanned Retail Outlet(Manju Nandwani (2018), pg 3). The automation in fleet refueling system works with following things:

1. Vehicle Passive Tags,
2. Sender,
3. Receivers,
4. Handheld tags/driver tags,
5. Radio frequency Nozzle,
6. Homebase Site controller.

When vehicle arrives at the station of refueling the driver need to provide the tags to filler who scans the tag in scanner. After successful scan the nozzles comes out from the dispenser and when attendant places it on tank it scans vehicle passive tags from RFID sensor and the process starts. The fueling amount, empty tank all things are received by Automatic Receiver and updated in Home side controller.

Oil Marketing Company have tried to develop this thing for particular customer only as its in developing phase and consumption was limited so company can get overall learnings from it. In future this telematics will be implemented in Retail Sales to cater all customers efficiently.

The Automated system was established so that the client can use it efficiently for its consumption.

Fig. 4: Automation System Setup Consist of FCC Provided to Client

As we can see in the above picture FCC (Forecourt Controller) has provided in form of setup to client with which it can use automation system effectively. The system consists of various components like battery backup, sensor, etc. which help in seeing the daily consumption of product, the amount of quantity left in tank.

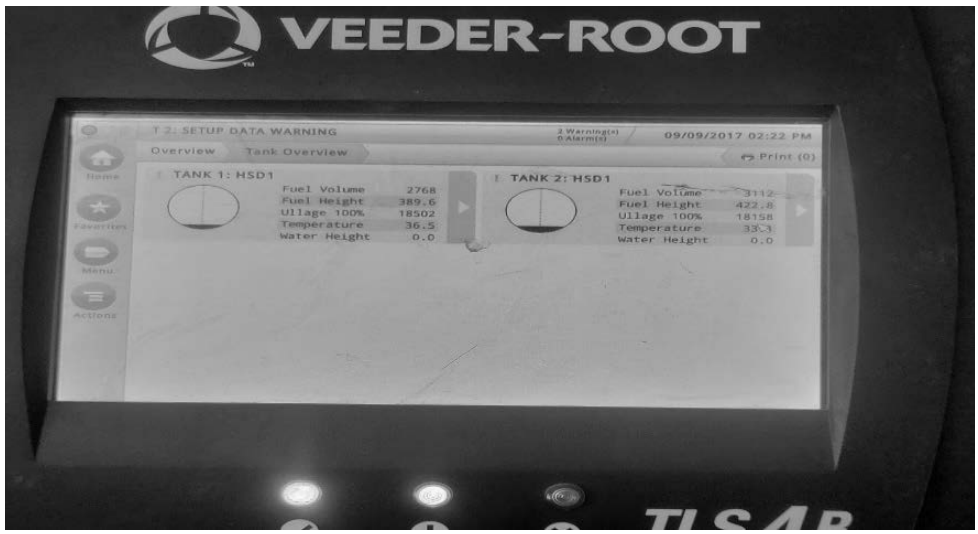

Fig. 5: The Automatic Tank Gauge in Packaged Screen

As we can see in the above picture the screen displays quantity in two tanks after the consumption from daily usage. The screen displays the consumption and to maintain it power backup is used.

Fig. 6: The Pump with Automated Setup of Nozzle and Sensor

As, we can see in above picture the pump is specially calibrated with automated technology so that the client can have fast and easy refueling of product. The nozzle can only be taken out of machine after the quantity required is inputted into computer from sensor box. The sensor box needs a special key with which the machine can start.

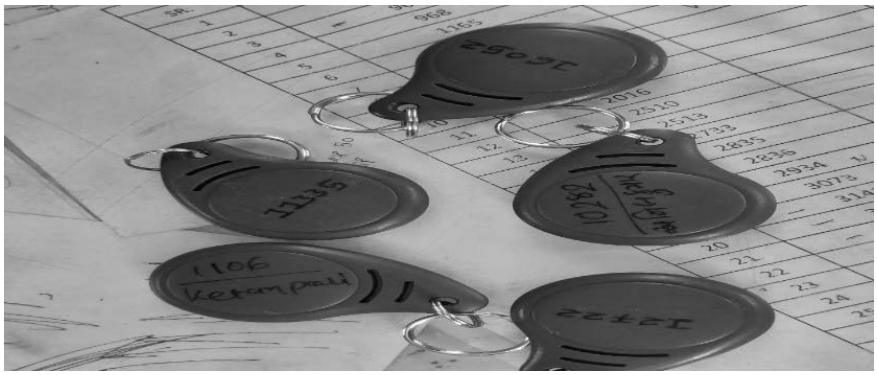

Fig. 7: A Sample Figure of Handheld RFID Tags

The above figure is the special access key given to individual which has all the information of person in it. So, when they need to refill, they will show this key to sensor and entry of concerned will be done with the requirement quantity in system of client. Due to it there will be no hazzle of manual entry and it will be fast.

In furthe\r we also saw a step forward implemented to avoid fraud in product purchase by making false claim of purchase and client can be saved from it. The nozzle will come out of dispenser after keys and quantity is given but will only start after the RFID sensor which is implemented on fuel tank comes in contact of sensor on nozzle. The fueling will be automatically and when full it will stop the flow. So, extra cannot be taken out for other reasons.

Fig. 8: A Sample of RFID Connected with Nozzle Sensor

The system implemented is fully automated which keeps every update of the transaction done from machine and we also provide the software (MIS) with which client can see the process of refueling by whom and at what time. For this we have provided special ID and password to client. The process will be a big push to automation and will change the face of Indian Petro Retailing. The customer which is used to make manual entry of data will be relived as software will play main role in Maintance with the help of telematics.

Result of test were collected as various test have been performed by Oil Marketing Company to make authentic prediction which can help in understand customer consumption pattern. The test were done in various stages and that data was collected by Oil Marketing Company performed in SPSS to better understand the outcome and improve when needed to make customer centric. The first test was done in which road test was conducted by creating some manual constrain where V5 is equal to error which

on average the fleet were going after refueling and V6 extra km it goes on road test. This was done with purpose to understand the refueling and what past data says about the refueling process so that it can be see hassles it faces all time during refueling.

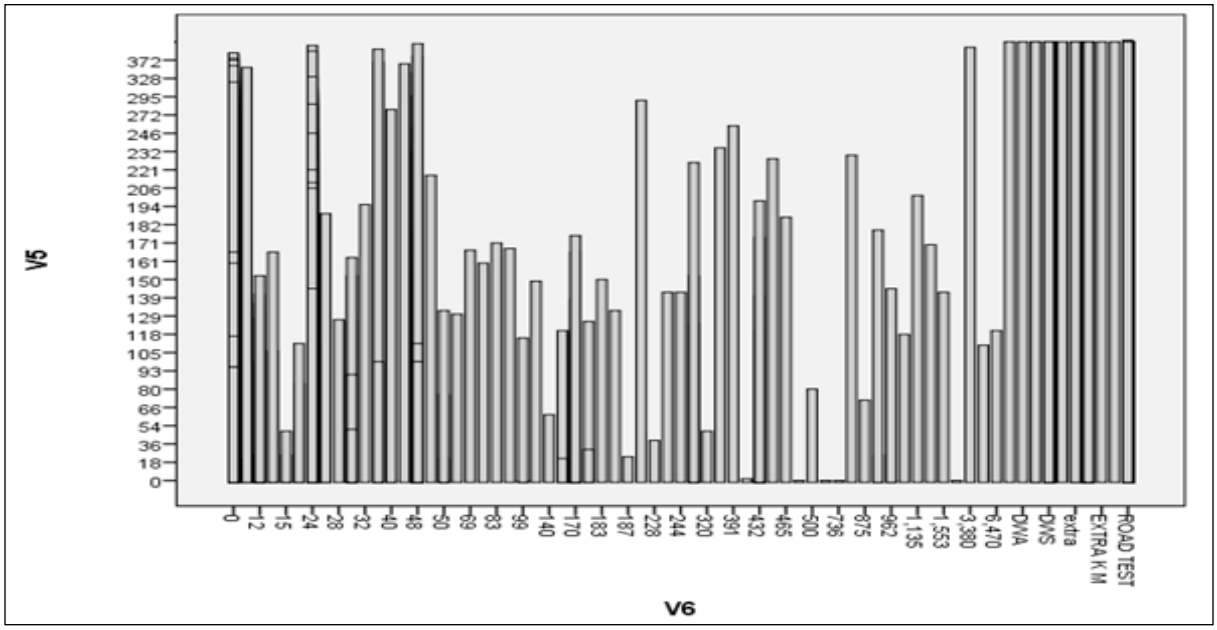

Fig. 9: Error *vs.* Extra KMs

In second test the data was collected and performed in SPSS of the extra KMs the fleet were able to run after filled with Automated Nozzle. The constrain were V6 extra km it goes on road test and V4 the error it got after trying to improve with automation.

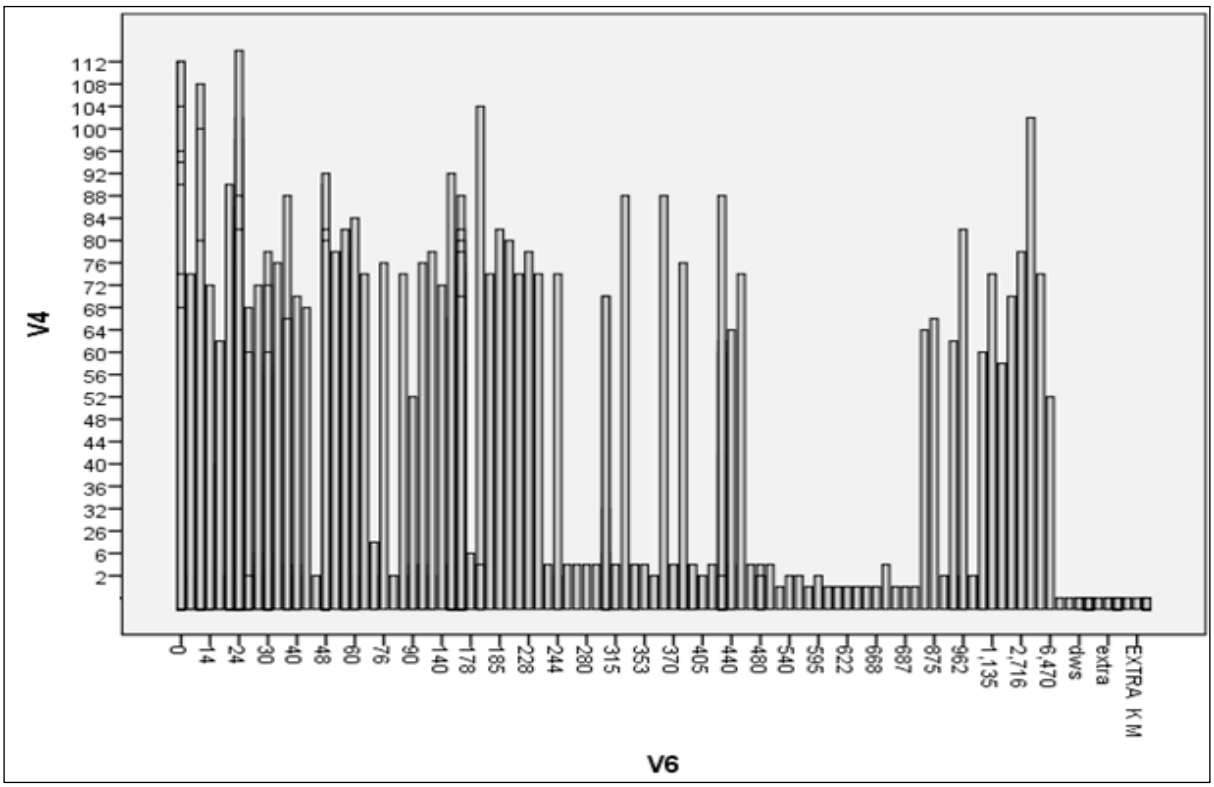

Fig. 10: Error after Automation *vs.* Extra KMS

Compared to past data we can say that automated process was giving less error in refueling while run on extra KMs.

The Third test they performed was on the manual entry was done on stocks where maintain. Here, V9 was the HSD Stock Quantity received and V15 was the error it got on complete of that stocks. When past data was analyzed they came to know that the stock was not getting used all time. There may be chances of some malpractices in refueling.

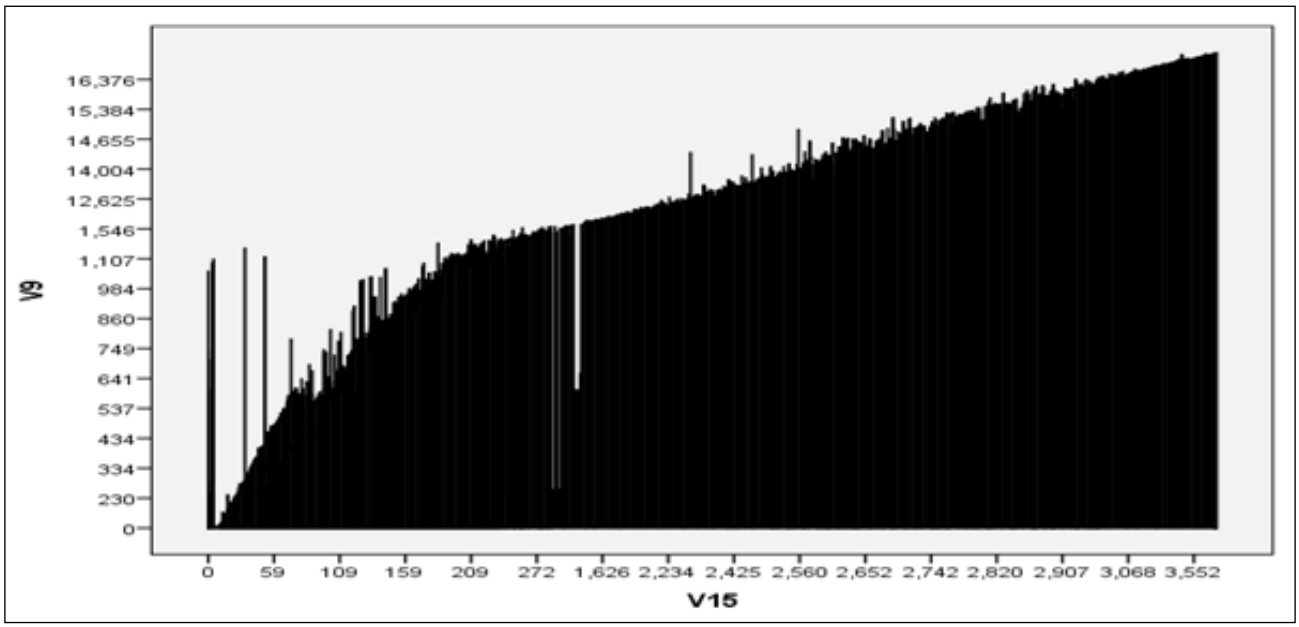

Fig. 11: Error in Total Stock Received *vs.* Manual Stock Entry

After this fourth test was conducted in which V9 was the HSD Stock Quantity received V20 was the error it got in Automation system. While comparing errors were reported less compared to manual entry and it was further analyzed that software was in developing stages so some error were seen as collaboration of sensor and software was issue.

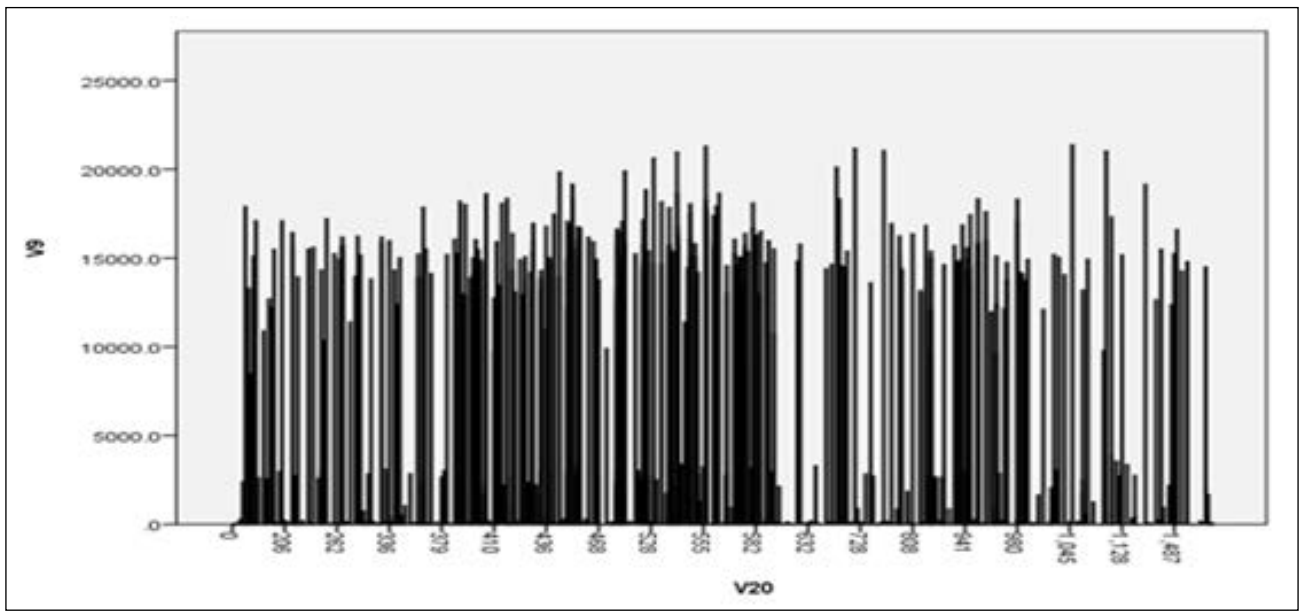

Fig. 12: Error in Total Stock Received *vs.* Automated Stock Entry

LIMITATION

These programs are in development phase so will mainly focused on how Automation will help in serving the bulk consumers and the small consumers are left unnoticed. So, data collected and interpreted may have some changes in future. There won 't be such differentiation once Oil Marketing Company will start full flagged Automation to catering to every segment of consumers.

CONCLUSION

Petro Retailing is in business which frequently needs customer retention. It gets affected by loyalty of customer as it has low product differentiation and costless switchovers. The customer retention has key issue which Oil Marketing Company is trying to strengthen by catering customers from Retail Sales and Institutional business departments. This departments caters various segment of customers with loyalty program and specific services to retain existing customer and attract new customer in this competitive world.

India being the second largest consumer of petroleum products will see the major push from Automation in future for catering the customer at Petro Retailing. The new thing will mainly depend on four forces such as Mobile, IOT, Loyalty and Security. Mobile will be used for fuel app, in-app payments. IOT will be used for providing alerts of fuel level, nearest station, etc. Loyalty is such which helps customer as well as retailer and Automation will take this to new level where loyalty and payment cards will be merged and will be used as targeted rewards. All this thing will be required secured platform. This will change the face of retail outlet where Automation will help Oil Marketing Company to make customized offers based on past data for everyone's customers. Richer information will help companies to give better experience to customers. It will help companies to get real time data and provide much insights with which it can increase retail throughput.

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CNG Queue Management System and Social CRM-Mobile Application

Prajakta Naik[1], Umang Trivedi[2] and Sumit S. Mehta[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management, Pandit Deendayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: [1]prajkta.npgp18@spm.pdpu.ac.in, [2]umang.tpgp18@spm.pdpu.ac.in,
[3]sumit.mpgp18@spm.pdpu.ac.in

Abstract—Compressed Natural Gas (CNG): Is a fossil fuel substitute for gasoline (petrol), diesel, or propane/LPG. Although its combustion does produce greenhouse gases, it is a more environmentally clean alternative to those fuels, and it is much safer than other fuels in the event of a spill (natural gas is lighter than air, and disperses quickly when released)It is stored and distributed in hard containers at a pressure of 200–248 bar (2900–3600 psi), usually in cylindrical or spherical shapes. As we all know, CNG is the most practical form of alternative fuel for today's automotive industry.It is low in cost as compared to Petrol. It is also easy and simple to use in the vehicle capable of running either on Petrol or CNG. Now many car manufacturers are rolling out CNG version cars.The long-term market potential for high-pressure CNG in India is high. The key factor driving the market is the cost efficiency of CNG as a fuel.

There is frequent hikes in the prices of petrol and other fuels. Due to these hikes, car owners have no options but to go for other cheap fuel options. CNG is one of the most preferred among the available options. But, due to long queues at the CNG refuelling, The car owners need to wait for refuelling CNG. This is a severe problem faced by the industry. The study aims at understanding the reasons and remedies to this problem.

The aim of the study was to understand the CNG retailing business & trying to optimized queue in front of CNG Station. It Promote CNG fuel among consumer. The paper Also cover Traffic management & increase utilization of underutilized Station.

Keywords: Oil and Gas, Artificial Intelligence, Operational Efficiency

INTRODUCTION

Compressed natural gas (CNG) is the most practical form of alternative fuel for today's automotive industry. It is low in pollutants as it reduces the vehicular exhaust emissions thus offering greener environment. It is low in cost as compared to Petrol. It is also easy and simple to use in the vehicle capable of running either on Petrol or CNG. Now many car manufacturers are rolling out CNG version cars like the Hyundai Accent, Santro. The Mahindra Logan and Fiat Palio, almost half of Maruti-Suzuki cars are not apart. Even the luxury car manufacturer Mercedes-Benz also rolled out its CNG version. The long-term market potential for high-pressure CNG in India is high. The key factor driving the market is the cost efficiency of CNG as a fuel. (Technical Evaluation and Assessment of CNG/LPG Bi-Fuel and Flex-Fuel Vehicle Viability by J.E.Sinor)

Due to the absence of any lead or benzene content in CNG, the lead fouling of spark plugs is eliminated. CNG-powered vehicles have lower maintenance costs when compared with other fuel-powered vehicles. CNG fuel systems are sealed, which prevents any spill or evaporation losses. Another practical advantage observed is the increased life of lubricating oils, as CNG does not contaminate and dilute the crankcase oil. CNG mixes easily and evenly in air being a gaseous fuel. (Technical Evaluation and Assessment of CNG/LPG Bi-Fuel and Flex-Fuel Vehicle Viability by J.E.Sinor)

CNG has a Research Octane Number in excess of 120. The excellent knock resisting property of CNG allows for use of a higher compression ratio resulting in an increased power output and greater fuel economy when compared to petrol. (Aslam, MU & Masjuki, H.H. & Kalam, M. A. & Abdesselam, H. & Mahlia, T M Indra & Ma, Amalina. (2006). An experimental investigation of CNG as an alternative fuel for a retrofitted gasoline vehicle. Fuel. 85. 717-724. 10.1016/j.fuel.2005.09.004.)

CNG can be used in engines with a compression ratio as high as 12:1 compared to normal gasoline (7.5:1 to 10:1). At this high compression ratio, natural gas-fuelled engines have higher thermal efficiencies than those fuelled by gasoline. The fuel efficiency of CNG driven engines is about 10-20% better than diesel engines. (Aslam, MU & Masjuki, H.H. & Kalam, M. A. & Abdesselam, H. & Mahlia, T M Indra & Ma, Amalina. (2006). An experimental investigation of CNG as an alternative fuel for a retrofitted gasoline vehicle. Fuel. 85. 717-724. 10.1016/j.fuel.2005.09.004.)

There happen a lot of hues and cries on frequent hikes in the prices of petrol and other fuels. Due to these hikes, car owners have no options but to go for other cheap fuel options. CNG is one of the most preferred among the available options or we can rather say that CNG is emerging as a fuel of 21st century in India. But, long queues at the CNG refuelling stations have become a common phenomenon. The car owners are found hapless while waiting for their turn for refuelling CNG. This is a severe problem faced by the industry.

PROBLEM STATEMENT

Long Queues at CNG Refuelling Stations

There happen a lot of hues and cries on frequent hikes in the prices of petrol and other fuels. Due to these hikes, car owners have no options but to go for other cheap fuel options. CNG is one of the most preferred among the available options or we can rather say that CNG is emerging as a fuel of 21st century in India. But, long queues at the CNG refuelling stations have become a common phenomenon. The car owners are found hapless while waiting for their turn for refuelling CNG. This is a severe problem faced by the industry. The study aims at understanding the reasons and remedies to this problem.

RESEARCH CONDUCTED AT CNG STATIONS

Secondary data has been collected from 14 different CNG stations situated in Ahmedabad area. Minute wise data has been collected from the flow meters whereas hour wise data has been collected from the dispensers.

This data was further used to calculate the service time of individual dispensers located at various refuelling stations.

The results obtained by analysing the data is as follows:

1. Vadaj CNG Station

Statistics	Value
Maximum Server Utilization	0.75
Maximum Waiting Time In The System(In Minutes) To Get Fuel	14min
Min Unproductive Time(Including Loading & Unloading Time)	15min
Peak Hours	12:00pm To 8:00pm
Highest Vehicle Filled Per Hour per Dispenser	13
Service Time	4:36 Minute

2. Gota CNG Station

Statistics	Value
Maximum Server Utilization	0.58
Maximum Waiting Time In The System(In Minutes) To Get Fuel	15min
Min Unproductive Time(Including Loading & Unloading Time)	25min
Peak Hours	2:00pm T0 8:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	13
Service Time	4:36 Minute

3. Krishnanagar CNG Station

Statistics	Value
Maximum Server Utilization	0.91
Maximum Waiting Time In The System(In Minutes) To Get Fuel	11min
Min Unproductive Time(Including Loading & Unloading Time)	5min
Peak Hours	7:00 Pm To 8:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	15
Service Time	4 Minute

4. Anjali CNG Station

Statistics	Value
Maximum Server Utilization	0.66
Maximum Waiting Time In The System(In Minutes) To Get Fuel	15min
Min Unproductive Time(Including Loading & Unloading Time)	20min
Peak Hours	2:00pm To 8:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	15
Service Time	4 Minute

5. Chandola CNG Station

Statistics	Value
Maximum Server Utilization	0.733
Maximum Waiting Time In The System(In Minutes) To Get Fuel	12min
Min Unproductive Time(Including Loading & Unloading Time)	16min
Peak Hours	9:00am To 2:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	13
Service Time	4:36 Minute

6. Jamalpur CNG Station

Statistics	Value
Maximum Server Utilization	0.733
Maximum Waiting Time In The System(In Minutes) To Get Fuel	15min
Min Unproductive Time(Including Loading & Unloading Time)	16min
Peak Hours	9:00am To 11:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	13
Service Time	4:36 Minute

7. Maninagar CNG Station

Statistics	Value
Maximum Server Utilization	0.65
Maximum Waiting Time In The System(In Minutes) To Get Fuel	17min
Min Unproductive Time(Including Loading & Unloading Time)	21min
Peak Hours	11am To 12pm
Highest Vehicle Filled Per Hour per Dispenser	11
Service Time	5:27 Minute

8. Memco CNG Station

Statistics	Value
Maximum Server Utilization	0.933
Maximum Waiting Time In The System(In Minutes) To Get Fuel	7min
Min Unproductive Time(Including Loading & Unloading Time)	4min
Peak Hours	9:00 Am To 11:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	18
Service Time	3:19 Minute

9. Memnagar CNG Station

Statistics	Value
Maximum Server Utilization	0.6
Maximum Waiting Time In The System(In Minutes) To Get Fuel	9 Min
Min Unproductive Time(Including Loading & Unloading Time)	24min
Peak Hours	9:00am To 9:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	12
Service Time	5 Minute

10. Shri Lakhminarayan IOCL Station

Statistics	Value
Maximum Server Utilization	0.86
Maximum Waiting Time In The System(In Minutes) To Get Fuel	10min
Min Unproductive Time(Including Loading & Unloading Time)	8min
Peak Hours	9:00am To 9:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	18
Service Time	3:19 Minute

11. Paldi CNG Station

Statistics	Value
Maximum Server Utilization	0.66
Maximum Waiting Time In The System(In Minutes) To Get Fuel	15min
Min Unproductive Time(Including Loading & Unloading Time)	20min
Peak Hours	9:00am To 1:00 Am
Highest Vehicle Filled Per Hour per Dispenser	19
Service Time	3:09 Minute

12. Pragatinagar CNG Station

Statistics	Value
Maximum Server Utilization	0.71
Maximum Waiting Time In The System(In Minutes) To Get Fuel	5min
Min Unproductive Time(Including Loading & Unloading Time)	17min
Peak Hours	10:00am To 1:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	15
Service Time	4 Minute

13. Sabarmati CNG Station

Statistics	Value
Maximum Server Utilization	0.65
Maximum Waiting Time In The System(In Minutes) To Get Fuel	10min
Min Unproductive Time(Including Loading & Unloading Time)	21min
Peak Hours	Mostly Free
Highest Vehicle Filled Per Hour per Dispenser	13
Service Time	4:36 Minute

14. Sarkhej CNG Station

Statistics	Value
Maximum Server Utilization	0.911
Maximum Waiting Time In The System(In Minutes) To Get Fuel	15min
Min Unproductive Time(Including Loading & Unloading Time)	5 Min
Peak Hours	9:00am To 11:00 Pm
Highest Vehicle Filled Per Hour per Dispenser	12
Service Time	5 Minute

The consumer behaviour is as follow:

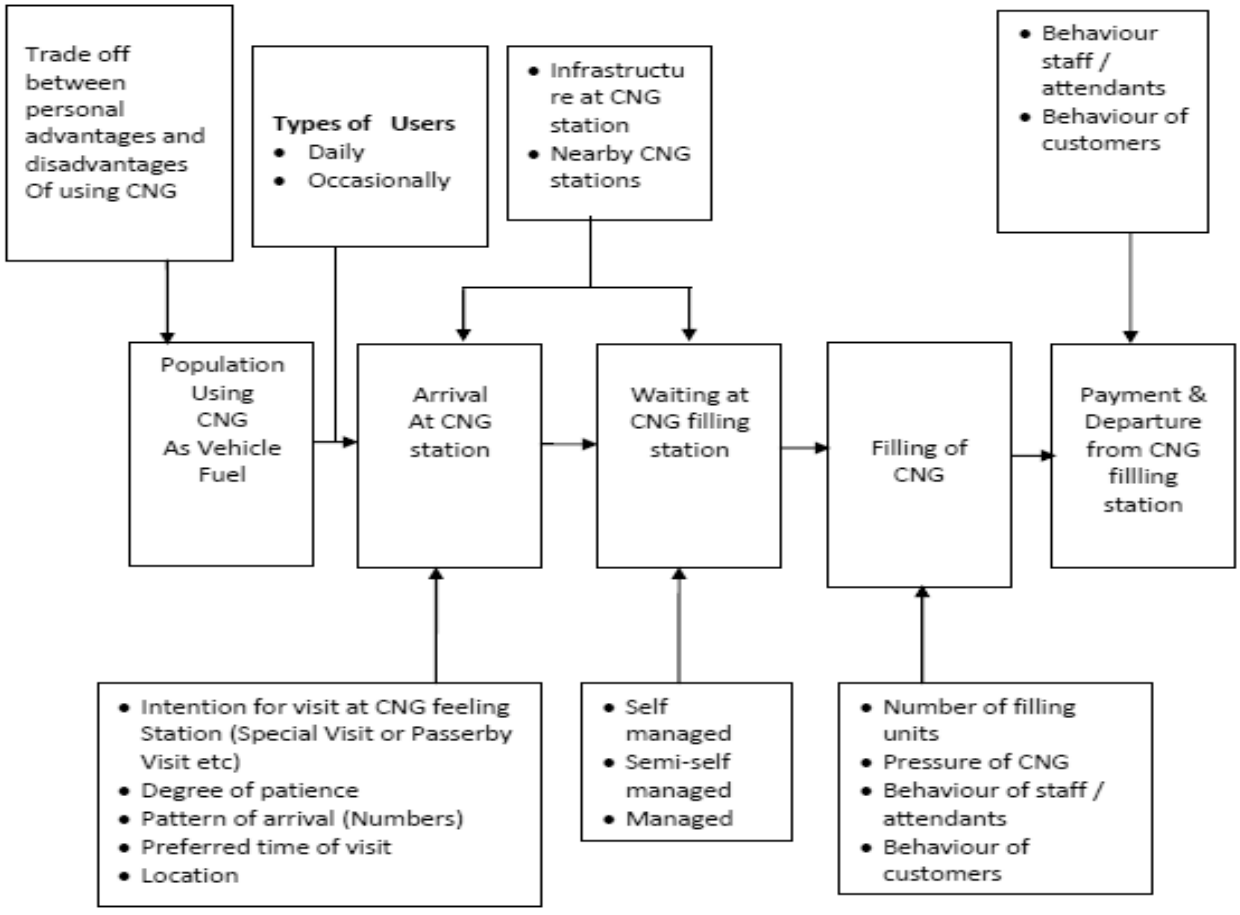


Fig. 1: Consumer Behaviour

RECOMMENDATIONS

Find The Waiting Time In The System & Then Diverting Traffic To Idle CNG Pump Through Showing That Waiting Time Will Be Shown In The CRM App

RFID SYSTEM

Radio-Frequency Identification (RFID) Is The Use Of Radio Waves To Read And Capture Information Stored On A Tag Attached To An Object. A Tag Can Be Read From Up To Several Feet Away And Does Not Need To Be Within Direct Line-Of-Sight of The Reader To Be Tracked (K. Nisar *et al.,* "Indoor Roaming Activity Detection and Analysis of Elderly People using RFID Technology," 2019 1st International Conference on Artificial Intelligence and Data Sciences (AiDAS), Ipoh, Perak, Malaysia, 2019, pp. 174-179.)

Fig. 2: RFID Inlay

HOW DOES A RFID SYSTEM WORK?

A RFID System Is Made Up Of Two Parts: A Tag Or Label And A Reader. RFID Tags Or Labels Are Embedded With A Transmitter And A Receiver. The RFID Component On The Tags Have Two Parts: A Microchip That Stores And Processes Information, And An Antenna To Receive And Transmit A Signal. The Tag Contains The Specific Serial Number For One Specific Object. To Read The Information Encoded On A Tag, A Two-Way Radio Transmitter-Receiver Called An Interrogator Or Reader Emits A Signal To The Tag Using An Antenna. The Tag Responds With The Information Written In Its Memory Bank. The Interrogator Will Then Transmit The Read Results To An RFID Computer Program. (What is RFID Retrieved from https://www.epc-rfid.info/rfid)

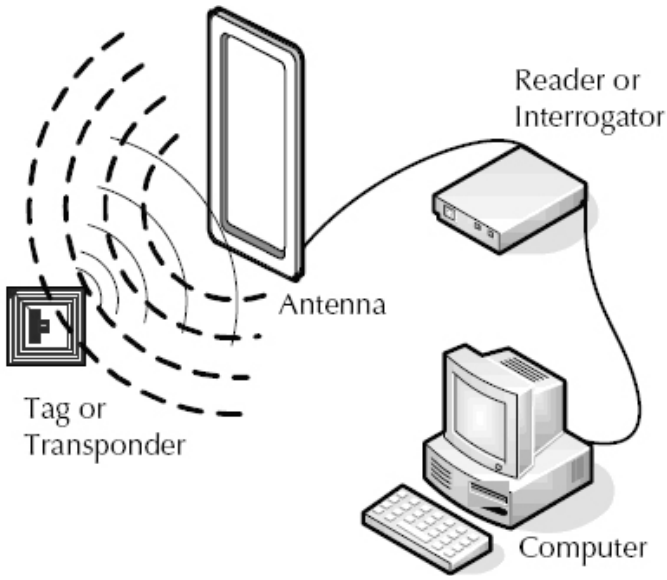
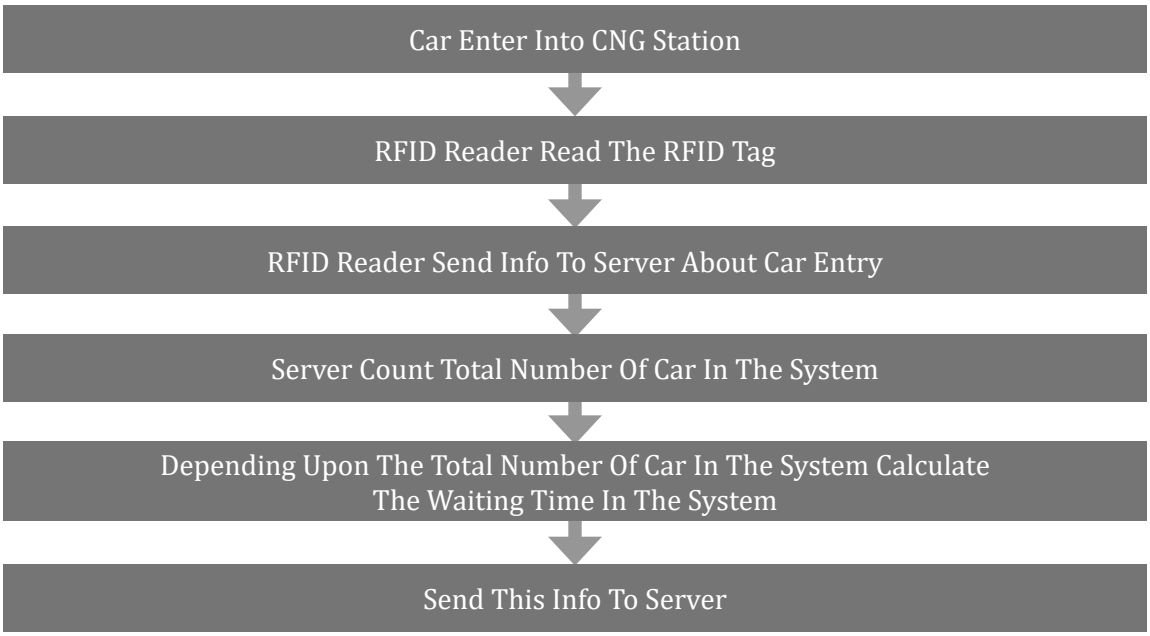


Fig. 3: RFID System

Source: https://www.epc-rfid.info/rfid

RFID SYSTEM FLOW CHART



SMART CAMERA

Smart Surveillance Cameras Will Be Positioned Over Entry Point Of CNG Station. Camera Should Obtain Car Image From The Distance Of 35-40 Meter ("What Are the Different Types of CCTV Camera?" Retrieved from https://www.caughtoncamera.net/news/different-types-of-cctv/)

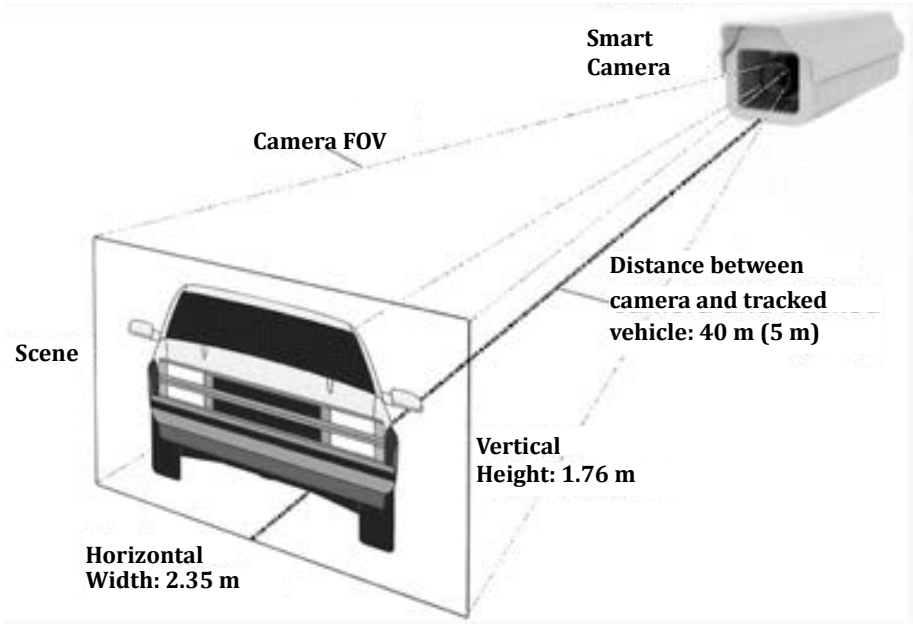
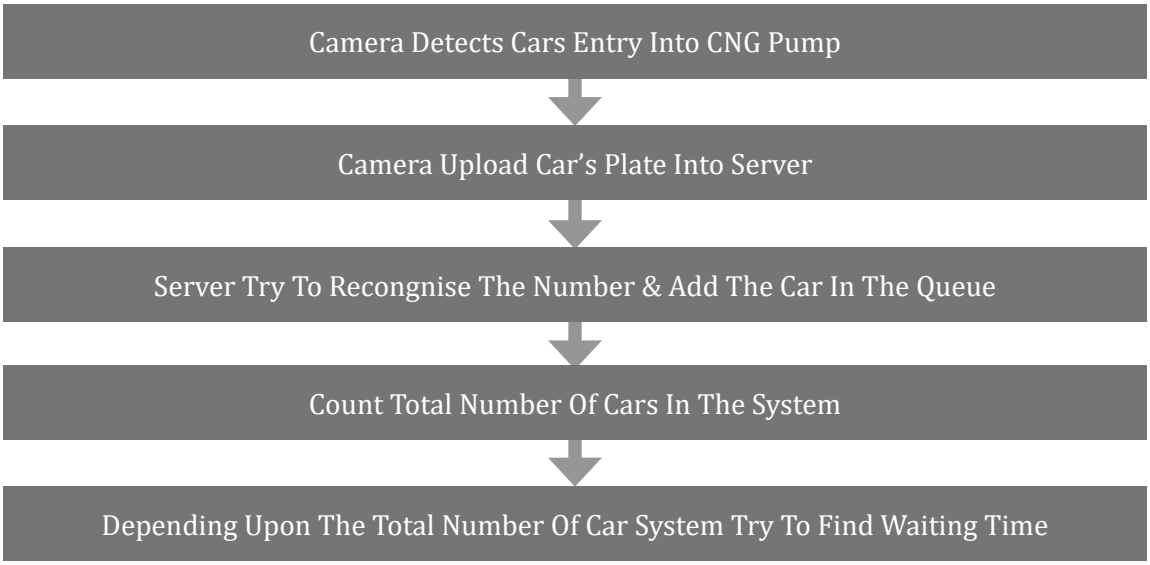


Fig. 4: Smart Camera System

Source: https://link.springer.com/article/10.1007/s11042-015-3151-y

FLOW CHART



COSTING OF QUEUE MANAGEMENT

There is always some Some investment needed to implement smart technology. Here is financial breakup For 12 CNG ststion.

RFID System

Device Name	Quantity Needed Per Outlet	Price (in INR)	Total Cost (in INR)	Total Number of Outlet	Total Cost (in INR)
Rfid Reader	1 Per Outlet 1exit	80000	160000	12	1920000
Rfid Tag	On Every Car & Auto	10	2000000	1	2000000
Moniter System	Per System Per Outlet	50000	50000	12	600000
Server Cost	1 Server Centrally Needed	100000	100000	1	100000
App Maintance Cost	100000 Rs Annual Maintance Cost	100000	100000	1	100000
Total Cost					4720000

- Total 4720000 Rs. needed to develop this queue management system

Smart Camera System

Device Name	Quantity Needed Per Outlet	Price (in INR)	Total Cost (in INR)	Total Number of Outlet	Total Cost (in INR)
Smart Traffic Camera	2 Camera	10500	21000	12	252000
Wired Communication	Aprox 20,000(Depending Upon Distance Between Camera & Monitoring System)	20000	20000	12	240000
Monitoring Sysytem	Per System Per Outlet	50000	50000	12	600000
Server Cost	1 Server Centrally Needed	100000	100000	1	100000
App Maintance Cost	100000 Rs Annual Maintance Cost	100000	100000	1	100000
Total Cost					1292000

- Total 1292000 Rs. Needed To Implement This Smart Camera Queue Management System
- So according to this financial analysis smart camera system is cheaper to implement

CRM-MOBILE APPLICATION

Mobile Application Is Best Way To Manage Customer Relation. Mobile Application Should Have Following Features

1. Location Of All 57 CNG Station
2. Waiting Time At All CNG Station
3. Detail Of Each Station Whether It Is In Service Mode Or Shut Down Mode
4. History Of Past Consumption
5. Station Selection System(If Selected Pump Has More Waiting Time Then Suggest Other Nearest CNG Pump
6. Safety And Fuel Savings Tips
7. Payment Option
    a. Pre Loaded Money
    b. UPI
    c. Debit/Credit Card
    d. Other Third Party Wallet
8. Fuel Reminder(Optional If User Wants Reminder After Particular Time Period)
9. Automated Bill Received On The App
10. Link Domestic LPG Account In The App
11. Domestic LPG Bill Payment
12. Launch Complaint About LPG & CNG Service
13. Information About Celebration(For Example Tree Plantation Program,Green Merethon,World Envirment Day Celebration,Etc)

OTHER SUGGESTIONS

Give Extra Discount During Idle Hour For Example 1 Rs Or 1.5 Rs Discount Can Be Given Between 12am To 6 Am At Memco,Anjali,Jamalpur & Paldi CNG Station.

CONCLUSION

Government is Trying To Shift From Coal And Oil-Based Economy To Gas-Based Economy, Which Boosted CGD Industry. Major Chunks Of Revenue Of CGD Companies Comes From CNG And Industrial Sector And Companies Are Always Trying To Increase Sale. By Improvising Supervision On Man-Power Deployed At CNG Ros, Service Level, Technical Issues, Proper Advertising Would Help To Increase The Sale Of CNG.BY Imposing Queue Management System Adani Will Encourage & Help Consumer Hence More Consumer Will Attract Towards CNG Fuel And Ultimately It Will Increase Sales. In This Way Adani Solve The Problem Face By The Consumer And Encourage New Consumers To Use Green Fuel.

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Review of Research on Outsourcing of Services for Operation and Maintenance of Thermal Power Generating Plants

Aseemkumar Joshi
Ph.D. Research Scholar,
Mechanical Engineering, School of Technology,
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat
E-mail: aseemjoshi2006@gmail.com

Abstract—A number of areas such as procurement, supply, logistics and transportation, operations management, marketing, management information systems, and strategic management have contributed to the numerous SCM literature. From the innumerable research, it can be seen that a substantial progress has been made toward understanding the essence of SCM. Some of the Core focused area of SCM is Procurement of materials and various services in various industrial sectors like energy sector, power generation and so many industries. As a result of this study, through successive stages of measurement analysis and refinement, set of reliable, valid procedures for services procurement functional area is elaborated which is proven in various diverse industries across the power sector. Supply chain management is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by the supply chain firms to develop and run supply chains in the most effective & efficient ways possible. Supply chain activities cover everything from product development, sourcing, production, and logistics, as well as the information systems needed to coordinate these activities. The organizations that make up the supply chain are "linked" together through physical flows and information flows.

Like other industries and businesses, power generation industries have also started majority of the activities like operations, maintenance and other related works on Outsourcing basis. More advantages have been proved while going on outsources models. When adopting outsourcing, a resources can be utilized focusing on the core business which helps in effective utilization. Outsourcing shall become more effective for numbers of activities which are needed by power plant on temporary basis and for limited durations. Outsourcing helps directly or indirectly in enhancing operational efficiencies and also many of works are completed in time bound and even faster modes. Major advantage of outsourcing model can be proved profitable to organizations since there would not be any long term Commitment with outsourcing agencies or outsourcing partners. It helps in saving money by avoiding long term jobs / salaries by substituting regular employments of manpower resources. Outsourcing agencies are more specialized, these days they have more specialized expertise which a company normally can not afford. Agencies are normally having specialized tools and required equipments hence it would also be a substantial saving on investment part by client organizations. Inventory optimization can also be obtained by adopting outsourcing models since agencies would keep the required bare minimum consumables and other parts during outsourcing duration.

Power generating plants in India have a frequent practice of awarding various service contracts in order to avail technology availability for major equipments like Steam Generators, Steam Turbines, Efficient BOP (Balance of Plant) equipments, coal and ash handling plants etc. Service Contracts plays a very crucial role in O&M of thermal power plants. Power Generation is linked directly performance of these contracts. Major O&M service contracts constitute a substantial high cost may be approx. 40%-50% cost in total Equipment O&M Cost of the entire thermal power station. Outsourcing of these services bring cost economy in operating and maintaining the plants and equipments. It also helps in assuring uncompromised Quality in required materials and other consumables needed during O&M activities of the power plant. This ensures timely procurement to meet plant running schedules. Outsourcing facilitates cost economic logistics activities and schedules with fastest deliveries to ease time bound plant schedules. Another major benefits of outsourcing would be a consistent long duration spares availability and supplies for Operations and maintenance once projects are commissioned.

Although lot many advantages and benefits are gained from the outsourcing of the services in thermal power stations, still there are some of the areas of concerns with needs to be addressed which are hampering or affecting the smooth execution of the service contract activities and performance in totality. In the context of overall ownership of the plant area or as a whole in which the service provider is responsible, there have been observed quite a lack of work ownership or accountability. Client on the other side have been facing challenges to search and appoint a good service provider due to various reasons like plants being in the remote areas or coastal areas. Majority of the thermal power plants are located in our country are in a remote locations far from the city areas manly due to ease of accessibility of the water and coal. Plant locations are preferred near to coal mines and water

sources upto the extent possible. There have been seen a higher level of turnover amongst manpower from service provider as well for owners of the power plants. To address the manpower resources availability have always been a major area of concern. Some other areas of Challenges are to appoint right service provider / associate looking to financial Capabilities as well technical competence. Many of the Challenges are faced in context of safety, health and environmental considerations of the employees of Service providers. Other grey area of major concern are challenges faced in context of CSR and Local community related issues like land loosers, projected affected people (PAP), project affected villages (PAVs). There are lot many issues and demand expectations from PAPs and PAVs in terms of business opportunities, local employments etc. which needs to be fulfilled by owner / client / service providers of the power plant.

Supply chain management represents one of the most significant paradigm shifts of modern business management by recognizing that individual businesses no longer compete as solely autonomous entities, but rather as supply chains. SCM, along with a number of other emerging areas in operations management, is, however, still in its embryonic stage . The scientific development of a coherent supply chain management discipline requires that advances be made in the development of measurement instruments as well as in theoretical models to improve our understanding of supply chain phenomena , so the research agenda in supply chain management must not be driven by industrial interest alone . Research about supply chain management as a conceptual artifact of the modern world is also essential. Indeed, it is necessary to understand the broader context before robust prescription is possible. In thermal power generation, award and execution of O&M service contracts play a crucial role with higher cost contribution which directly affects power generation. Outsourcing of these contracts is frequent practice these days, however these are faced by various challenges specifically during execution stage. Meticulous discussions with contract managers, execution managers and service provider business associates are of a need of an hour. Systematic analysis and thorough understanding of difficulties faced at every stage would bring a thought to develop solutions and better practices and hence would increase productivity in performance and cost optimization

Keywords: Supply Chain, Power Generation, O&M, Service Contracts

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Application of Agile Methodology in Energy & Infrastructure

Tushar Bhajipale[1], Abhinek Kumar[2] and Dhruvit Shah[3]
[1,2,3]M.B.A. (Energy & Infrastructure) Student,
School of Petroleum Management, Pandit Deenadayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: [1]tushar.bpgp19@spm.pdpu.ac.in,
[2]abhinek.kpgp19@spm.pdpu.ac.in,
[3]dhruvit.spgp19@spm.pdpu.ac.in

Abstract—Energy & Infrastructure industry has undergone many evolutionary stages and paradigm shifts in going from a low production (according to demand and the production itself) to mass production (due to increasing in market demands and/or to increase revenue); then to lean production (to decrease and/or control oil prices, Raw material), to next stage (agile oil production, agile). Business are restructuring and reengineering themselves in response to the challenges and demands of the twenty-first century.

Petroleum companies have great interest in developing their countries through improving their resources to be more competitive. They are also trying to maintain a high level of responsiveness to achieve agility and to remain competitive in the global marketplace especially after instability of oil prices and global financial crisis. Agile systems (AS) is considered as the next industrial revolution. Agile systems are considered as production and/or management philosophies that integrate the available technology, people, production strategies and organization management systems. Although agility is the set of capabilities and competences that the petroleum companies need to thrive and prosper in a continuously changing and unpredictable business environment, measuring the level of agility in these companies is still unexplored according to the capabilities and competences. The focus area will be , a conceptual model that will be proposed to measure the agility level of the petroleum companies based on existing technologies, level of qualifying human resources, production strategies, and organization management systems. These studies provide the readers with an insight into the companies and their agility levels.

The way in which construction projects are managed has not changed significantly in the last decades; however stakeholders, materials, competition, and user requirements are continuously changing. This creates a gap between the current managerial view on how construction projects are conducted and how they could be managed to increase efficiency. This research covers the implementation of a framework from the IT sector into the construction industry: Scrum. Conducting a case study, the implementation and application of Scrum was analyzed through the evaluation of its different artifacts. This research covers the following questions: Can Scrum be implemented in the design phase of the construction industry? What adaptations are needed to use Scrum to improve the design phase of construction projects? How and where could Scrum, or parts of it, be used by the design and planning departments of construction companies?

Keywords: Project Management, Agile Measurement, Energy & Infrastructure Industry, Sprint, Scrum

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Implementing Block Chain Technology in Project Management

Gaurav Raj[1], Kuldeep Modh[2] and Pankaj Maan[3]
[1]M. Tech Student, Institute of Infrastructure Technology Research and Management
[2]PGPM Student, Management Development Institute Murshidabad
E-mail: [1]rajgaurav912@gmail.com, [2]kuldeep.18pgpm020@mdim.ac.in, [3]mann56pankaj@gmail.com

Abstract—Block chain is at very nascent stage and Gartner Emerging Hype cycle, 2018 depicts it to be in the trough of Disillusionment. But with the increased applications of Block Chain Technology, it is clear that in no time it would reach the plateau of productivity. We would be emphasizing more on how this technology can be implemented in Project Management. Block Chain being decentralized, fast, secure, transparent and cost effective how its implementation can help in decreasing cost, lead time. The scope of day to day transactions will also be discussed such as information sharing, sending reports, releasing funds and payments, task completion and much more. The decentralized nature makes is apt for project management & in modern days it is important that we have loosely coupled structure or value chain. It would increase team coordination, collaboration, accountability. Block chain has two important key- Public Key and the private key. In project management, the user (in our case the manager) will be able to register the transaction with the private key i.e., the manager would be able to assign roles, task and responsibilities and manage permissions to the juniors by assigning a private key to each of them while the public keys would be used to know the addresses where the information would be shared. Block Chain Technology comes with features like smart contracts where transactions related to subcontractors' terms and conditions can be automated, registering work performance data like procurement, assigning activities and tasks, tracking progress. All the stakeholders in the project must have clear knowledge about the exact status which can be modeled as public information which all the project members must know and confidential information which is to be known to known to management team and to the key stakeholders. Various means to implement technology in the value chain and project will be discussed keeping in mind the all the necessary tradeoffs. One of the possibilities that blockchain gives to developers is to create a cloud storage system that will be immutable, untouchable, way more robust, secure and less prone to human errors, hacking attacks, and data loss. The big picture is that blockchain will change the way we manage supply chain because it will result in an increase in safety and security in every record, regarding the different exchanges of value between the individuals involved in the project. The transactions will be documented in a permanent decentralized record, and the system will allow the various participants to monitor all the factors securely and transparently. Data related to how much time your employees are taking to complete their tasks will be part of this permanent record. And data such as document sharing will be safer. Blockchain will also be more effective because it enables superior operational workflow. Implementing a blockchain-based project will create business value. It will result in time-saving, cost removal, and risk reduction. When time, cost, and risk are the concerns, who else but the project manager is the ideal person to manage these.

Keywords: Supply Chain, Public Key, Private Key, Information

SECTION–VI

HUMAN RESOURCE MANGEMENT & SOCIAL DEVELOPMENT

A Qualitative Study of Impact of Rewards and Recognition Program in an Organization towards Employee Satisfaction

Rajshree Ayushee
Business Analyst, Business Transformation and Automation,
Global Business Operations, VMware Software Pvt. Ltd., Bengaluru, India
E-mail: rayushee@vmware.com/ rajshree.ayushee@gmail.com

Abstract—Rewards and recognition has since time immemorial been an integral part of any organization. It is deemed to act as a motivating force for the employees, something to look forward to. Rewards alone are not enough, and must be bundled with proper channel of recognition to honor the reward itself. The primary study conducted reflects a dire need of a consistent rewards and recognition program across the operations unit in order to ensure that the gaps and disparities in employee experience are covered from one team to another. In order to achieve an optimal level of employee satisfaction, one and all, must be presented with the same opportunities, experiences and thus be a part of a wholistic program tending to a centrally placed need of being rewarded and recognized for a job well done. This document attempts to justify the same, while case in point being the program established in one of the companies showing positive results.

Keywords: Rewards, Recognition, Employee Satisfaction, Consistency, Performance, Methodologies and Framework, Governance

INTRODUCTION

This document attempts to examine the rewards and recognition mechanism in an operations unit of a maturing IT product organization. While the details follow subsequently, this model summarizes the efforts undertaken in the form of building blocks that lay the foundation to achieve results.

THEORETICAL FRAMEWORK

The operations unit in this case, is an organization spread across 7 locations across the world, with around 700+ employees, distributed into 8 functions or teams. These teams come together as a part of the bigger value chain under Finance and Operations of the company.

Rewards and recognitions in the operations landscape was being carried out in silos. Each of the functions had been following different frameworks, award pay-outs, cadences and recognition channels.

As a result, employees came across disparate experiences. Having realized the scope of improvement in the R&R culture, the imperative need was a holistic program. A program that would drive consistency in R&R practices across the entire operations unit and play a crucial role in unifying and enhancing employee experiences.

The opportunity, thus defined, was to design an employee-focused program, which would be corporate aligned, logical yet flexible and scalable at the same time. This program would focus on driving consistent employee experience across all teams.

THE STUDY

The primary study was designed to find the anomalies that existed in the current rewards and recognition program that was being followed at the moment across the operations team, for all sites. The below set of questions were shared with all people managers, above director (from a hierarchy point of view) and responses were requested for.

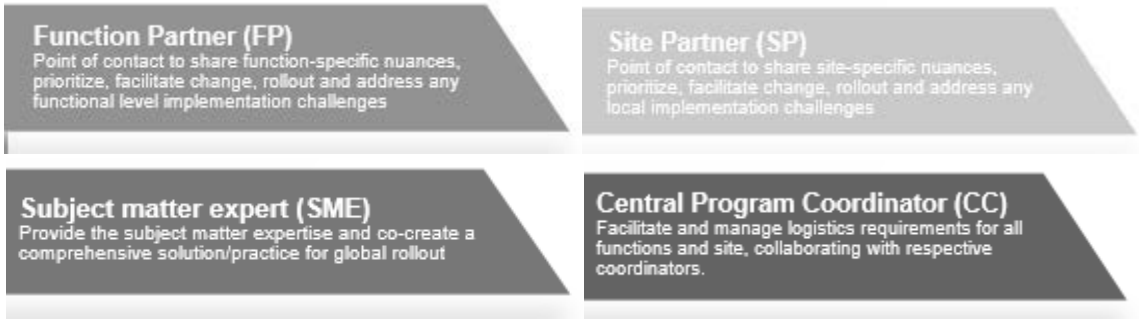
Each of those people managers shared their responses discretely and the data was a clear representation of inconsistencies, lack of an established framework and standardization. This would further prove the urgency of the need and thus validate the said framework in works.

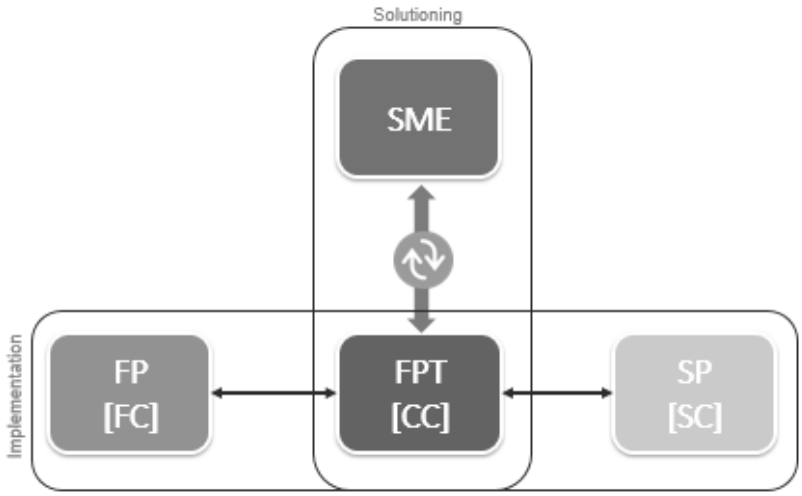
S.No.	Questions	Response	Additional Comments
1	Do you have a structured R&R program for your function?		
	If yes, which sites are covered under the program?		
2	Do you have designated owners to drive & manage R&R process in your function?		
3	Do employees in your function have clear visibility & understanding of R&R criteria & nomination process ?		
	If yes, which platforms are used to communicate nomination, award & selection criteria's? (Source, SharePoint, email, town hall etc.)		
4	For which awards do you use Socialcast platform?		
5	Which awards are there for immediate recognition (spot, kudos, informal etc)?		
	Audience Scope (FTE/AWF; Analyst/manager/ all employees)		
	Reward/recognition instruments (Written/verbal, felicitation, public/private praise, award/gifts, certificates, monetary etc)		
	% of FTEs awarded/recognized in H1 2016		
6	Do you have dedicated awards linked to current function priority (innovation, execution etc)		
	Audience Scope (FTE/AWF; Analyst/manager/ all employees)		
	Frequency (Monthly/ quarterly/ annually/ Adhoc)		
7	Do you have mechanism to recognize people mgmt excellence?		
8	Do you have periodic performance awards? (don't consider spot awards here)		
	Audience Scope (FTE/AWF; Analyst/manager/ all employees)		
	Frequency (Monthly/ quarterly/ annually/ Adhoc)		
	Reward/recognition instruments (Written/verbal, felliciation, public/private praise, award/gifts, certificates, monetory etc)		
	% of FTEs awarded/recognized in H1 2016		
9	Do you have recognition for celebrating tenure & association?		
#	What % of function R&R budget was utilized in H1 2016		

METHOD

GOVERNANCE AND ENGAGEMENT

In order to put the program into its place, the first step was to create an engagement/ governance model. The model, considers a team of the all the functional leaders and/ or their representatives.





This would ensure all key stakeholders are acknowledged in the decision-making process at every stage. Also, the model would define the participation and engagement levels amongst all the parties involved in bringing the designed framework into reality. This would essentially establish the process flows through which the program will be executed.

The team would take the agile approach of working towards the solutioning and thus designing the core framework which would best recognize the employees.

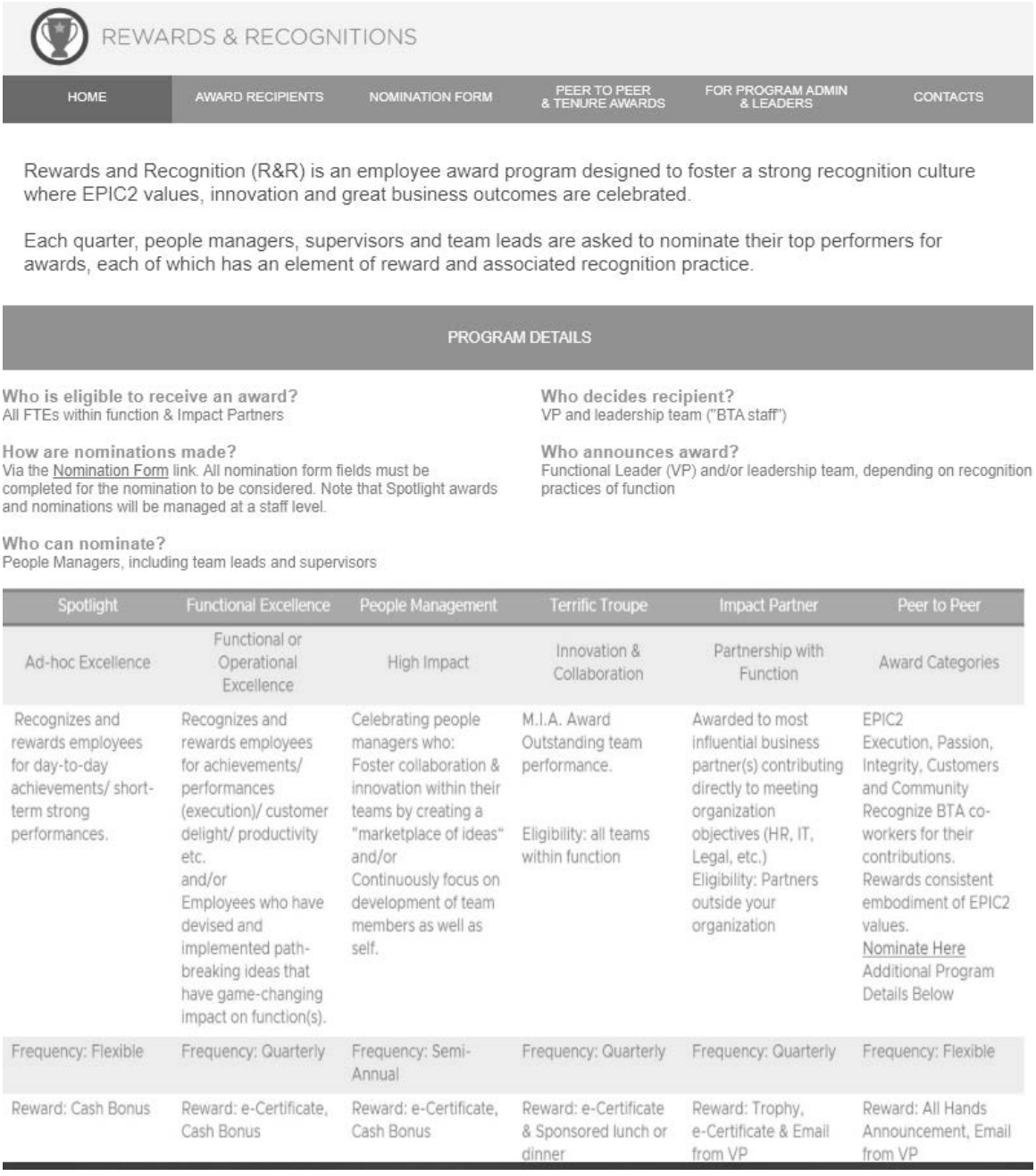
CORE FRAMEWORK

As the team began designing the solution, a number of parameters were put to test.

To start with, it was important for the team to lay down the foundation for developing the solution, on which rest of the parameters would be based upon. The team researched through the corporate rewards and recognition policies and guidelines along with operations unit's R&R history over the past few years and the findings gave the team a solid coverage percentage of total employees, which would be set as the target for the program, keeping in alignment with industry benchmark at the same time.

Having set the target, the design moved to its framework. Based on the headcount distribution across different functions within operations unit, a statistical model was devised ensuring fair allocation of number of awards under each of the categories for each of the functions.

The pre-set award categories were formulated in alignment with the goals and priorities of the organization. The categories were meant to resonate with the nature of work being performed by the operations unit employees. To ensure continuous sharing of information and build awareness around the program, a microsite was developed accessible to all employees.



REWARDS & RECOGNITIONS

HOME | AWARD RECIPIENTS | NOMINATION FORM | PEER TO PEER & TENURE AWARDS | FOR PROGRAM ADMIN & LEADERS | CONTACTS

Rewards and Recognition (R&R) is an employee award program designed to foster a strong recognition culture where EPIC2 values, innovation and great business outcomes are celebrated.

Each quarter, people managers, supervisors and team leads are asked to nominate their top performers for awards, each of which has an element of reward and associated recognition practice.

PROGRAM DETAILS

Who is eligible to receive an award?
All FTEs within function & Impact Partners

Who decides recipient?
VP and leadership team ("BTA staff")

How are nominations made?
Via the Nomination Form link. All nomination form fields must be completed for the nomination to be considered. Note that Spotlight awards and nominations will be managed at a staff level.

Who announces award?
Functional Leader (VP) and/or leadership team, depending on recognition practices of function

Who can nominate?
People Managers, including team leads and supervisors

Spotlight	Functional Excellence	People Management	Terrific Troupe	Impact Partner	Peer to Peer
Ad-hoc Excellence	Functional or Operational Excellence	High Impact	Innovation & Collaboration	Partnership with Function	Award Categories
Recognizes and rewards employees for day-to-day achievements/ short-term strong performances.	Recognizes and rewards employees for achievements/ performances (execution)/ customer delight/ productivity etc. and/or Employees who have devised and implemented path-breaking ideas that have game-changing impact on function(s).	Celebrating people managers who: Foster collaboration & innovation within their teams by creating a "marketplace of ideas" and/or Continuously focus on development of team members as well as self.	M.I.A. Award Outstanding team performance. Eligibility: all teams within function	Awarded to most influential business partner(s) contributing directly to meeting organization objectives (HR, IT, Legal, etc.) Eligibility: Partners outside your organization	EPIC2 Execution, Passion, Integrity, Customers and Community Recognize BTA co-workers for their contributions. Rewards consistent embodiment of EPIC2 values. Nominate Here Additional Program Details Below
Frequency: Flexible	Frequency: Quarterly	Frequency: Semi-Annual	Frequency: Quarterly	Frequency: Quarterly	Frequency: Flexible
Reward: Cash Bonus	Reward: e-Certificate, Cash Bonus	Reward: e-Certificate, Cash Bonus	Reward: e-Certificate & Sponsored lunch or dinner	Reward: Trophy, e-Certificate & Email from VP	Reward: All Hands Announcement, Email from VP

An innovative enhancement to the solution was the centrally allocated, monitored and managed budget. The entire program was orchestrated to be funded from a single source at the SVP/ operations unit level. The same would be continuously controlled and monitored by the team.

In addition to the core framework, the team provided infrastructural support in terms of

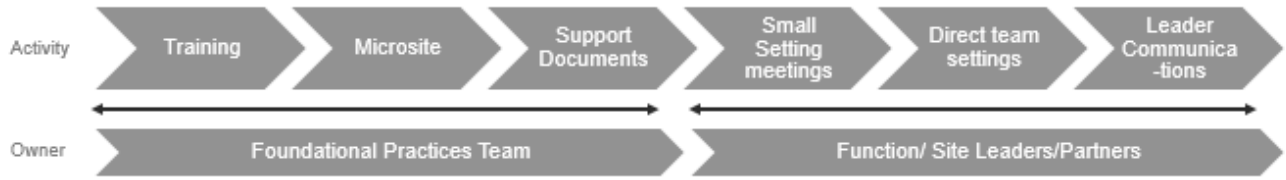
a. Online Nominations Tool: To gather the award nominations submitted by the people managers, later to be review by the function leaders' team in selecting the winners.
b. Centralized Vendor Management: To handle the logistics for the recognition channels i.e. trophies and certificates (procurement and distribution).
c. Microsite: To ensure seamless flow of information about the different aspects of the program. Also utilized to display list of award recipients quarter-on-quarter.

PROCESS AND EXECUTION

The model being established, next action was to position and implement the R&R Program. To get this rolling, FP Team designed a comprehensive adoption strategy. The building blocks of this strategy, keeping the people at the center, were

a. Accurate and timely communications
b. Leadership investment and visible participation
c. Program awareness and orientation
d. Support and query handling (24*7 on the internal social media of the company)

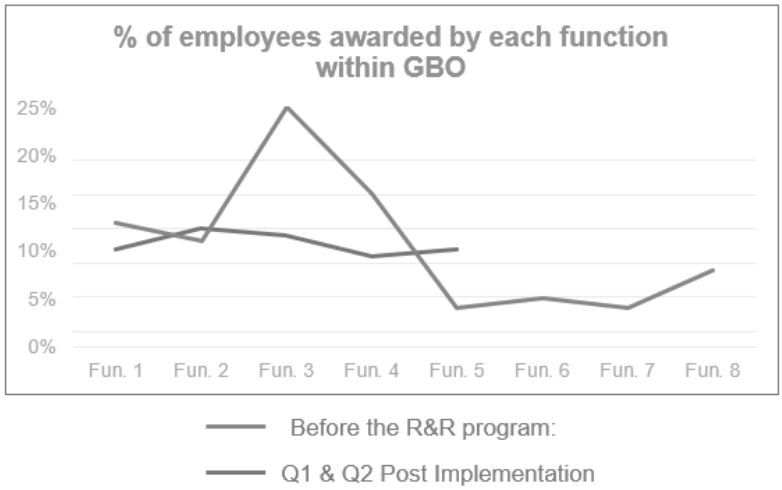
The primary focus of the strategy was to engage with all people managers across functions and sites ensuring complete awareness and participation. This strategy was built-in in two segments. The segments were distinguished based on the target audience. The first segment, meant for the leaders and people managers, composed of training and orientation sessions along with a series of preparatory communications throughout the period of 2 months. The second segment was the program launch communication to the entire operations population.



This delivery pattern ensured end-to-end population coverage along with the support for the employees to understand and be a part of the program. The pre-program orientation sessions with the leaders and people managers helped the team to enable them to be our ambassadors.

RESULTS

The program significantly impacted the operations unit as a whole driving consistency and efficiency in the rewards and recognition space. The most striking difference was observed in the discrepancies in employee population being awarded across functions. The variance in the range of employee being rewarded was 35% before the program and was drastically reduced to 3% later, thus driving standardization and unified employee experience, as intended.



Before the program, around 20 people managers, director plus employees only, identified, nominated and finalized the winners. later, when the group of empowered people managers was extended to senior managers and managers as well, it resulted in 130 employees participating in the process.

Along with the above people-oriented benefits, operational and financial benefits were also met. A centralized vendor was set up, being funded from a single source, resulting in cost savings and economies of scale. Additionally, trophy models were reduced from 20 to 8 and a single e-certificate format was templated for recognizing all the winners.

These results, put together, show the success of the program since its implementation and continued revisions are in place to make sure the success is sustainable. The program acceptance was a reflection of higher employee engagement and thereby spreading a sense of community at the business unit level. Announcement of the awards is now a major highlight for all our 'Town Hall' gatherings.

ACKNOWLEDGEMENTS

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Learning Agility and its Impact on Business and Learning Outcomes

Mrs. Susmita Ghosh[1] and Dr. Ashutosh Muduli[2]
[1]Ph.D. Scholar, School of Petroleum Management,
Pandit Deendayal Petroleum University, Raison, Gandhinagar–382007
[2]Professor, School of Petroleum Management,
Pandit Deendayal Petroleum University, Raison, Gandhinagar–382007
E-mail: [1]susmita.gphd16@spm.pdpu.ac.in/ me.susmita@yahoo.com
[2]ashutosh.muduli@spm.pdpu.ac.in

Abstract—Purpose: This paper aims to study the role of learning agility and its facets on business and learning outcomes. In this paper through empirical study we tried to examine that some facets of learning agility are the key competency of the success and development of any business.

Design/ Research Methodology/ Approach: A group of empirical and expert research articles were reviewed to study and observe the concepts of learning agility and business development and try to explore the relationship and effectiveness on business. In this empirical research paper data and information are collected to examine the effect of learning agility on learning and business outcome.

Findings: Success and development of any business depend on employees learning agility. Again this effectiveness can be enhanced by exploring different facets of learning agility.

Practical Implications: Different employees are enriched with different facets of learning agility in different percentage. If leaders can identify the learning ability and potentiality of the employees and can try to enhance those features and utilize their capability in practical field, then the success and development of the business automatically flourished.

Originality/Value: This research is unique in its attempt to understand the role of employee's agility to learn can enhance the effectiveness of learning business outcome. This study helps us to identify the facets and competency of learning agility; and the effect of learning agility on business outcome, growth & development.

Keywords: Learning Agility, Learning Outcome and Business Outcome

INTRODUCTION

Chamorro-Premuzic says: "Learning agility is critical for today's leaders: if leaders can't learn from experience and acknowledge past mistakes to avoid repeating them, they will become a liability."

Laszlo Bock, former senior Vice President HR of Google says – "We have found that learning agility is the leading predictor of success, number one above intelligence and education!"

During past 18 years, the popularity of the concept "learning agility" has increased extensively throughout the business world.

Gravett and Caldwell in the book "Learning Agility: The Impact on Recruitment And Retention" elucidate another study, published in June 2011, High-Impact Learning Culture: The 40 Best Practices for Creating an Empowered Enterprise, Bersin & Associates shared some interesting statistics. They found that organizations with strong learning cultures are:

- 46% more likely to be strong innovators in their markets.
- 34% more likely to get to market before their competitors.
- 33% more likely to report higher customer satisfaction than other organizations.
- 39% more likely to report success in implementing customer suggestions.
- 58% more likely to be successful at developing the skills needed for meeting future customer demand.

Moreover, seven of the CEOs in that survey said that they have observed a direct correlation between learning agility and these characteristics: critical analysis; problem solving; self-awareness; and ability to deliver results effectively in first-time or challenging circumstances. There was no doubt with this group of leaders that learning agility has a direct and strong impact on their bottom line because of a linkage to problem solving, decision making and customer retention.

A study of IBM research is in the financial, insurance and healthcare industries in the U.S., U.K. and India in 2010 analyzed that leaders and businesses have increased their agility in every field and enjoyed improved business results as a consequence. All those companies have shown a positive correlation between their employees' learning agility and these following:

- Growth in new business
- Cost reductions across the organization
- Innovative solutions that improved brand image
- Expansion of call centre productivity without staff increases

De Meuse &Tang (2008) in their study has used an example of one another study, which found that fully 71% of high performers were not high potentials (Corporate Leadership Council, 2005). Rather, such high performing employees had limited success at the next level due to shortcomings in their ability, aspiration, motivation, or engagement. Amusingly, the same study found that 93% of high potential employees also were high performers.

Therefore learning agility is relevant and critical for business performance and success in the present business scenario. The present study is a modest attempt to fill this void. Thus the present study is exploratory in nature and aimed at finding the influence of learning agility on performance. Also the study intends to find out that how different dimensions of the leaning agility influences different types of performance.

CONCEPTS AND LITERATURE REVIEW ON LEARNING AGILITY AND BUSINESS OUTCOME

Business outcome is a significant concern for leaders, managers and employees, as it allows them to measure the success of any business in terms of reaching up-to their goal. Business outcomes are identified as business commitment, job satisfaction, reactions of stakeholders, organisational citizenship behaviours and satisfaction of overall outcome (Hornibrook *et al.*, 2009). But all these outcomes depend on the strategy of the management and their decisions on various aspects. One most important element is human resource. In this volatile environment if business has to sustain then they have to focus on the learning agile human resource, as learning-agile individuals are distinguished by their willingness and ability to learn from experience. But they also excel at applying that learning to perform successfully in new and challenging situations.

In another way, learning-agile people know the strategy "learned how to learn" from their experiences and made a strong commitment to seek new challenges that allow them to both apply what they have learned and get new lessons for later application. Few people who are learning agile have been explicitly taught the skills that have helped them become that way. Not surprisingly, they have developed these skills on their own and come to recognize these skills and their value as a result of experience. They are more likely to use terms such as "quick study" or "lifelong learner" to describe their abilities than say they are learning agile. Nor can they easily describe the specific behaviours that make up their approach of learning.

In 'High Potential High Learner' Eichinger and Lombardo's (2000) describe; potential involves learning new skills (or honing current skills) in order to perform in new or different situations. In general, high learning agile individuals are motivated to learn and are attracted to ideas and people in order to constantly learn.

In between 2000 and 2018, several claims were made with regard to the importance of learning agility and leadership success. The mass media, blogs, and websites boldly contended that learning agility is a critical success factor in today's global, dynamic business world. Some alleged it was "the most in-demand business skill of the 21st Century" (Delaney, 2013). The president of CCL also stated that "learning agility equals leadership success" (Ryan, 2009). Marketing brochures in talent management consulting firms emphasized that learning agility is the single most important predictor of executive and leadership success.

Drinka (2018) says that the study of learning agility, the ability to quickly physically or mentally reconfigure activities in light of change as new needs arise, suggests that learning agility could be critical to differentiating between average and high potential employees. Another survey ("Potential: Who's Doing What," 2015) revealed that learning agility was the most frequently used principle to measure leadership potential.

According to the World Economic Forum, the most valuable assets for success of any business are human resources and most important traits are learn-ability, the will and capacity to learn. Burke (2017) at Columbia University calls this ability is learning agility and he presents us with nine facets of behaviour which combine into learning agility: flexibility, speed, experimenting, collaborating, information gathering, interpersonal risk taking, performance risk taking, reflecting and feedback seeking.

- ***Flexibility:*** Being open to new ideas and proposing new solutions; solutions that others see as innovative.
- ***Speed:*** Acting on ideas quickly so that those not working are discarded and other possibilities are accelerated; quickly develop solutions to problems.
- ***Experimenting:*** Trying out new behaviours (i.e., approaches, ideas) to determine what is effective, Experiment with unproven ideas by testing them out
- ***Collaborating:*** Finding ways to work with others that generate unique opportunities for learning; Work with colleagues from different backgrounds or job functions to share perspectives. ,
- ***Information Gathering:*** Using various methods to remain current in one's area of expertise; read trade journals, newspaper articles, books, or other sources to stay informed.,
- ***Feedback Seeking:*** Asking others for feedback on one's ideas and overall performance; ask my peers to provide me with feedback on my performance. And
- ***Performance Risk Taking: S***eeking new activities (i.e., tasks, assignments, roles) that provide opportunities to be challenged, Take on new roles or assignments that are challenging.
- ***Interpersonal Risk Taking:*** Discussing differences with others in ways that lead to learning and change; bring up problems and tough issues with others
- ***Reflecting:*** Take time to reflect, seeking to understand why things happen, in addition to what happened. Slowing down to evaluate one's own performance in order to be more effective; stop to reflect on work processes and projects.

LEARNING AGILITY AND BUSINESS OUTCOME: A LINK

According to Collins (2001) the great and successful business gives emphasis on "who" than "what" within the business. The great business leaders understand business is the people. They build capacity within the people who only can work hard and support the business to meet their expected outcome. Not only working hard, business has the requirement of those people who can understand the depth and breadth of the situation fully (Hallenbeck *et al.*, 2016) and give the finest outcome to the business. These individuals also have high agility to inspire others and solve problems in first-time situations (Cashman, 2013) and obviously have a significant impact on outcomes (Korn Ferry, 2016).

Hallenbeck *et al.*, (2016) said whose quality number of experiences are more and who are getting more opportunity to implement those experiences in practical field they are learning agile and these individuals have the potentiality to give support in the business by giving an unexpected outcome. Lombardo & Eichinger (2000), who introduced the term leaning agility, indicated that managers who were rated as highly agile were also labelled as high potential. Dries *et al*. (2012) used the measurement designed by Lombargo and Eichinger (2000) for assessing the relationship between learning agility and high potential and also found that learning agility is a good predictor of potential.

On the basis of existing research De Rue *et al*., (2012) developed a framework to explain the affect of learning agility on performance. Gong *et al*. (2009) perceived when employees are innovative and creative, they increase sales-performance (Drinka, 2018), where innovation, experimentation are major features of learning-agile persons (Burke, 2017). In De Meuse's (2019) meta-analysis, he reviewed 20 field studies and found a relationship between learning agility, potentiality and performances as well as these are the indicators of learning outcome and success and several other outcomes. Some people are more flexible and faster in learning process (DeRue, 2012). Inter-correlations of dimensions are positive and moderate; information gathering and feedback seeking correlated with continuous learning; speed was shown strong correlation with performance outcomes, result oriented outcome (Burke, 2018). Therefore this discussion leads to the following hypothesis:

Hypothesis1 (H1): Learning agility has a significant positive relation with learning outcome.

Hypothesis2 (H2): Learning agility has a significant positive relation with business outcome.

RESEARCH METHODOLOGY

The present study is an exploratory research based on primary data using cross-sectional design.

Sample and Procedures

The target population of this study was employees working in the different private and public sector organizations in India. Data were collected randomly using a standard questionnaire covering variables of interests from a total of 229 employees working at different levels in their organization. Both industrial and service sector organizations were chosen for this study. Demographic data were also taken from respondents. Less than 25 years to more than 55 years of age group employees are the respondents of my study, which consists of male and female in the ratio of 71 and 29 percent (approximately) respectively. All the necessary information regarding the study and ways to respond on questionnaire were shared with all respondents. Respondents were assured of confidentiality of their responses and were told that their responses shall be used for the research purpose only.

Measures

Learning Agility

In this study Burke Learning Agility Inventory instrument is used to measure the employees' learning agility as an independent variable. The instrument is having 38 Questions: 5 questions for Flexibility and Speed both, 4 questions each for other 7 dimensions. Items were assessed on a 5-point Likert scale (1 – Not at all, 3 – Occasionally, 5 – Very Frequently).

Outcome

In this study business outcome was measured through 7-item scale developed by Chand and Katau, (2007). Learning outcome is measured using 4-item measure scale developed by Buckingham and Goodall (2015).

ANALYSIS AND RESULTS

This study aims to explore the influence of learning agility on overall outcome and also different facets of the learning agility on business and learning outcome; correlation and regression analysis were carried out. Correlation was used to see how all the variables of interest were related to each other. Regression analysis was applied to ascertain how explanatory variables influence outcome variables. The data were analyzed with the help of Statistical Package for Social Sciences (SPSS, Version 20). The result in the table below (table 1) shows relationship among variables used in the study. The table reveals that learning agility is positively and significantly related to outcome. The table indicates that some of the dimensions of the Learning agility generate positive outcome among the employees in the business of the study.

Table 1: Mean, SD and Correlation Coefficient among Variables (N=229)

	Mean	SD	FES	INS	PRS	IRT	CLB	EXP	REF	FLX	SPE	LAG	ORP	IND	OUT
FES	14.93	2.990	1												
INS	16.23	2.515	.557**	1											
PRS	15.55	2.846	.380**	.478**	1										
IRT	15.07	2.726	.500**	.497**	.535**	1									
CLB	15.77	2.460	.402**	.436**	.626**	.602**	1								
EXP	15.13	2.922	.442**	.472**	.657**	.567**	.595**	1							
REF	14.91	2.656	.412**	.459**	.532**	.512**	.583**	.649**	1						
FLX	19.12	3.173	.445**	.496**	.598**	.629**	.625**	.761**	.682**	1					
SPE	19.82	3.342	.442**	.464**	.582**	.504**	.544**	.566**	.585**	.631**	1				
LAG	146.52	19.747	.664**	.694**	.778**	.769**	.773**	.828**	.780**	.853**	.780**	1			
BUO	27.48	5.346	.260**	.384**	.241**	.312**	.271**	.348**	.368**	.308**	.261**	.394**	1		
ILO	16.53	2.542	.330**	.470**	.347**	.415**	.416**	.428**	.472**	.447**	.498**	.552**	.670**	1	
OUT	44.00	7.297	.305**	.445**	.297**	.373**	.344**	.404**	.434**	.381**	.365**	.481**	.966**	.839**	1

Sources: Data Analysis
Note: ** Correlation is significant at the 0.01 level (2-tailed).

IRT = Interpersonal Risk Taking
CLB = Collaborating
EXP = Experimenting
FLX = Flexibility
LAG=Learning Agility
BUO=Business Outcome
ILO = Individual Outcome
OUT= Outcome
FES = Feedback seeking
INS = Information gathering
REF = Reflecting
SPE= Speed

LEARNING AGILITY AND OUTCOME

Following table reveals the relationship of Learning agility and Outcome.

Table 2: Overall Outcome as Function of Learning Agility

Independent Variable	Beta	t-value	Sig.	R Square	Adjusted R Square	F	Sig. F Change
LAG	.481	8.272	.000	.232	.228	68.418	.000

Sources: Authors Compilation.

Learning agility is found to be significantly influencing ($\beta = .481$, $t = 8.272$, $p = .000$) the overall outcome. R^2 is .232 which indicates that approximately 23 percent variation is explained in outcome by learning agility. F value found in this model is significant ($F=68.418$, $p = .000$).

In order to know that how much different dimensions of learning agility influences outcome, we need to focus on regression analysis presented in the table below:

Table 3: Outcome as Function of Facets of Learning Agility

Independent Variable Entered	Beta	t-value	Sig.	R Square	R Square Change	Adjusted R Square	F	Sig. F Change
INS	.281	3.717	.000	0.535	.286	.257	9.759	.000

Sources: Authors Compilation.

In predicting outcome only information gathering dimension of learning agility is found to be significantly influencing (β = .281, t = 3.717 p = .000). R^2 is .535 which indicates approximately 53 percent variation can be explained in the outcome by the value of information gathering feature. F value found in this model is significant (F = 9.759, p = .000).

Table 4: Business Outcome as Function of Facets of Learning Agility

Independent Variable Entered	Beta	t-value	Sig.	R Square	R Square Change	Adjusted R Square	F	Sig. F Change
INS	.261	3.280	.001	.459	.211	.179	6.512	.000
REF	.208	2.314	.022					

Sources: Authors Compilation.

Above table (table 4) shows that two values of learning agility (information gathering and reflecting) are explaining the variance in business outcome in significant manner. Here information gathering is regressed on business outcome and is found to be significantly influencing (β = .261, t = 3.280; p = .001). As well as reflecting dimension is also regressed on business outcome (β = .208, t = 2.314; p = .022) and added with information gathering. R^2 is .459 which indicates that approximately 46 percent variation can be explained in the business outcome. F value found in this model is significant (F = 6.512, p = .000).

Table 5: Learning Outcome as Function of Facets of Learning Agility

Independent Variable Entered	Beta	t-value	Sig.	R Square	R Square Change	Adjusted R Square	F	Sig. F Change
INS	.259	3.614	.000	.601	.361	.335	13.757	.000
REF	.161	1.990	.048					

Sources: Authors Compilation.

Table 5 shows that information gathering and reflecting, these two facets of learning agility are explaining the variance of learning outcome in significant manner. Here information gathering is regressed on learning outcome and is found to be significantly influencing (β = .259, t = 3.614; p = .000). Added with information gathering, reflecting dimension is also regressed on learning outcome (β = .161, t = 1.990; p = .048). R^2 is .601 which indicates that approximately 60 percent variation can be explained in the learning outcome. F value found in this model is significant (F = 13.757, p = .000).

DISCUSSION

The present study is an exploratory study aimed at achieving two objectives: firstly, to explore influence of learning agility on overall outcome and secondly, to explore influence of different dimensions of learning agility on two types of outcome. Findings of the study support the assertion that learning agility

influences outcome significantly. It may be possibly that learning agility works as a psychosomatic force that helps in generating individual employee's learning towards their performance as well as motivate them in the direction of overall business outcome. Learning agile employees are adaptable and nimble probably it results in employee's ability in learning from experiences and develops new skills, strategies towards the success of business outcome (Dai, 2013).

The study partially supports that different dimensions of learning agility influence different dimensions of output. Data indicates that learning with information gathering and reflecting dimensions influence employee's learning outcome as well as overall organisational outcome. This may probably be related employees intention or ability to gather different valuable information related to objective and shares that information among other employees, working together in a team and uses that knowledge in solving business problems more efficiently. Positive attitude of employees towards the information gathering and knowledge sharing positively affects the learning outcome of the employees as well as the organisational outcome.

Similarly this study also says that people are reflecting in different situations and in different environment. In this uncertain, volatile environment it is needed for organisation that employees should be flexible and adjustable. This study also proved that flexibility feature of learning agility has a positive correlation with individual outcome as well as organisational outcome.

LIMITATIONS AND FUTURE RESEARCH

The findings of the study have a few limitations. Self-report process was used to evaluate the constructs. It might cause common methods of variance challenges. Another limitation can be the use of employees alone to measure variables could have affected the validity of the responses. Employees might not have been fully aware of some or all of their potentialities; as a result they can't able to use their abilities and might give inaccurate responses. Learning agile employees always enjoy steeper growth than their low learning agile colleagues. Small sample size is another limitation.

Research design is cross-sectional which reflect the picture of specific point of time. Probably longitudinal design will be better to get better picture of the issue. The author recommends undertaking future research factoring above limitations to have better understanding of the relationship and influences of issues taken in the study. Nonetheless, the study shall be treated as valuable because of its empirical assessment of the issues which is relevant in present time and are unexplored.

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Rural Infrastructure Support, Public Service Motivation and Turnover Intention among Health Professionals of Gujarat

Dr. Jallavi Panchamia[1] and Dr. Anamika Sinha[2]
[1]Assistant Professor (Organizational Behavior & HRM),
Indian Institute of Public Health, Gandhinagar, Gujarat, India
[2]Associate Professor (Organizational Behavior & HRM),
Goa Institute of Management, Goa, India
E-mail: [1]jpanchamia@iiphg.org/ jallavi1@gmail.com, [2]anamika@gim.ac.in

Abstract—This study examines the influences of infrastructure support, public service motivation and perceived organizational justice on turnover intention of government medical officers posted in rural region of Gujarat. Based on a survey of 147 government medical officers of rural areas of six districts of Gujarat, the study examines the potential mediating role of public service motivation (PSM) in determining the linkage between infrastructure support (IS) & turnover intention (TI). In order to estimate the path coefficients between the latent variables, Maximum Likelihood (ML) estimation method was used, whereas mediating effect of PSM was analyzed using the procedure suggested by Baron and Kenny (1986). Final research model demonstrated a best fit with GFI of 0.770.

Keywords: Infrastructure Support, Public Service Motivation, Health Professionals

INTRODUCTION

The geographical maldistribution of medical officers towards urban areas is a universal phenomenon and is not unique to the states of India. (Good fellow *et al.,* 2016; Nallala, 2015; Rao, 2013) This skewed pattern has been seen everywhere regardless of the degree of economic development, service demand and health system organization.

In general, rural area relate to poor physical infrastructure, high levels of poverty, geographically hostile environment, low educational opportunities, poor health conditions, and limited access to basic amenities/ services (Kanbur and Venables, 2005). The remote and locational disadvantage hinders the medical professional's further development, family life, career opportunity and capability to earn better. The government salaries are often considered to be insufficient and therefore retaining the medical officer in a rural job is a major HR challenge for the government. This behaviour of medical professionals is not untrue for remote rural areas of Gujarat where multiple challenges make employment unfavourable.

At the same time, since 70% of Indian population lives in rural areas, rural population witness higher number of health issues compared to urban habitation. Scarcity of health professionals in rural area compromises access to timely health care and the quality of services.

This creates a gap in the availability of government medical officers who are needed the most in rural area. Past literature has identified Public service motivation as being able to address the issue of poor infrastructure as a demotivator to choosing to work in rural government job. By understanding the relationship between PSM and Poor infrastructure facilities in predicting the turnover intention of the medical professionals, a unique HR framework can be arrived at which focuses on the core issue. In this paper we study the mediating role of PSM in determining the linkage between IS & TI.

There are various factors impacting the turnover intention, among which public service motivation (PSM) is less studied in context to health sector of Gujarat. According to Bright (2008), PSM has a direct positive impact on the attitudes and behaviours of public employees.

Practitioners are interested in learning the impact that PSM has on the critical human resource issues that they are facing. For example, many public organizations are developing strategies to attract the next generation of employees in the wake of increasing retirements among Baby Boomers. This task has become more difficult as the interest in government employment declines among young adults (Frank and Lewis, 2004). Government must overcome this situation and find individuals who are best suited for public sector work. Failing at this task will increase the costs of low job performance and high turnover. Scholars suggest that PSM can be used as a tool to find individuals who are best suited for public service work (Perry & Wise, 1990). These scholars hypothesize that individuals with high levels of PSM will have significantly higher levels of retention and performance in government organizations when compared with individuals with lower levels of PSM. If this is the case, it would be worthwhile for government to use PSM as a guide for recruiting, training, and socializing employees. This could include identifying the characteristics of individuals with high levels of PSM and selecting these characteristics in job applicants.

India has developed a large healthcare infrastructure for rural health care services and presently, the structure includes subsidiary health centres for population of 3000–5000 people without doctors but manned by AYUSH professional, nurses and paramedical staffs, primary health centres (PHCs) for population of around 30 000 people with one doctor and paramedical staffs, and community health centres (CHCs) for the population of 100 000 people with four specialists (i.e. physician, surgeon, gynaecologist and paediatrician) along with paramedical staff and operating facilities. From CHCs, patients can be referred to better-equipped taluka (subdivision) or district hospitals, which are supposed to have all the facilities required for managing 90% of ailments. Thus, healthcare needs of rural population depend on the availability of these health professionals.

The data collected by the National Rural Health Mission (Ghosh, 2018) indicates that, <10% of PHCs do not have a medical officer. Data also suggest a 30% deficit in medical professionals in CHCs where specialist doctors are usually employed. There are number of reasons which has led to reluctance of medical officer to serve in rural area. One of the primary reasons is lack of infrastructure support in rural area including improper housing and recreational facilities, poor connecting transportation roads, less public transports, lack of better school education facilities and other physical infrastructure required for better living in village.

In spite of all the challenges and adversities, medical officers serve in the rural area. The decision to serve in rural is not only attributed to external motivation such as salary package or other benefits but more over to intrinsic motivation. The intrinsic motivation refers to make a difference in other people's lives, known as 'public service motivation' (Perry, 2008).

Prendergast (2007) have shown that intrinsically motivated health professionals exert more effort and demand fewer extrinsic incentives than self-interested professionals. In developing this line of argumentation, the present study proposes to study the mediating role of prosocial motivation between the relationship of rural infrastructure support and turnover intention of medical officers in rural Gujarat. The objective of the paper is to explain the role of PSM to explain the self-selection of doctors into the rural area of Gujarat (Besley and Ghatak, 2005; Serra *et al.,* 2010).

It has been observed that no study has considered the role of public service motivation in the decision to take up jobs in rural disadvantaged areas. Yet if medical officers care about the benefits they bring to social service beneficiaries (e.g. patients, rural villagers), they might be willing to trade off some of their own welfare against the additional welfare rural recipients derive from having access to health care services (Hu and Liden, 2015).

To understand the relationship among the variables such as PSM, turnover intention and infrastructure support, data would be collected from 147 medical officers of rural area of Gujarat. The scope of the study would be government medical officer serving in rural area.

RESEARCH GAP

As seen in literature review, only handful studies are conducted to understand the role of PSM in public health setting. Issues related to infrastructure support in rural area and impact on PSM have not been addressed in public health setting, especially in the case of Gujarat. Literature have highlighted the influence of extrinsic factors such as financial incentives, location, promotion, infrastructure on attitudes of medical officers in rural area. The proposed study is using the process theory of Public Service Motivation and Social-Exchange perspective in order to highlight the significance of intrinsic motivation to reduce effect of adverse factors on quit intention of doctors in rural area. There seems a valid research gap that can address the following research questions: - Does public service motivation among government medical officers reduce the impact of lack of infrastructure on their quit intention? ; Does higher PSM lead to lower quit intention?

OPERATIONAL DEFINITIONS

Infrastructure Support (IS): It refers to infrastructure with potential to provide basic amenities to improve their quality of life including proper housing and recreational facilities, connecting roads and public transports, better school education facilities and electricity, telecommunication & water supply. (Mbaruku *et al.,* 2014).

Public Service Motivation (PSM) refers to a set of motives that drive an individual to engage in behaviors that benefit society (Perry; 1997)

The Turnover intention: It refers to the willfulness to quit the present job (Mobley *et al.,* 1978).

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Public Service Motivation has received much attention from public administration researchers in the last two decades (Perry, Hondeghem, and Wise 2010; Gould-Williams *et al.,* 2013; Shim *et al.*;2015). PSM was first defined by Perry and Wise (1990, 368) as "an individual predisposition to respond to motives grounded primarily or uniquely in public institutions." Based on this definition, Perry (1996) developed a measurement scale comprising four dimensions that form the basis of our study: attraction to public policy formation, commitment to civic duty and public interest, compassion, and self-sacrifice. Recently, Vandenabeele (2007, 547) suggested an "overarching" definition of the concept. He defines PSM as "the beliefs, values and attitudes that go beyond self-interest and organizational interest, that concern the interest of a larger political entity and that motivate individuals to act accordingly." Thus, PSM can be viewed as a value or attitude that motivates individuals to engage in behaviours that benefit society.

According to Perry and Wise (1990), an individual's Public service motivation may be attributed to a combination of rational, affective and norm-based motives (Perry and Wise; 1990). The *rational motives* are explained by choices/decisions made by an individual based on an assessment of the gains and losses that may result from choosing among a number of alternative actions. *Normative motives* are based on social values and norms of what is appropriate. Whereas, *affective motives* refer to the emotions and willingness to help others (Perry and Wise, 1990). Individuals with high affective motives direct their efforts towards the needs of others before fulfilling their personal needs.

According to the concept given by Perry (1997), Public service motivation has been characterized by four dimensions, including Commitment to public interest, attraction to public-policy formation, compassion, and self-sacrifice. Attraction to public-policy measures rational motives, while commitment to civic duty and public interest measures normative motives, and both compassion and self-sacrifice measure affective motives (Perry, 2000). However, when measuring PSM, still controversy exists (Vandenabeele, 2008; Wright, Christensen and Pandey, 2013). The dimensions of attraction to public-policy making and self-sacrifice were found to be highly correlated which suggests redundancy (Vandenabeele, 2008; Wright and Pandey, 2008). Furthermore, there is a conceptual similarity and overlap between the dimensions of compassion and self-sacrifice (Moynihan and Pandey, 2007a). As a result of this controversy, when measuring PSM, some researchers have combined or omitted one or more of these 4 dimensions (e.g. Moynihan and Pandey, 2007; Leisink, and Steijn, 2009; Gould-Williams *et al.,* 2013), while others have attempted to develop additional dimensions beyond these 4 such as democratic governance (Vandenabeele, 2008). In the current study, the focus will be on the 4 dimensions developed by Perry so as to shed light on their applicability to the Indian rural context.

If government sector organizations provide opportunities to satisfy their employee's altruistic motives, then those employees with high PSM are more likely to identify themselves with their organization. In turn, they will develop a strong emotional attachment to their organization, be more willing to work towards the achievement of its goals and less likely to quit. Very few studies have tested the relationship between PSM and employee turnover intentions (Bright, 2008; Park and Rainey, 2008; Gould-Williams *et al.,* 2013). These studies indicate that PSM is negatively related to employee quit intentions.

Based on the process theory of public service motivation, it is argued that medical officers with high PSM may expected to have lower level of turnover intention because they tend to choose government job and are more likely to endure the obstacles and stresses that generally come with government job (Lewis and Frank, 2002; Shim *et al.,* 2017), that too in rural region. Several studies have examined the association between PSM and turnover intention but have found the associations to be moderate or insignificant (Bright, 2008; Kim and Lee, 2007). In light of this, the current study will examine how PSM can reduce the employees' turnover intention.

HENCE

***Hypothesis H1*:** Public service motivation is significantly and negatively related to Turnover Intention.

Rural region generally characterised by low level of infrastructure support including mainly

poor physical infrastructure, high levels of poverty, geographic hostile environment, low educational opportunities, poor health conditions, and limited access to basic amenities/ services (Kanbur and Venables, 2005). As suggested by Maslow's hierarchy of needs, infrastructure need comes as basic need which should be fulfilled for higher level of motivation. Upon failure to meet these needs, individual is likely to intend to leave the job,

HENCE, IT IS HYPOTHESIZED

***Hypothesis H2*:** Infrastructure support is significantly and negatively related to Turnover Intention.

Past studies have argued that poor infrastructure support and work place amenities are related to lower motivation among employees (Noorizan *et al.,* 2016; Vian *et al.*, 2015). It has been studied that government setups with low resources and basic facilities perform poor compare to private healthcare setups with proper infrastructure facilities in place (Vian *et al.*; 2015). As found by Briner (2000), the quality of the employees' workplace environment impacts on their level of motivation subsequently

performance. Work environment can be thought of simply as the environment in which people work (Briner, 2000). Hardly any studies have reported relationship between IS and PSM in past. Although few researchers have studied the influence of working conditions on PSM (Camilleri, 2007; Moynihan and Pandey, 2007), particularly infrastructure factors were not included. Findings of the studies reported significant relationship between working condition related factors and PSM.

Hence, it has been Hypothesized

***Hypothesis H3*:** Infrastructure support is significantly and positively related to PSM.

Further, based on the social exchange theory, we argue that PSM mediate the relationship between SI and TI of employees. As per the 'norm of reciprocity' (Gouldner, 1960), if employees see favorable infrastructure support given by organization by all means, they might feel obligated to repay the organization by continuing their participation (Shore and Wayne, 1993). It is inferred that if infrastructure support is weak, officer's turnover intention will be high, but if their PSM is high enough, it will mediate the relationship between IS and IT in such a way that officer will not intend to leave even after low IS.

Hence

***Hypothesis H4*:** PSM mediates the relationship between Infrastructure support and turnover intention, such that under condition of high PSM, the association between IS and TI would be weaker.

DATA AND METHODOLOGY

The cross-sectional descriptive study undertook the data collection from medical officers posted in Primary Health Centres (PHC) and Community Health Centres (CHC) of rural province of six districts of Gujarat, namely, Gandhinagar, Ahmedabad, Anand, Surendranagar, Sabarkantha and Bharuch. As per the NHSRC (National Health system Resource Centre) data, total 570 medical officers are posted in these districts, from which our sample would be around 147 officers from rural area.

Measures

Based on the three motives (rational, normative and affective) Perry (1996) developed a scale of 35 items to measure Public service motivation. Perry (1997) later reduced the scale to 24 items, reducing it to four PSM dimensions or four subscales: attraction to public service, commitment to public interest, compassion, and self-sacrifice (Perry, 1997). Rational motive was measured by dimension of attraction to public-service, normative motive by commitment to public interest values, while affective value was measured by both compassion and self-sacrifice (Perry, 2000). The scale was used after contextualization to health sector. Total 16 statements were used to measured total four dimensions of PSM. Sample items included 'I think equal access to provision of health care services for common public is very important.' The alpha reliability for the 16-item scale was 0.78. Infrastructure support was measured using basic scale developed by Mbaruku *et al.* (2014). Few more items were added considering the context of health sector in Gujarat. Total 7 items were used to measure the construct and the sample item included 'there is adequate frequency of public transport available near health care center'. The alpha reliability for scale was 0.77. Turnover Intention was measured by only three items scale developed by Mobley *et al.* (1979). It was to measure the intention of employee to leave the organization. The sample items included 'If I may choose again, I will choose to work for the current organization'. The alpha reliability for scale was 0.86. All the items were measured on a seven-point Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (7). As recommended by Nunnally (1978), all scales met the criterion of reliability coefficient of .0.7. Along with Cronbach's alpha, composite reliability was also used to measure internal

consistency (refer table1). In order to address the issue common method variance, Harman's one-factor (or single-factor) test (Podsakoff *et al.,* 2003) was used.

Data analysis was conducted using the AMOS (Analysis of Moment Structures) version 19.0 program to test the proposed relationships among the study variables. The current study was based on recursive path model. Before analyzing the structural model, the fit of a confirmatory factor analytic model to the observed data was estimated to determine if the observed items loaded on their respective scales.

RESULTS AND FINDINGS

Final sample of 147 government medical officers posted in rural area of Gujarat was an adequate representation across different age, experience, and regions. Attention was given to check the multivariate normality of the data due to the sensitivity of SEM on the distributional characteristics of the data (Hair *et al.,* 2010). The respondents for the present study were medical officers. 169 MRs responded the questionnaire, from which 147 questionnaire were used for analysis. Sample represent 74 % male and 26% female respondents. It was observed that rural area of various districts, i.e. 22 % Gandhinagar, 27 % Ahmedabad, 12 % Anand, 17 % Surendranagar, 13% Sabarkantha and 9 % Bharuch region's respondents were in sample. Average tenure of 9.23 years was observed. Data were collected with non-probability sampling method.

DESCRIPTIVE STATISTICS AND CORRELATION

Data were checked for reliability. Mean, standard deviations, internal reliability and correlations are reported in Table 1. All reliability measures showed high internal consistency ranging from 0.74 to 0.87. The pattern of inter correlations was consistent with the hypothesized relationships. Turnover intention showed significant negative correlation with Infrastructure support and PSM. This result was in support with the findings received by Bright (2008).

Table 1: Descriptive and Correlation Analysis

Variable	Reliability	Mean (SD)	IS	PSM
IS	0.771	4.48(1.41)		
PSM	0.789	5.90(1.70)	0.51*	
TI	0.866	4.14(0.96)	-0.33*	-0.48*

*Correlation is significant at the 0.01 level (2-tailed).

Where, SD depicts Standard Deviation, SI = Infrastructure support, PSM = Public service motivation, TI = Turnover Intention.

Data analysis was conducted using the AMOS (Analysis of Moment Structures) to test the proposed relationships among the study variables. The measurement model follows confirmatory factor analysis which tests the construct validity of the model by representing how well the indicators reflected their intended constructs/ latent variables. All latent variables are allowed to co-vary in the measurement model. The structural model specifies the hypothesized causal relationship among latent variables. In order to estimate the path coefficients between the latent variables, Maximum Likelihood (ML) estimation method was used.

ASSESSMENT OF MEASUREMENT MODEL

The convergent validity of the measurement models of the constructs was assessed by examining the standardized regression coefficient (loading) between the indicator and their constructs. The loadings

estimate ranged from 0.56 to 0.71 PSM, and 0.40 to 0.73 for Infrastructure support, and 0.70 to 0.87 for turnover intention.

Since one of the 1st order variable 'Compassion' showed insignificant loading (loading estimate = 0.08) on the second order variable PSM, it was dropped in subsequent specification of measurement model. In order to improve the value of χ^2 in subsequent model, model was modified by adding two covariance between the error terms of IS6 and IS7 and IS2 & IS3. The results of the confirmatory factor analysis indicated an average model fit by most indices (i.e. $\chi 2 = 602.084$, $p = 0.00$, GFI = 0.764, AGFI = 0.715, CFI = 0.734, RMSEA = 0.062).

In the second stage of the analysis, structural model was tested for the plausibility of the derivational relationship among the latent variables. In this step, each latent variable of the model was regressed on the other latent variable to reveal causal or explanatory relationship, or precedence of its existence (Byrne, 2010). The values of fit indices were acceptable for structural model such as GFI (Goodness of fit index) = 0.768, AGFI (Adjusted GFI) to 0.720 and CFI (Comparative fit index) to 0.740.

The structural model specifies the hypothesized causal relationship among latent variables. In order to estimate the path coefficients between the latent variables, Maximum Likelihood (ML) estimation method was used. Table 2 shows the values of path coefficients.

Table 2: Hypothesis Testing using Path Coefficient

Hypothesis	Path Coefficient	P Value	Remarks
H1: PSM→ TI	-0.40	0.00	Supported
H2: IS →TI	-0.09	0.079	Not Supported
H3: IS →PSM	0.44	0.00	Supported

MEDIATION OF PUBLIC SERVICE MOTIVATION

To test the mediating effect of PSM as proposed in hypothesisH4, procedure suggested by Baron and Kenny (1986) was followed.

According to the mediation conditions given by Kenny, PSM proves to be a mediator between SI and turnover intention. It is shown in the table 3 that the path coefficient value (for path IS →TI) becomes insignificant in the free model, which previously was significant ($\beta = 0.46$, $p < 0.01$) for constrain model. The results confirmed that free model has a better fit and higher GFI value compared to constrained model. Therefore, hypotheses H4 has been partially accepted.

Table 3: Mediation Test of Perceived Organizational Support

Causal Path	Path Coefficient	Model Statistics
H4: PSM as a Mediator	-0.39*	Chi-square = 647.89 GFI = 0.759
IS →TI when PSM →TI constrained		
IS →TI when PSM →TI opened	-0.10	Chi-square = 602.08 GFI = 0.768

*Significant at p< 0.05

Based on the findings from the statistical results, revised research model of the study was constructed. This model redirects a relationship between IS & turnover intention and treats PSM as mediator. A graphic representation of the final structural model, which includes the standardized path coefficients, is displayed in the Figure 1.

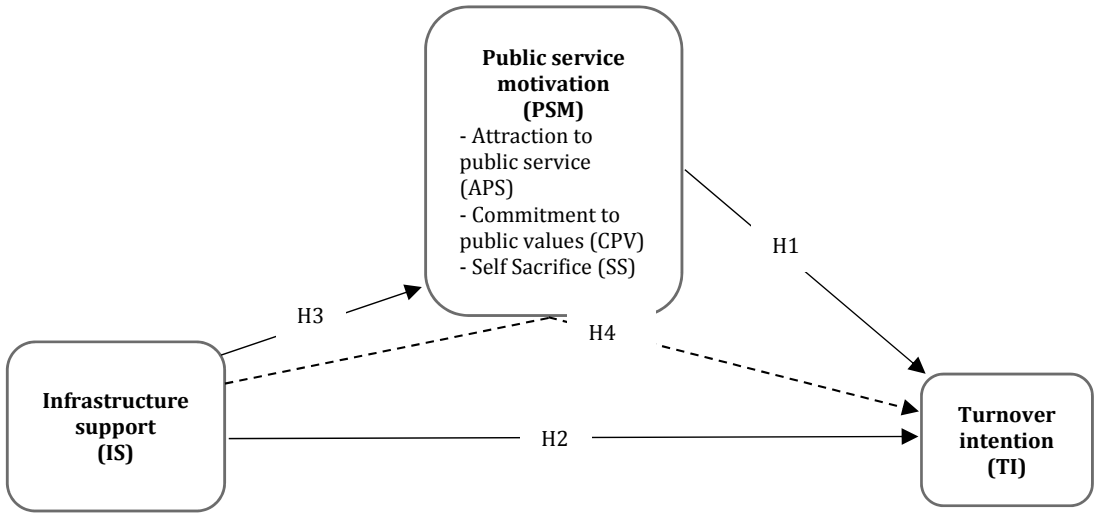

Fig. 1: Research Framework

Final research model with the acceptable model fit was constructed after removal of one variable Compassion from PSM. Final research model demonstrated a best fit with GFI of 0.770. As per the result of Hypothesis two, the IS does not directly influence turnover intention of Government medical officer of Gujarat. Although, IS affect the TI through PSM as a mediator. It was found from the results of the study that infrastructure support's adverse or unfavorable effect on turnover intention was reduced through the mediation of PSM.

CONCLUSION

The proposed study was based on the process theory of Public Service Motivation and Social-Exchange perspective in order to understand the relationship between PSM, IS and TI among government medical officers posted in rural Gujarat.

The acceptance of the first hypothesis (PSM →TI) of the study indicates that medical officers with higher public service motivation display somewhat lower quit intention, although relationship was found to be moderately significant. This finding was consistent with other studies (Bright,2008; Mathieson, 1991). The significant results suggest that a positive and strong motives of public service motivation will lead to higher intention to remain in the job. Descriptive statistics indicates that APS (Attraction to public service) scores highest mean value of 6.42 in comparison to SS (Self-sacrifice with mean value = 5.10). This means medical officers carry higher rational motive compare to affective motive of their motivation.

According to few of the past studies, positive effects of PSM on turnover intention are contingent on the degree of congruence between employees' values and those of the organization (Bright 2008; Kim 2012; Wright and Pandey 2008).

The second hypothesis (IS→TI) was not supported with the fact that medical officer's quit intention does not depend on/relate to infrastructure support received at their work place. In consistent with the results received by Hsiao and Lin (2018), external factors such as working condition does not show significant relationship with turnover intention. A reason for insignificant role of IS in predicting turnover

intention might be the causes responsible for attrition among medical officers, which are not related to infrastructure support.

Consistent with the social exchange theory, medical officer who perceived the higher infrastructure support, they tend to show higher PSM (β = 0.44). Although, relationship between IS and PSM was not strong, but moderately significant.

PRACTICAL AND THEORETICAL IMPLICATIONS

The findings highlight the significance of intrinsic motivation to reduce effect of adverse factors on quit intention of doctors in rural area. The study will be an important input for the process of policy making in government system regarding the recruitment, transfer and placement.

The results explain the inter- relationships among constructs of the current study and gives interesting insight into the possible antecedents of turnover intention, which contributes to existing body of literature. Therefore, the present study fulfils the gap of existing research in relevant field. It was found from the results of the study that infrastructure support's adverse or unfavorable effect on turnover intention was reduced through the mediation of PSM in rural medical officers of Gujarat. Moreover, the findings related to Public service motivation among medical officers will provide a foundation to other research scholars, since there was a dearth of studies in the area of public service motivation with health setting context and its relation to other constructs.

RECOMMENDATIONS FOR FUTURE RESEARCH

Several recommendations for future research have been offered based on the results of this study. The present study serves as a foundation for further studies on antecedents of turnover intention. Hence, further research is required that explores the potential predictors.

The present study was an attempt to analyze the PSM by evaluating four dimensions covering three motives (Perry, 1997), though there can be some other dimensions which may constitute the motivation. Further studies can be carried out to measure and study the other types of motivation which remained unmeasured here. Also, the nature of industry can be varied to improve the generalization of the results (Panchamia & Pestonjee, 2015).

Lastly, although the study focused on turnover intention among medical officers, it does not examine the actual turnover of medical officers of Government health sector. It would be interesting to study the actual turnover of medical officers in order to develop a more comprehensive model of the turnover intention process.

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Skill Development Initiatives in Rural Areas of Gujarat: Challenges in Policy Implementation

Dr. Yogesh C. Joshi[1], Dr. Darshana Dave[2] and Brijesh M. Patel[3]
[1]Dean, Faculty of Management, Director and Professor,
G.H. Patel Postgraduate Institute of Business Management,
Sardar Patel University Vallabh Vidyanagar, Anand, Gujarat
[2]Professor, G.H. Patel Postgraduate Institute of Business Management,
Sardar Patel University Vallabh Vidyanagar, Anand, Gujarat
[3]Research Associate, G.H. Patel Postgraduate Institute of Business Management,
Sardar Patel University Vallabh Vidyanagar, Anand, Gujarat
E-mail: [1]joshiyogesh_2000@yahoo.com., [2]davedarshana@rediffmail.com, [3]patelbmpatelbm@gmail.com

Abstract—Introduction: Continuous skill development for up - gradation of manpower is a pre-condition for economic development of any nation. Skill development of people in rural as well as urban areas is imperative for continued and sustained development of any nation. In India as well skill development has been emphasised since beginning of planning era. The present government again reemphasised its importance with initiation of skill India programme during 2015, with objective of ensuring faster economic development and creation of skilled work force in nation.

The state of Gujarat is one of the leading states in the country from view point of economic development. In Gujarat state also skill development efforts are being undertaken through initiating many programmes and schemes. Besides these, many ministries of government and institutions are working for skill development among people. The present paper draws from two separate research studies undertaken by authors in the state of Gujarat. First study is 'Study of skills and capability development among youth in rural areas of Gujarat' funded by Rajiv Gandhi National Institute of Youth Development, Sriperambdur, Tamil Nadu and 'Post project evaluation of Sansad Adarsh Gram Yojana in Gujarat and Rajasthan' sponsored by Ministry of Rural Development, Government of India, New Delhi. Both these studies were conducted during years of 2018 and 2019.

The paper discusses present status and challenges faced in improving skill development among youth in rural areas of Gujarat. The results are further supplemented and corroborated with skill development efforts at grassroots level in selected Gram Panchayats (GPs) based on primary data and observations. In the first study sample constituted of two set of respondents, first, youth in villages and second, students undergoing skill development training in selected industrial training institutes i.e. ITIs in the state of Gujarat. Further, based on above mentioned two research studies, the paper highlights and analyses role of selected government institutions engaged in skill development efforts in Gujarat. The policy implications are also suggested in the end.

The results indicate that youth in rural areas lack not only skills but also awareness on various skill development efforts of government. The awareness of government programmes and skill development among students of ITIs is also found to be limited. It is found that some institutions engaged in skill development in rural area are doing well but their efforts at present are at very small scale and hence needs to be up-scaled to make a real impact through skill development among people in rural areas to contribute to development of country.

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A Qualitative Study of Corporate Environmental Citizenship: An Ethical Approach towards Environmental Sustainability

Shreya Sharma
M.B.A. Student,
School of Petroleum Management,
Pandit Deenadayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: shreya.spgp19@spm.pdpu.ac.in

Abstract—The purpose of this paper is to contribute an international perspective to corporate social responsibility (CSR) and sustainability discussions by examining CSR/ Sustainable reporting practices of the 200 largest state-owned and private companies in India.

Corporate Environmental Citizenship has become a buzz word in today's competitive world as it redefines the relationship of individuals with the nature and narrates the responsibilities of individuals towards nature. Smarter we use environmental resources and better systems we create for further distribution. One way to contribute more and even distribution of the resources is to be more aware of what we buy and how it is produced. The business houses are dealing a great part with this system of production and distribution. So the corporation need to keep in mind the concept of equitable share and equitable responsibility. This is where the concept of Environmental Ethics arises which relates to our obligations and responsibilities towards nature. Environmental Ethics guides the corporation to bring the appropriate approach of employees towards Environmental Sustainability. Considering the aspects of Environmental Ethics "environmental Citizenship" has become a new phenomenon and important requirement of 21th century. Corporate Environmental citizenship (CEC) includes the exercise of environmental rights and duties of the corporations as well as the identification of the underlying structural causes of environmental degradation and environmental problems. Thus the paper focuses on how corporations are developing a sense of rightness and wrongness and acting responsibly and positively towards the environment while contributing to a just society.

Accumulated empirical evidence, some telling criticisms, and even the most cursory glance at the business press compel us to rethink the defining character of organizational citizenship behavior (OCB). It no longer seems fruitful to regard OCB as extra-role, beyond the job, or unrewarded by the formal system. A more tenable position is one that defines OCB much along the lines of what Borman and Motowidlo (1993) called contextual performance. Some preliminary suggestions are offered for the repositioning and articulation of the OCB construct as redefined; due attention is given to the problems that nonetheless remain, and will occupy us for some time to come as we reckon with root changes in the very character of organizations.

Keywords: Environmental Citizenship, Sustainability, Ethics

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Child Labour and Human Rights Violations in Oil and Gas Industry

Bharvi Amitbhai Shah
M.B.A. Student,
School of Petroleum Management,
Pandeet Deendayal Petroleum University,
Gandhinagar, Gujarat, India
E-mail: bharvi.spgp19@spm.pdpu.ac.in

Abstract—Oil and Gas Industry by its nature, generally operates in disadvantageous areas in the world. And that encourages illegal employment of child labour. Places where such industry operates generally do not have any restrictions as no one is to know and ask about it's activity. That encourages easy human right violation and child labour engagements.

Increase in partnerships between international and national oil companies: The 2013 Review of Resource Economics states that 90 per cent of global oil reserves and 73 per cent of production are controlled by national oil companies (state-owned enterprises). 10 National oil companies are increasingly partnering with international companies for a variety of reasons, including: States have competing priorities to balance against resource exploitation and may not be able to afford or justify it. States are accountable to their populations and therefore less able to risk government funds on exploration activities that may not come to fruition. Partnering with international companies allows them to manage the risk. States may not have the technical expertise to extract resources, and geopolitical issues may restrict peer-to-peer learning on resource extraction between companies. Joint ventures, however, may expose international oil companies to potential association with human rights violations committed by a government. Such human right violations along with child as a labour is a matter of worry and must be taken into light to abolish such practices.

In 2012, UNICEF, the United Nations Global Compact and Save the Children released the Children's Rights and Business Principles (the Principles), which built upon the United Nations Guiding Principles on Business and Human Rights as well as the Convention on the Rights of the Child and relevant International Labour Organization Conventions. The Principles offer comprehensive guidance to companies on the range of actions they can take to respect and support children's rights, prevent and address the risks to children from their activities, and maximize positive business impact in the workplace, marketplace and community.

In a study conducted by UNICEF, an almost total lack of knowledge of the impacts of the oil and gas sector on children's rights was stated as challenges in the study process. Study findings indicated that there is currently no agenda on the impacts of the oil and gas sector on children, and very little understanding or articulation of how the sector specifically impacts children as stakeholders distinct from the family or community. Therefor my study focuses on reflection of a child's right, human rights and impact on oil and gas industry. Though very less data is available regarding the exact numbers and situation of the labours in the industry, a basic study can be a seed to encourage further growth of study and improvement in this topic.

Keywords: Oil and Gas Industry, Child Labour, Human Rights

Pradhan Mantri Ujjwala Yojana (PMUY): Rural Transformations and Women Development in India

Dr. Sanjay Kumar Pradhan
Assistant Professor,
Social Sciences, School of Liberal Studies
E-mail: sanjay.pradhan@sls.pdpu.ac.in

Abstract—The Pradhan Mantri Ujjwala Yojana (PMUY) is a socio-economic and rural transformative approach and flagship programme of the Union government for welfare and development of the rural women and rural transformations in India. It is a step towards social security in the form of reduction of indoor air pollution and risks, ensuring of clean fuel, removal of the hardships faced by women, and extend LPG access, even to the remotest parts of the country. The scheme was launched on 1 May 2016 with the intention of distributing 50 million LPG connections to the women of the BPL families in the initial years of the launch of programme. In 2016, the connections were distributed to 22 million against the target of 15 million, 30 million in 2017 and 58 million by December 2018, and for the financial year 2018–2019 the target was set to include 80 million poor households- who were basically from the rural areas. Significantly, of the total beneficiaries, 44 percent were from the families belonging to the SCs and STs. To popularise the programme, the government has made awareness campaign for the use of natural gas for household purpose. As a consequence, the scheme has led to a growing use LPG by 56% between the period 2014 and 2018. Yet, the scheme faced some challenges in meeting the objectives and real benefit of the women. Still, women and the households are not ready to quit wooden stoves completely. While the access to the LPG gas stoves and cylinders has increased in the scheme, in reality, the use of LPG remains low and thus there has been a growing gap in costumer-consumption pattern. Information gaps relating to the government facilities and advantages not yet reached to the stake holders completely. The long waiting time and sparse LPG distribution centres raises the issue of inadequacy of energy infrastructure and facilities. Further, the price of gas cylinders is not affordable for rural, far-flung and poor women, even if there is a subsidy.

Looking into all these aspects, the paper will highlight and discuss the advantages and achievements of PMUY for rural transformation and women development, challenges in the execution of policy, and suggestions for making the scheme a grand success.

Keywords: Women, Rural, Poverty, Development, Challenges

SECTION–VII

ACCOUNTING AND FINANCIAL MANAGEMENT

Relationship between Foreign Direct Investment in Infrastructure and Economic Growth: Evidences from Indian Economy

Dr. Pravin Jadhav[1], Dinabandhu Singh[2] and Dr. Parashram Patil[3]
[1]Assistant Professor of Economics,
Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad
[2]Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad
[3]Advisor, APEADA, Ministry of Commerce and Industry, Govt.of India

Abstract—This study explores the relationship between foreign direct investment (FDI) in Infrastructure and the economic growth in India for a period of thirteen years (2006-2019). It also inspects the infrastructure development in India along with its worldwide comparison and attempts to assess the effects of FDI on infrastructure and economic growth. The data utilized in this study has been collected from several sources such as Reserve Bank of India, Department of Industrial Policy and Promotion, World Bank, Global Competitiveness Report for evaluating the impact of FDI in infrastructure and economic growth of India.

Overall data indicate that there exists a wide inter-sectoral variation in India for FDI inflows in Infrastructure. The inflows in FDI is highly skewed towards construction growth and telecommunication but several areas like a harbour, energy, airport expansion, and highways are unable to allure much FDI. Hence, it is essential for the government to make policy reforms leading to allure more FDI in aforesaid sectors. The findings from the FDI and economic growth indicate that FDI plays a significant role in the financial development of India.

The comprehensive outcomes explain that infrastructure development in India is not satisfactory; therefore, the government needs to adopt proactive policies to allure more FDI in India.

Keywords: FDI, Infrastructure, Policy, India

JEL Classification Numbers: F21, F23

INTRODUCTION

Infrastructure is one of the pillars of economic development of a nation. A good infrastructure not only escalates the production and but also cuts the comprehensive cost of production. It is evident that accessibility of best quality physical infrastructure can also increase the investment atmosphere by financing the expense of whole investment and in this manner raising the pace of return. In a nutshell, the attributes of physical infrastructure plays a significant role in choosing the area of investment by overseas venture capitalist specifically for efficient-quest development. Likewise, public infrastructure concerning edification and healthiness-allied services participate considerably to the social investment creation and subsequently impact the FDI inflows through different components. From one perspective, vigorous and sophisticated personnel improves the efficiency of the system. At the same time, the absence of wellbeing and edification services may increase wellbeing-allied budgets when the overseas venture capitalists wish to create or expressively sponsor the edification and healthiness-allied services to their workforces. Such expanding expenses of edification and healthiness-allied services are probably going to influence venture capitalists to return antagonistically. (Chatterjee *et al.,* 2013)

Infrastructure is a key constituent while evaluating a nation's territorial advancement. With regards to advancement in the infrastructure segment, the Government of India has consistently been dynamic. Being the fastest developing country with several states, India has constantly accorded greater significance to the infrastructure division and gotten extensive consideration from the legislature along with the private venture capitalists. An enormous spotlight has consistently been accorded on accomplishing allied ventures by means of Public-Private Partnerships (PPPs), financial impetuses, tariff schemes,

fiscal shares, and cooperation of privately owned businesses. Indian infrastructure segment mostly incorporates the improvement of streets, air terminals, transporting and ports that have significantly supported the Indian economy in the course of the most recent years. However, India is not able to create significant development in Infrastructure sector.

As indicated by India Brand Equity Foundation, for endurable growth in the nation, India requires venture worth Rs 50 trillion (US$ 777.73 billion) in infrastructure by 2022. As India's present domestic finance availability is low, the role of FDI in Infrastructure growth becomes imperative as there is a deficiency of capital with the Indian government.

In this context, the present paper attempts to analyses trend, and the role of FDI in infrastructure and economic growth. The main purpose of the paper is to find out the effect of FDI inflows in infrastructure on economic growth. For that, the panel data techniques have been employed. The remainder of the paper is structured as follow. The coming section assesses the theoretical and experimental writings on FDI and economic growth, followed by Infrastructure development in India with its overall assessment and trends of FDI inflows to Indian Infrastructure. This will be followed by a discussion on the data and methodology applied to find the effect of FDI on infrastructure and economic growth. The outcomes have been discussed in the subsequent section followed by conclusion and policy implication at the end.

LITERATURE REVIEW

The noteworthiness of FDI in the financial growth of a nation is very much perceived. FDI inflows conquer any hindrance between the anticipated and the real value of investment, mostly when native venture is not efficient to drive the real investment standard as far as the anticipated value (Hayami, 2001; Noorbakhsh *et al.,* 2001). The existed works of literature experimentally explore the progressive rapport between FDI and economic growth. FDI attracts non-dues making investment flows as well as moves the innovation, produces work openings in the recipient country. It has benefited through the back and forth associations inside the economy of the recipient country by Greenfield capital (Alfaro and Rodriguez-Clare 2004; NCAER 2009; Javorcik 2004; Ho and Rashid 2011). The policymakers believe that the FDI boosts the economy of recipient states by encouraging contest in the marketplace. (Caves, 1974).

Moreover, FDI likewise attracts enhanced innovation (in tangible and intangible form) and the executive's traineeship to the recipient nation leading to progressively focused economy through collateral impacts. Furthermore, it can likewise substitute global business and fence the menaces of revelation to overseas trade. It has been witnessed that the FDI inflows in the field of natural gas lead to successive developments in the productivity of Central Asian countries and their terms and conditions of business made them happier nation (Barry, 2009). In the same way, FDI inflows seem to have a noteworthy progressive influence on trade operation of Turkey (Vural and Zortuk, 2011). Several investigations (e.g., Rozas and Vadlamannati, 2009; Quazi, 2007; Moosa and Cardak, 2006; Banga, 2003; Kumar, 2002; Noorbakhsh, Paloni and Youssef, 2001; Chen, 1996; Wheeler and Mody, 1992 etc.) discover infrastructure as a significant element of FDI inflows.

A few reviews found a frail connection between FDI inflows and infrastructure. For instance, Chakravorty (2003) discovers limited noteworthiness of infrastructure in deciding the area or amount of innovative trade venture, while Kirkpatrick, Parker and Zhang (2006) and Pradhan (2008) discover the adverse effect of the trade on FDI inflows. As per a panel set up by the Planning Commission of India in 2012, till 2017, India needed a trillion US dollars or nearly 10 percent of India's GDP to be used upon infrastructure. Considering the nation's constrained civic investments and reviewing the infrastructure gap, India needs solid support in terms of local and overseas venture capitalists under the public-private partnership (PPP) model. FDI is a prime source of investment that speeds up the infrastructure growth by attracting non-dues investment flows, up-to-date innovation, and finest organizational traineeship in India. FDI inflows in infrastructure division in India will improve the overall infrastructure excellence causing sustainable development and economic growth.

Several empirical studies on determinants of FDI found that market size, relative production cost, government FDI policy, openness of the country, relative labour cost, inflation rate, exchange rate, political and institutional quality are important determinants of FDI. It is anticipated that greater market size has a positive effect on FDI (Asiedu 2006; Cleeve 2008; Dunning 1988; Mohamed and Sidiropoulos 2010). The size of the marketplace has been extensively recognized as an element of FDI inflows in a majority of the experimental works of literature. Most of the studies used real GDP or GNP per capita to explore the size of the marketplace or income in the state. (Schneier & Matei 2010; Bhavan *et al.,* 2011; Lv et.al 2010; Leitao 2010; Hailu 2010). Several works of literature on FDI used the stake of business in GDP as a substitute for openness (Cleeve 2008; Mhlanga *et al.,* 2010; Bhavan *et al.,* 2011; Leitao 2010). The progressive connection among FDI and the size of the business infers that nations that desire to pull in more FDI should build the exchange. The existing works of literature say that the exchange openness is absolutely linked to the FDI in recipient nation however the effect of openness on FDI relies upon the situation of investment i.e. export-directed or market search. (Cleeve 2008; Mhlanga *et al.,* 2010).

As indicated by the "tariff jumping" theory, less open economy with business constraints can positively affect FDI (market search). Export-directed MNC's want to situate to a progressively open economy since business assurance usually countries greater transportation rate related to trading. A greater compensation relates to an inferior status of FDI. Greater compensation replicates extra fabrication rate thus it prompts less aggressive MNCs both at overseas and home markets. A few researches have demonstrated that wasteful establishments as accessed by bribery, political variability, and pathetic implementation of agreements discourage overseas investment (Wei 2000; Asiedu 2006).

TRENDS OF FDI INFLOW IN INDIAN INFRASTRUCTURE

In 1991, the considerable rise in FDI inflows to India forwarded the influence of liberalization in the Indian economy in addition to steady opening up of the capital account. As a component of the capital account liberalization, FDI was continuously permitted in practically all segments, barring a few significant sectors of national importance, under the principles and guidelines of RBI. Amid the last worldwide slowdown in the years of 2009-10, when there was a noteworthy decrement in worldwide FDI flows, the FDI flows declination to India was comparatively moderate. It was due to the strong equity flows on the rear of solid bounce-back in local development before worldwide salvage and sturdy recapitalised incomes (just about 25 percent of share) replicating enhanced productivity of overseas firms in India. FDI inflow in the infrastructure section in India is expanding yet not according to the prerequisite of the nation. In India, the Infrastructure segment in 2018 perceived private sector's share and project funds worth US$ 1.97 billion. An investment of US$ 200 million into the National Investment & Infrastructure Fund (NIIF) has been declared by the Asian Infrastructure Investment Bank (AIIB) in June 2018. In 2017, 91 M & A contracts of US$ 5.4 billion was observed by Indian infrastructure segment (IBEF, 2019). Table 1 depicts the year wise inflow of FDI in major infrastructure sectors in India.

Table 1: Year-wise FDI Inflows in Major Infrastructure Sectors in India

Year	Telecommunication	Construction	Power	PNG	Air Transport	PORT	Railway Related Component	Total FDI
2007	43.5	60.6	10.2	13.9	4.4	0.0	0.3	132.9
2008	116.0	113.5	54.6	56.4	2.1	56.5	0.9	400.0
2009	123.7	159.7	75.6	18.2	0.9	3.4	1.3	382.8
2010	69.1	72.4	48.7	27.1	6.2	0.5	2.6	226.6
2011	104.9	95.0	78.4	99.9	1.5	0.0	2.7	382.4
2012	4.3	127.2	39.1	12.0	1.0	0.0	1.3	184.9

Table 1 (Contd.)...

...Table 1 (Contd.)

Year	Telecommunication	Construction	Power	PNG	Air Transport	PORT	Railway Related Component	Total FDI
2013	17.7	69.2	33.8	6.9	2.5	0.0	9.5	139.6
2014	234.6	61.8	66.8	61.5	4.5	0.1	12.9	442.2
2015	83.4	10.6	50.1	7.9	3.2	0.0	4.6	159.8
2016	389.7	7.1	79.3	7.8	26.9	0.0	5.6	516.4
2017	394.3	25.0	99.3	8.1	38.4	0.0	7.0	572.1
2018	162.1	15.6	82.1	8.4	14.9	0.0	3.0	286.1
2019[1]	319.6	14.9	20.0	1.3	5.8	0.0	2.5	364.2
Total	2062.9	832.6	738.0	329.4	112.4	60.5	54.2	

Source: FDI statistics, Department of Industrial Policy and Promotion

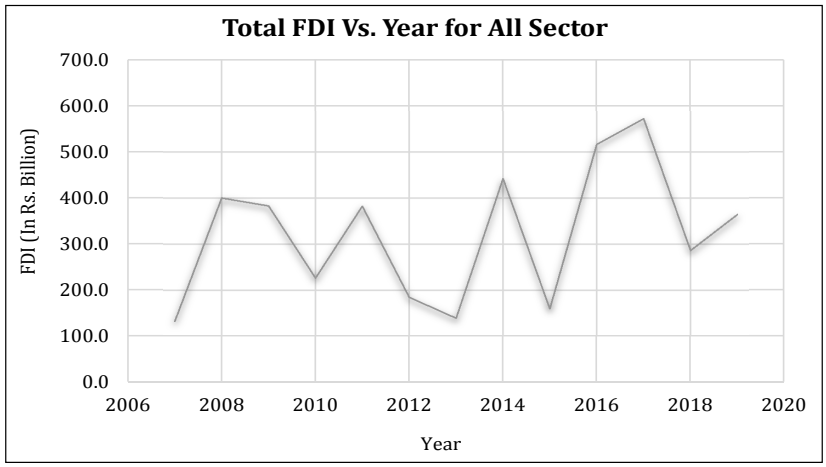

Fig. 1: Year-wise Total FDI Inflows in Indian Infrastructure

Figure 1 illustrates the total FDI inflows in Indian infrastructure segment from 2007 to June 2019. Overall FDI inflows show an increasing trend with fluctuations in the year 2010 2015, 2018. These years there was a significant decline in the FDI inflows due to the global financial crisis.

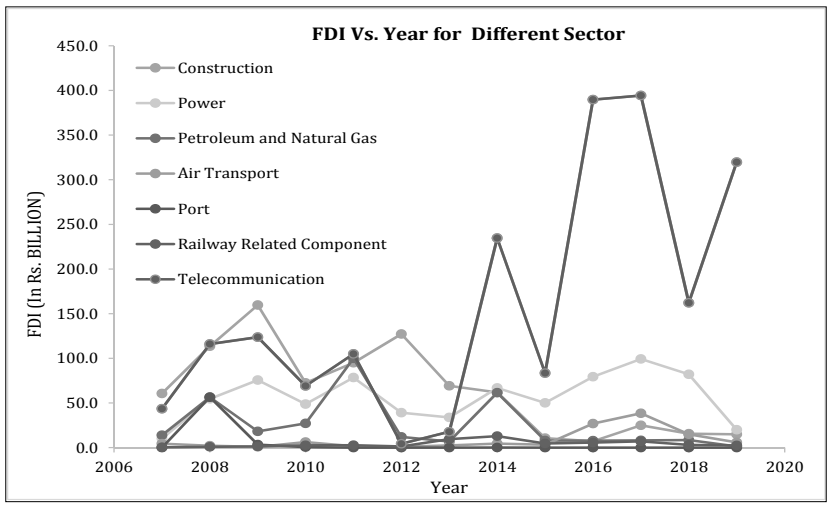

Fig. 2: Year-wise FDI Inflows in Major Infrastructure Sectors in India

[1]2019 data is from January to June

Year-wise FDI inflows in major infrastructure sectors in India is depicted in figure 2, which reveals that the telecommunication sector is up-surging most of the FDI is among main infrastructure sectors in recent years with a total inflow of ₹ 2062.9 million from 2007 to June 2019. Telecommunication sector is followed by construction and power. In 2008-09 construction sector was ranking first in FDI inflows but in recent years there is a downfall in the FDI inflows. Port sector is unable to attract FDI inflows in India because Adani infrastructure has most of the stake in the port sector and Indian Government manages other ports. In India, FDI inflows in the infrastructure segment are typically lured by telecommunications and construction growth divisions whereas the divisions like harbour, energy, air terminal expansion, and transportations are unable to fascinate many FDI inflows. Consequently, there is a need to commence policy reforms by the government of India to allure higher FDI inflows in such segments.

GOVERNMENT INITIATIVES TO ENCOURAGE FOREIGN INVESTMENT IN INDIA

Since 1990, a noteworthy amendment has been observed in India's way to tackle overseas venture with essential monetary changes enveloping practically every one of the segments of the economy. At present, the government of India permits 100% FDI in almost all infrastructure segments. Government has permitted 100 percent FDI in several construction growth sectors such as housings, townships, and built-up infrastructure. As for energy segment, the government of India has permitted 100 percent FDI with involuntary route for infrastructure improvement in the segment. Beneath automatic route, 100% FDI for private sectors has been allowed by the Government of India in several fields of infrastructure such as flammable gas pipelines, oil-based goods, and oil refining. Public Sector Undertaking (PSU) oil refining firms have a provision of 49 percent FDI under Government route. On the other hand, attenuation or transfer of inland shares is presently permitted in prevailing PSUs. For establishing modern industrial and commercial parks, the government of India has allowed 100 percent FDI beneath an automatic route. In recent times, the Indian government has permitted 100% FDI in Indian Railways beneath an automatic route for constructing, operating and maintaining the specific tasks.

METHODOLOGY AND DATA

Model Specification and Estimation

To evaluate the impact of FDI inflows in Indian Infrastructure on Economic growth, the following panel data model is specified:

$$Y_{it} = \alpha_{it} + \sum_{k=1}^{k} X_{kit} + u_{it}$$

Where,

Y= Growth (Real GDP)

X= FDI inflows in major infrastructure sectors

i=1,2….N (refers to cross-sectional units)

t= 1,2….T (refers to a given time period)

Thus, Y_{it} representing the Growth rate of India economy in terms of real GDP for the segment *i* at the time period *t*. X_{kit} refers to FDI inflows in major infrastructure sectors for the segment *i* at time *t*. The exploration commences with estimating pooled regression model supposing that there is no substantial country or chronological impacts then this work assesses fixed effects model (FEM) and the random-effects model (REM) to regulate segment-specific and chronological impacts if any. This work implements F test, LM test and Hausman test to select the suitable model.

Consequently, the equation is expected as:

$$Growth_{i,t} = \alpha + Xt + \varepsilon_{i,t}$$

Data: The data utilized for sector-level study are yearly FDI data with interpretations from 2006 to 2019 for 7 essential areas of Infrastructure, The investigation emphases on 7 essential areas of Infrastructure, responsible for the most of FDI inflows in Infrastructure. Data on FDI inflows broken down into telecommunication, construction, power, port, air transport, sea transport and railways are collected from Department of Industrial Policy and Promotion. The dependent variable in the specifications is the real GDP of India and independent variables are FDI inflows in major infrastructure sectors.

RESULTS

The selection of suitable model specifies the dominance of a panel model on pooled model affirmed by LM test and F test. Hausman test demonstrates a Fixed Effect model to be generally proficient when contrasted with the Random Effect model. Consequently, the fiscal analysis of the outcomes depends on the Fixed Effect model as it were. Table 2 delineates the independent variable and their related coefficient along with their association to the dependent variable.

Table 2: Empirical Results of Proposed Mode

Dependent Variable: D(GDP)

DAte: 11/30/19 Time: 23:28
Sample (adjusted): 2008 2019
Periods included: 12
Cross-setions included: 7
Total panel (balanced) observation: 84

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FDI)	31.40197	17.13306	1.832829	0.0705
C	8418.617	1065.947	7.897781	0.0000
R-squared	0.039354	Mean dependent var		8505.081
Adjusted R-squared	0.027639	S.D. dependent var		9897.735
S.E. of regression	9759.994	Akaike info criterion		21.23349
Sum squared resid	7.81E+09	Schwarz criterion		21.29137
Log likelihood	-889.8067	Hannan-Quinn criter		21.25676
F-statistic	3.359262	Durbin-Watson stat		2.266247
Prob(F-statistic)	0.070457			

Table 2 depicts the results attained from the Fixed Effect model. It was observed that the regression model gives 4 percent (R2) of variation in Indian GDP. The F-statistic is 3.35, and the probability of the F-statistic is 0.7, which displays that the outcomes are statically noteworthy and the null hypothesis of the independent variables having no impact on Indian GDP is dismissed.

The result further indicates growth of India economy is increased by 31% with 1% increment in FDI in Indian infrastructure.

CONCLUSION AND POLICY IMPLICATION

The accessibility of appropriate infrastructure facilities is important for the speeding up of fiscal growth of a nation. Henceforth, governments take interest to invest in several fields of infrastructure namely railroads, streets, energy, media communications, harbours, air terminals, water supply, healthcare, sewage, edification, training, and empowerment to upsurge their excellence.

In India, FDI inflows in infrastructure are typically allured by construction and telecommunications fields yet divisions like harbour, energy, air terminal advancement and streets are unable to allure more FDI. The fields that are drawing in more FDI don't require street or railroad-related infrastructure. Rather, overseas venture in telecommunication brings about extension and improvement of correspondence infrastructure. Consequently, the government requires attempting policy reforms to pull in more FDI in aforesaid sectors. The outcomes from FDI and economic growth demonstrates that FDI assumes a significant job in fiscal development of India.

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A Comparative Analysis of Financial Health of Public Sector Banks in India

Karishma R. Shah
Assistant Professor,
Swami Veevekanand College of Commerce and Arts, Palitana
M.K. Bhavnagar University, Bhavnagar, Gujarat, India
E-mail: kiya2005in@gmail.com

Abstract—A healthy financial system depends upon healthy banking system. Public Sector Bank needs to occupy a sound, prudent, safe and secured financial health. This research focused on comparison of financial health of SBI Group of Banks and other PSBs in India. Financial reforms increased the competition among PSBs thus, it is necessary to compare the performance of PSBs in India. The financial health can be better measured by different profitability and management efficiency Ratio. An analysis of changes of various ratios over time reveals changes in bank policies and strategies and/or in its business environment. The researcher tried to do Ratio analysis of selected SBI Group of Banks and Other Public Sector Banks. The SBI group bank did very good with four (4) ratios (Viz. Interest Income to Total Funds ratio, Non-Interest Income to Total Funds ratio, Profit before Provisions to Total Fund**s** ratio, Net Profit to Total Funds ratio) and the non SBI group bank did well with one (1) ratios (Viz. Interest Expended to Total Funds ratio). It means the SBI group bank performed outstanding compared to the non SBI group bank. The study also shows phenomenal development and changes in the selected public sector banks during the study period. Profit is main factor for the stable life of every business institute. And good financial health is depended on high profitability and management efficiency. The result of the study disclose that Ratio of Interest Income to Total Funds, Ratio of Interest Expended to Total Funds and Non-Interest Income to Total Funds differs significantly for the SBI group bank and other the non SBI group bank. The SBI group bank performed outstanding due to increased volume of business, high operational efficiency, high profit and increase non-fund based business compared to the non SBI group bank. So the study reveals that non SBI group bank has to improve financial health to survive in today's competitive environment.

Keywords: Bank's Performance, Financial Health, Profitability, Public Sector Banks in India, Ratio Analysis

INTRODUCTION

Development of any economy is depending upon healthy financial system, which needs healthy banking system. In a globalizing environment the challenges faced by financial institutions are multiple. The crises and challenges are sluggish world economy, slowdown in industrial growth and the domestic economy has also been experiencing slowdown with decreasing GDP growth rate. Indian Banking Industry is facing deregulated competition. There is a lot of competitive pressure on Banks Viz. competition regarding pricing, product and services and also in term of proliferation of innovation, specialized markets, cross selling etc. And due to all these factors, Public Sector Banks are experiencing competition from Private Sectors Banks, Foreign Banks, Co-operative Banks, RRBs and NBFC (Non Banking Financial Companies). Due to all above mention reasons, financial health of Public sector banks does not shows stable and healthy growth. Public Sector Bank needs to occupy a sound, prudent, safe and secured financial health.

SIGNIFICANCE OF THE STUDY

The Public sector banks are the backbone of the any country's economy by contributing directly to the GDP, channelizing investments and mobilizing savings. Public Sector Banks are still leading the entire banking sector. Market Share of Public Sector Banks was 77.9 % in 2011, which was highest compare to other Banks[1]. After the LPG in 1991 the challenges faced by Public Sector Banks are multiple Viz. rising of non-performing assets, Implementation of BASEL III norms and the world wide revolution in information

[1]Banking August 2012 Report by IBEF.

& communication technology forced Public sector banks to update in all aspects of technology based product. Thus, the competition among Banks has been going up more. And this is not limited to the Public Sector V/s Private Sector, but it is among Public Sector Banks too. All these factors has badly affected on the financial health of Public Sector Banks in India. So it is need of hour to do a comparison of Public Sector Banks.

Thus, actual financial health of bank can justify the real scene of bank. Profitability indicates earning capacity of the banks and which shows financial health of Bank. Profitability is the most important and reliable indicator as it gives a broad indication of the ability of a bank to raise its income level. And to analysed financial health of bank, ratio analysis can be used. This study is focused on a financial health of PSB in India with respect to comparison of SBI Group of Banks and other Public Sector Banks having operation in India during the study period from 2011–12 to 2015–16.

LITERATURE REVIEW

Jayanta Kumar Nandi (2012) has examined the performance of the selected banks for the period 2001–02 to 2010–11. The study shows that new private sector banks performed well as compared to selected public sector banks and old private sector banks from the bankers' point of view, but from the social point of view public sector banks are found the better performers as compared to others. The study recommended that though there is a magnificent development in both Public and Private sector banks in India after the banking sector reforms yet the public sector banks are still lagging behind. It may be advised that the PSBs in India should be more efficient in their overall asset management policy, employee performance, cost control and should have more customer-friendly banking operations to keep pace with the challenging performance of the private sector banks in India as well as to compete with the global players.

Dr. Aurag B. Singh and Ms. Priyanka Tandon (November 2012), reviewed a financial performance of 2 major banks SBI and ICICI. The study has been carried out the financial data for the five years 2007–08 to 2011–12. The various important ratios, credit/deposit ratio, interest expenses/total expenses, interest income/total income, other income/total income, net profit margin etc. are taken for the study. The study shows that peoples were preferred to avail loan from SBI and to invest their savings in ICICI and the growth in net profit in SBI is much higher than ICICI it reveals that SBI has managed their resources very efficiently. The conclusion of the study is that peoples prefer to avail their banking facility with the public sector banks compared to private sector banks.

Vader Suresh (2011) has selected 1211 NBFC based on their share trading investment, loan finance and asset finance. The review has been carried out for the profitability angles by analyzing income and expenditure data for the year 2007–08 and 2008–09. The comparative analysis reveals that the expenditure growth is higher than income growth and therefore the profit has been declined. The researcher has analyzed the performance by evaluating the financial data and the profitability ratios Viz. Return on equity, return on assets, operating profit margin, dividend rate, etc. The main conclusion is that the share capital, share trading and investment holding and loan finance have been decreasing while the investment in total uses of fund has been increased.

RESEARCH GAP

From the literature review it was found that no study has been conducted from the period 2011–12 to 2015–16 in context of the cited title. Further if there is any difference, the researcher tries to identify the difference with respect to particular ratios between SBI Group of Bank and Non SBI Group of Bank.

RESEARCH METHODOLOGY

Objective of the Study

The Primary objective was to examine, compare and analyze the Financial Health of the SBI group of Banks and other selected Public Sector Banks in India.

Universe of the Study

It consists of all SBI Group of Banks (6) and Public Sector Banks (19) operating in India during the study period.

Selection of Bank

The researcher has considered selected eight public sector banks in two groups.

1. **SBI Group of Banks** (Viz. SBI, SBM, SBT, SBBJ)
2. **Other Public Sector Banks** (Viz. BOB, BOI, Canara Bank, PNB)

The selected banks have an average market capitalization of 5 billion rupees or more during the last six months (prior to FY: 2011–12).

Research Technique

The study focused on profitability and management efficiency Ratios to justify the objectives of the research work. The ratios used in the study are **Interest Income - Total Funds Ratio, Non-Interest Income- Total Funds Ratio, Interest Expended- Total Funds Ratio, Profit before Provisions -Total Funds Ratio and Net Profit -Total funds Ratio.**

Further the hypotheses were developed and proven with the help of **T- Statistic**. The study tries to prove whether there is a significant difference in the performance of the banks as depicted by the profitability and management efficiency ratios for the period of 2011–12 to 2015–16. The study was dependent on the secondary data collected from annual reports of sample banks.

DATA ANALYSIS AND INTERPRETATION

The below mentioned tables shows the average value (in %), SD of average and CV of selected profitability and management efficiency ratio of the SBI group bank and the non SBI group bank with difference in it during the study period.

Comparative Analysis of Interest Income/Total Funds (%) with T-Statistics

Table 1 and Chart 1 shows the Mean of Interest Income to Total Funds Ratio of the SBI group bank is 8.84 % and that for the non-SBI group bank is 7.74 %. Average mean difference valued at 1.09 % among these groups. The SD of the SBI group bank is valued at 0.20 %, whereas SD of the non SBI group bank is valued at 0.41 %. Thus, the SD value shows that the non SBI group bank has more variability than the SBI group bank. CV of the SBI group bank is 2.29 % and the non SBI group bank is 5.28 %, therefore, CV of the non SBI group bank has more variance than the SBI group bank.

Difference of average Interest Income to Total Funds ratio of the SBI group bank and the non SBI group bank was highest at 1.34 % in the years 2014–15 and in 2015–16 and lowest at 0.68 % in the year 2011–12.

Table 1: Average of Interest Income to Total Funds Ratio of Selected Group Bank

Year	SBI Group Bank	Non SBI Group Bank	Difference
2011–12	8.84	8.16	0.68
2012–13	9.07	8.10	0.97
2013–14	8.93	7.77	1.16
2014–15	8.86	7.52	1.34
2015–16	8.52	7.18	1.34
Mean	8.84	7.746	1.09
SD	0.20	0.41	
CV (%)	2.29	5.28	

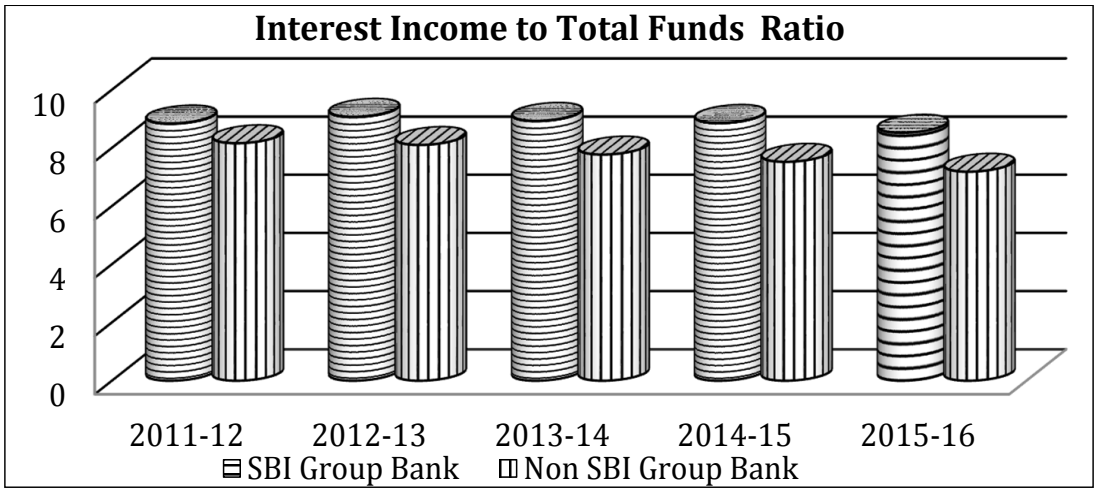

Chart 1: Average of Interest Income to Total Funds Ratio of Selected Group Bank

Hypothesis Testing of Interest Income to Total Funds Ratio

H_0: There is no significant difference between the mean of Interest Income to Total Funds Ratio for the SBI group bank and the non SBI group bank.

H_1: There is a significant difference between the mean of Interest Income to Total Funds Ratio for the SBI group bank and the non SBI group bank.

Table 2 shows the Mean of Interest Income to Total Funds Ratio of the SBI group bank is 8.844 % and that for the non-SBI group banks are 7.746 % and their corresponding variances are 0.04 and 0.17 respectively. As it is known that lesser the variance betters the consistency. Thus, the SBI group is more consistent in the case of this particular ratio. At the 5% level of significance and 8 degrees of freedom the calculated value of t-Statistic is 5.38 which is Significant. Therefore the null hypothesis is to be rejected. This implies that **the mean of Interest Income to Total Funds Ratio for the SBI group bank and the non SBI group bank differs significantly from each other.**

Comparative Analysis of Non-Interest Income/Total Funds (%) with T-Statistics

Table 3 and Chart 2 shows the Mean of Non-Interest Income to Total Funds Ratio of the SBI group bank is 0.982 % and that for the non-SBI group bank is 0.842 %. Average mean difference valued at 0.14 % among these groups. The SD of the SBI group bank is valued at 0.07 %, whereas SD of the non SBI group bank is valued at 0.03 %. Thus, the SD value shows that the SBI group bank have more variability than the non SBI group bank. CV of the SBI group bank is 7.60 % and the non SBI group bank is 4.15 % therefore, CV of the SBI group bank has more variance than the non SBI group bank.

Difference of average Non-Interest Income to Total Funds ratio of the SBI group bank and the non SBI group bank was highest at 0.27 % in the year 2015–16 and lowest at 0.04 % in the year 2011–12.

Table 2: T-Statistics with Respect to Ratio of Interest Income to Total Funds

Ratio of Interest Income to Total Funds	SBI Group Bank	Non SBI Group Bank
Mean	8.84	7.74
Variance	0.04	0.17
Observations	5.00	5.00
df	8.00	
t Stat	5.38	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.86	
P(T<=t) two-tail	0.00	
t Critical two-tail	2.31	

Source: SPSS output

Table 3: Average of Non-Interest Income to Total Funds Ratio of Selected Group Bank

Year	SBI Group Bank	Non SBI Group Bank	Difference
2011–12	0.94	0.90	0.04
2012–13	0.92	0.84	0.08
2013–14	0.93	0.84	0.09
2014–15	1.03	0.81	0.22
2015–16	1.09	0.82	0.27
Mean	0.98	0.84	0.14
SD	0.07	0.03	
CV (%)	7.60	4.15	

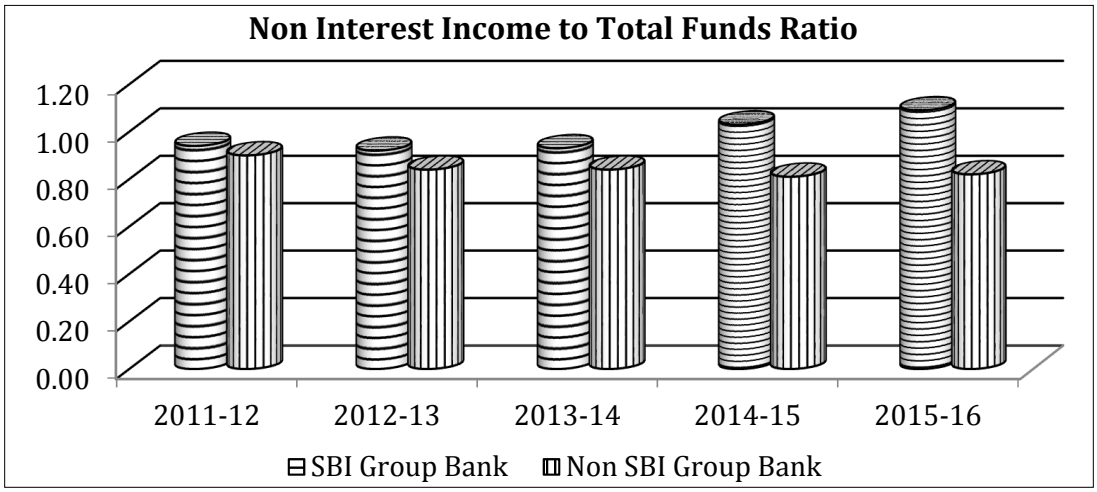

Chart 2: Average of Non-Interest Income to Total Funds Ratio of Selected Group Bank

Hypothesis Testing of Non-Interest Income to Total Funds Ratio

H_0: There is no significant difference between the mean of Non-Interest Income to Total Funds Ratio for the SBI group bank and the non SBI group bank.

H_1: There is a significant difference between the mean of Non-Interest Income to Total Funds Ratio for the SBI group bank and the non SBI group bank.

Table 4 shows the Mean of Non-Interest Income to Total Funds Ratio of the SBI group bank is 0.982 % and that for the non-SBI group bank is 0.842 % and their corresponding variances are 0.01 and 0.00 respectively. At the 5% level of significance and 8 degrees of freedom the calculated value of t-Statistic is 3.80 which is significant. Therefore the null hypothesis is to be rejected. This implies that **the mean of Non-Interest Income to Total Funds Ratio for the SBI group bank and the non SBI group bank differ significantly from each other.**

Table 4: T-Statistics with Respect to Ratio of Non-Interest Income to Total Funds

Ratio of Non-Interest Income to Total Funds	SBI Group Bank	Non SBI Group Bank
Mean	0.98	0.84
Variance	0.01	0.00
Observations	5.00	5.00
df	8.00	
t Stat	3.80	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.86	
P(T<=t) two-tail	0.01	
t Critical two-tail	2.31	

Source: SPSS output

Comparative Analysis of Interest Expended/Total Funds (%) with T-Statistics

Table 5 and Chart 3 shows the Mean of Interest Expended to Total Funds Ratio of the SBI group bank is 6.052 % and that for the non-SBI group bank is 5.466 %. Average mean difference valued at 0.59 % among these groups. The SD of the SBI group is valued at 0.16 %, whereas SD of the non SBI group bank is valued at 0.19 %. Thus, the SD value shows that the non SBI group bank has more variability than the SBI group bank. CV of the SBI group bank is 2.62 % and the non SBI group bank is 3.50 % therefore, CV of the non SBI group bank has more variance than the SBI group bank.

Difference of average Interest Expended to Total Funds ratio of the SBI group bank and the non SBI group bank was highest at 0.78 % in the year 2014–15 and lowest at 0.29 % in the year 2011–12.

Table 5: Average of Interest Expended to Total Funds Ratio of Selected Group Bank

Year	SBI Group Bank	Non SBI Group Bank	Difference
2011–12	5.89	5.60	0.29
2012–13	6.20	5.69	0.51
2013–14	6.14	5.46	0.68
2014–15	6.16	5.38	0.78
2015–16	5.87	5.20	0.67
Mean	6.05	5.47	0.59
SD	0.16	0.19	
CV (%)	2.62	3.50	

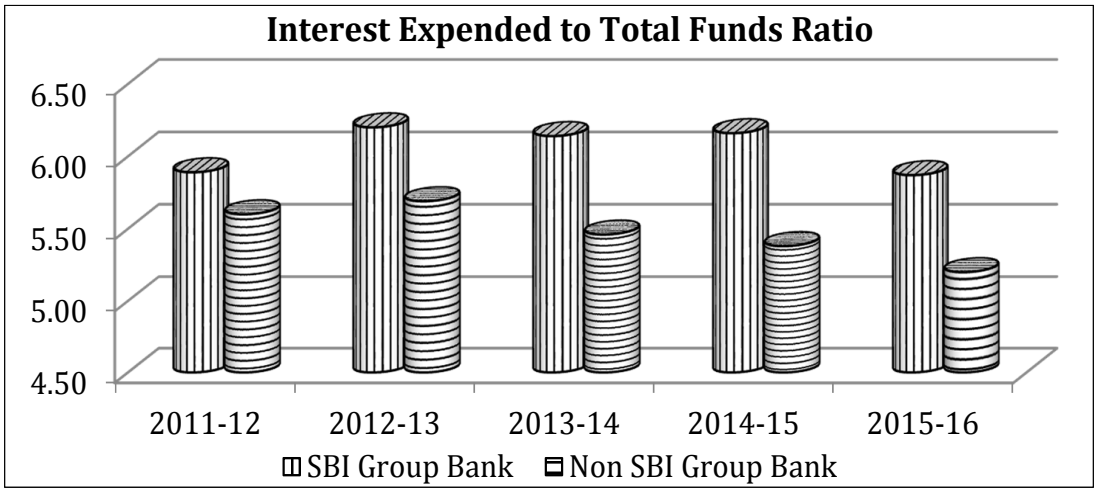

Chart 3: Average of Interest Expended to Total Funds Ratio of Selected Group Bank

Hypothesis Testing of Interest Expended to Total Funds Ratio

H_0: There is no significant difference between the mean of Interest Expended to Total Funds Ratio for the SBI group bank and the non SBI group bank.

H_1: There is a significant difference between the mean of Interest Expended to Total Funds Ratio for the SBI group bank and the non SBI group bank.

Table 6 shows the Mean of Interest Expended to Total Funds Ratio of the SBI group bank is 6.052 % and that for the non-SBI group bank is 5.466 % and their corresponding variances are 0.03 and 0.04 respectively. At the 5% level of significance and 8 degrees of freedom the calculated value of t-Statistic is 5.27 which is Significant. Therefore the null hypothesis is to be rejected. This implies that **the mean of Interest Expended to Total Funds Ratio for the SBI group bank and the non SBI group bank differs significantly from each other.**

Table 6: T-test Statistics with Respect to the Ratio of Interest Expended to Total Funds

Ratio of Interest Expended to Total Funds	SBI Group Bank	Non SBI Group Bank
Mean	6.05	5.47
Variance	0.03	0.04
Observations	5.00	5.00
df	8.00	
t Stat	5.27	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.86	
P(T<=t) two-tail	0.00	
t Critical two-tail	2.31	

Source: SPSS output

Comparative Analysis of Profit before Provisions/Total Funds (%) with T- Statistics

The below mentioned table and chart shows the average value (in %) of Profit before Provisions to Total Funds ratio of the SBI group bank and the non SBI group bank with difference in it during 2011–12 to 2015–16. And this table also reveals the Mean, the SD of average and CV during this tenure.

Table 7 and Chart 4 shows the Mean of Profit before Provisions to Total Funds Ratio of the SBI group bank is 1.872 % and that for the non-SBI group bank is 1.708 %. Average mean difference valued at 0.16 % among these groups. The SD of the SBI group bank is valued at 0.13 %, whereas SD of the non SBI group bank is valued at 0.27 %. Thus, the SD value shows that the non SBI group bank has more variability than the SBI group bank. CV of the SBI group bank is 7.03 % and the non SBI group bank is 15.67 % therefore, CV of the non SBI group bank has more variance than the SBI group bank.

Difference of average Profit before Provisions to Total Funds ratio of the SBI group bank and the non SBI group bank was highest at 0.47 % in the year 2015–16 and lowest at 0.01 % in year 2011–12.

Table 7: Average of Profit before Provisions to Total Funds Ratio of Selected Group Bank

Year	SBI Group Bank	Non SBI Group Bank	Difference
2011–12	2.04	2.05	–0.01
2012–13	1.96	1.86	0.10
2013–14	1.70	1.73	–0.03
2014–15	1.82	1.53	0.29
2015–16	1.84	1.37	0.47
Mean	1.87	1.71	0.16
SD	0.13	0.27	
CV (%)	7.03	15.67	

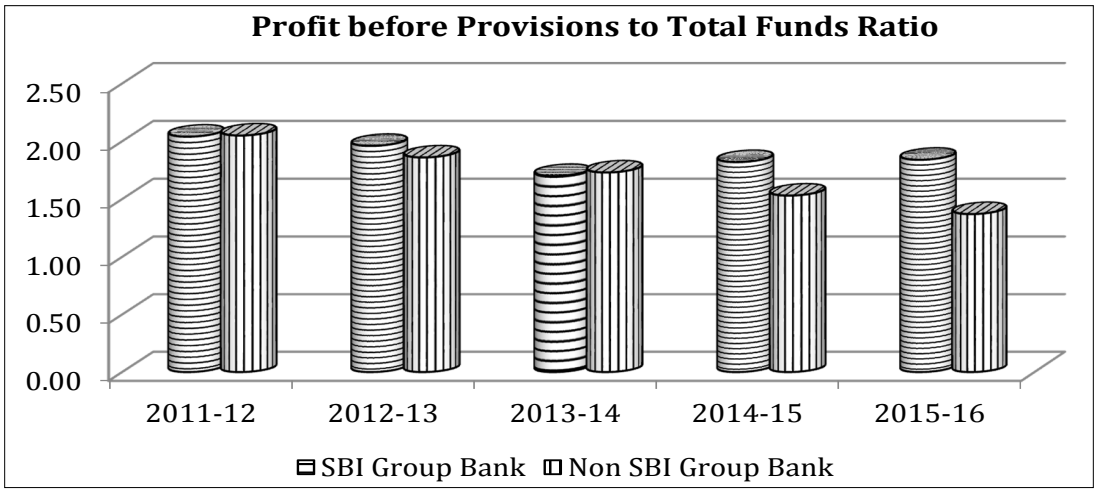

Chart 4: Average of Profit before Provisions to Total Funds Ratio of Selected Group Bank

Hypothesis Testing of Profit before Provisions to Total Funds Ratio

H_0: There is no significant difference between the mean of Profit before Provisions to Total Funds Ratio for the SBI group bank and the non SBI group bank.

H_1: There is a significant difference between the mean of Profit before Provisions to Total Funds Ratio for the SBI group bank and the non SBI group bank.

Table 8 shows the Mean of Profit before Provisions to Total Funds Ratio of the SBI group bank is 1.872 % and that for the non-SBI group bank is 1.708 % and their corresponding variances are 0.02 and 0.07 respectively. As it is known that lesser the variance betters the consistency. Thus the SBI group is more consistent in the case of this particular ratio. At the 5% level of significance and 8 degrees of freedom the calculated value of t-Statistic is 1.23 which is insignificant. Therefore the null hypothesis is to be accepted. This implies that **the mean of Profit before Provisions to Total Funds Ratio for the SBI group bank and the non SBI group bank does not differ significantly from each other.**

Table 8: T-Statistics with Respect to Ratio of Profit before Provisions to Total Funds

Ratio of Profit before Provisions to Total Funds	SBI Group Bank	Non SBI Group Bank
Mean	1.87	1.71
Variance	0.02	0.07
Observations	5.00	5.00
df	8.00	
t Stat	1.23	
P(T<=t) one-tail	0.13	
t Critical one-tail	1.86	
P(T<=t) two-tail	0.25	
t Critical two-tail	2.31	

Source: SPSS output

Comparative Analysis of Net Profit/Total Funds (%) with T-Statistics

Table 9 and Chart 5 shows the Mean of Net Profit to Total Funds Ratio of the SBI group bank is 0.642 % and that for the non-SBI group bank is 0.44 %. Average mean difference valued at 0.20 % among these groups. The SD of the SBI group is valued at 0.15 %, whereas SD of the non SBI group bank is valued at 0.69 %. Thus, the SD value shows that the non SBI group bank has more variability than the SBI group bank. CV of the SBI group bank is 23.06 % and the non SBI group bank is 156.23 % therefore, CV of the non SBI group bank has more variance than the SBI group bank.

Difference of average Net Profit to Total Funds ratio of the SBI group bank and the non SBI group bank was highest at 1.23 % in the year 2015–16 and lowest at 0.03 % in year 2012–13.

Table 9: Average of Net Profit to Total Funds Ratio of Selected Group Bank

Year	SBI Group Bank	Non SBI Group Bank	Difference
2011–12	0.80	1.02	–0.22
2012–13	0.80	0.83	–0.03
2013–14	0.52	0.62	–0.10
2014–15	0.59	0.46	0.13
2015–16	0.50	–0.73	1.23
Mean	0.64	0.44	0.20
SD	0.15	0.69	
CV (%)	23.06	156.23	

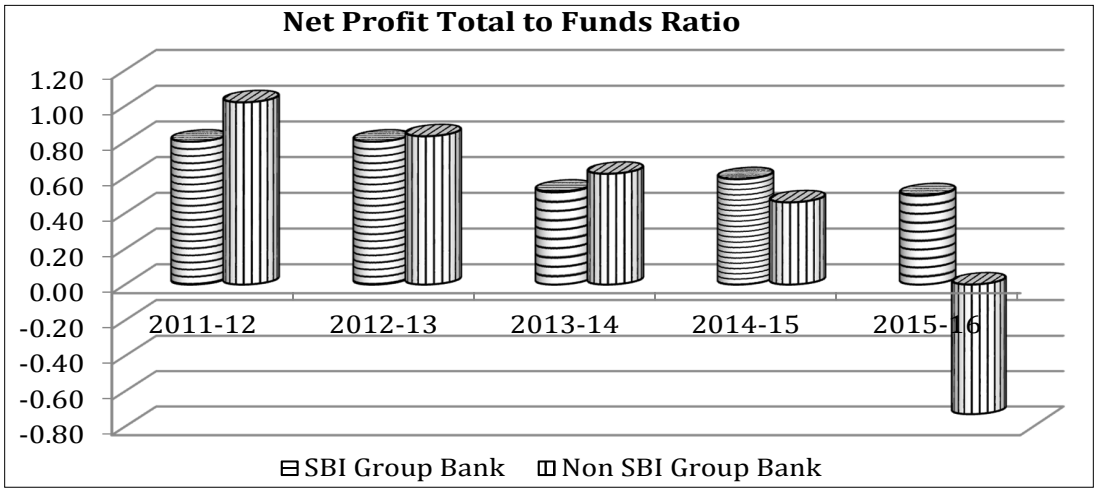

Chart 5: Average of Net Profit to Total Funds Ratio of Selected Group Bank

Hypothesis Testing of Net Profit to Total Funds Ratio

H_0: There is no significant difference between the mean of Net Profit to Total Funds Ratio for the SBI group bank and the non SBI group bank.

H_1: There is a significant difference between the mean of Net Profit to Total Funds Ratio for the SBI group bank and the non SBI group bank.

Table 10 shows the Mean of Net Profit to Total Funds Ratio of the SBI group bank is 0.642 % and that for the non-SBI group bank is 0.44 % and their corresponding variances are 0.02 and 0.47 respectively. As it is known that lesser the variance better the consistency. Thus, the SBI group is more consistent in the case of this particular ratio. At the 5% level of significance and 8 degrees of freedom the calculated value of t-Statistic is 0.64 which is insignificant. Therefore the null hypothesis is to be accepted. This implies that **the mean of Net Profit to Total Funds Ratio for the SBI group bank and the non SBI group bank does not differ significantly from each other.**

Table 10: T-Statistics with Respect to Ratio of Net Profit to Total Funds

Ratio of Net Profit to Total Funds	SBI Group Bank	Non SBI Group Bank
Mean	0.64	0.44
Variance	0.02	0.47
Observations	5.00	5.00
df	8.00	
t Stat	0.64	
P(T<=t) one-tail	0.27	
t Critical one-tail	1.86	
P(T<=t) two-tail	0.54	
t Critical two-tail	2.31	

Source: SPSS output

CONCLUSIONS

1. The mean value of Interest Income to Total Funds ratio of the SBI group bank is better and the average of each year shows more consistent performance compared to the non SBI group bank.
2. The mean value of Non-Interest Income to Total Funds ratio of the SBI group bank is better compared to the non SBI group bank and it shows excellent performance of the SBI group bank in the case of particular ratio.
3. The mean value of Interest Expended to Total Funds ratio of the non SBI group bank is better compared to the SBI group bank and it shows excellent performance of the non SBI group bank in the case of particular ratio.
4. The mean value of Profit before Provisions to Total Fund**s** ratio of the SBI group bank is better and the average of each year shows more consistent performance compared to the non SBI group bank but the derived results are not statistically proved. The Ratio of Profit before Provisions to Total Funds for the SBI group bank and the Non SBI group bank does not differ significantly from each other. So, there is a minor difference in the performance of these groups.
5. The mean value of Net Profit to Total Funds ratio of the SBI group bank is better and the average of each year shows more consistent performance compared to the non SBI group bank but the derived results are not statistically proved. The Ratio of Net Profit to Total Funds for the SBI group bank and the Non-SBI group bank does not differ significantly from each other. So, there is a minor difference in the performance of these groups.

Thus, the SBI group bank did very good with four (4) ratios (Viz. Interest Income to Total Funds ratio, Non-Interest Income to Total Funds ratio, Profit before Provisions to Total Fund**s** ratio, Net Profit to Total Funds ratio) and the non SBI group bank did well with one (1) ratios (Viz. Interest Expended to Total Funds ratio). It means the SBI group bank performed outstanding compared to the non SBI group bank.

The study also shows phenomenal development and changes in the selected public sector banks during the study period. Profit is main factor for the stable life of every business institute. And good financial health is depended on high profitability and management efficiency. The results of the study disclose that Ratio of Interest Income to Total Funds, Ratio of Interest Expended to Total Funds and Non-Interest Income to Total Funds differs significantly for the SBI group bank and other the non SBI group bank.

Mentioned suggestions are for improvement of performance of selected Banks.

1. ***Interest Income-Total Funds Ratio:*** The non SBI group bank and SBI (from the SBI group bank) has to improve this ratio by utilizing the assets of the banks in a very efficient manner to increase the profitability. The bank has to increase advances at the lower interest rate to priority sectors like, agriculture and unidentified sectors, etc. So bank must concentrate on both deposits and advance pattern to increase the interest income.
2. ***Non Interest Income-Total Funds Ratio:*** The non SBI group bank and SBT (from the SBI group bank) has to improve this ratio for striving for increasing fee-based income on services like the issue of drafts, issue of letters of credit, issue of guarantees and other ancillary services (deposit and transaction fees, insufficient funds fees, annual fees, monthly account service charges; inactivity fees, cheque and deposit slip fees, etc.). By implication of cited measures the non interest income will result into excellent profitability of the banks.
3. ***Interest Expended-Total Funds Ratio:*** The SBI group bank and CANB (from the non SBI group bank) has to improve this ratio by lowering interest rates on deposit and the banks should shed high cost deposits. The banks should strive for better deposit mix, thereby reducing the cost of the deposit and improve profitability.

4. ***Profit before Provisions-Total Funds Ratio:*** The non SBI group bank and SBT (from the SBI group bank) has to improve this ratio by increasing income and decreasing operating expenses which ultimately leads to rising in operating profit of these banks which shows better operating efficiency.

5. ***Net Profit-Total Funds Ratio:*** The non SBI group bank and SBT (from the SBI group bank) has to improve this ratio by taking some corrective steps like,

   a. Interest cost should be reduced so that the net profit of the banks will be increased.

   b. Transaction costs need to be reduced by fully leveraging technology. This would include the creation of new cost effective products, business models and delivery channels.

   c. By optimum utilization of manpower and increase in ancillary earnings may increase in net earnings from the banking operations. And banks have to cut down of wasteful expenditure, etc.

   d. High yielding advances should be aggressively marketed to improve earning / income.

   e. For increasing the net profit Bank should decrease NPA, which ultimately helps in decreasing provision for NPA.

Banks will have to develop special skills, knowledge and management capabilities in their staff in undertaking none fund business. There is an urgent need for popularizing concept of profit planning at all levels especially, in branches creating an awareness that profitability should be the hallmark of each banking operation at all levels, would go a long way in improving profitability of banks.

The main reason of sound financial performance are many, some of them are increased volume of business, high operational efficiency, high profit and increase non-fund based business in the case of the SBI group bank as compared to the non SBI group bank. Thus, the non SBI group bank has to improve financial health to survive in competitive environment. The financial health should be of great concern for the bank authority to improve other Public Sector Banks financial health. And excellent financial health of public sector banks leads to healthy financial system of country.

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Sustainability Reporting Practices in Indian Context

G.R.K. Prasad
Associate Professor (Financial Accounting & Financial Management),
Gitam Hyderbad Business School (GITAM HBS),
Hyderabad Campus, Rudram, Patancheru Mandal, Sangareddy Dist.
GITAM Deemed to be University, Hyderabad, India
E-mail: rkprasad.gutti@gitam.edu/ guthi1959@gmail.com

Abstract—Background: Reporting practices are meant for communication of various financial or non-financial performances to stakeholders (Sudhakara Rao 2014)[1]. Sustainability is the quality of not being harmful to the environment or depleting natural resources, and thereby supporting long-term ecological balance (Dictionary.com)[2] and Sustainability reporting (SR) is the process through which organisations communicate the social and environmental effects of their economic actions to stakeholder groups within society and to society at large (Gray *et al.,* 1996)[3].

The objective of any reporting provisions is to provide clear, precise and concrete information to enable to make informed decisions (Stephen A. Zeff 2013)[4]. Well developed national and international reporting provisions are available as far as financial matters are concerned; however, there are no well developed, accepted and clear reporting regimes available as far as non-financial matters are concerned, particularly about sustainability reporting.

The approach sustainability became the long term survival strategy for companies all over the world due to drastic climate changes that are taking place in the global business environment. To protect the short term approach of 'profit' within the triple bottom line – 'people' upper layer and the 'planet' lower layer need to be taken care for long run survival of business (Sahoo G, 2013)[5]. The word sustainability was first coined by Hans Carl von Carlowitz (1645–1714)[6] in response to Saxony's disappearing forests. The first sustainability reporting was introduced as an environmental report in the late 1980s by Chemical industry in the world (Wikipedia 2019)[7]. An independent international organization Global Reporting Initiative (GRI) has pioneered in developing sustainability reporting standards since 1997 (Global Reporting.org 2019)[8] and the first sustainability report was initiated by TATAs in India since 2001(ibid 8)[9].

Literature Survey: The Sustainability Report (SR) is a non-financial performance report that consist of three elements which are economic, environmental and social performance (Annnisa Hayatun N. Burhan et al 2012)[10]. The relevance of SR has greatly increased in recent decades (Helen, Maria Bollas Araya et al. 2016)[11] due to increased pressure on accountability and the corporate behavior transparency (Kolk 2008)[12.] The SR has increased manifold in response to stakeholders' concerns about environmental, social and economic issues(Kolk and Perego, 2010)[13].

The present regulations not being sufficient and clearer regulations are needed and more and more need to be adopted as a global standards of sustainability to compete globally (Godha and Gain 2015)[14]. The indicators of GRI promotes the dissemination of sustainability reporting and is successful in Asian and South American companies (Barkemeyer *et al.,* 2015)[15].

The increased trend of SR is also supported by the increasing number of guidelines provides by various governmental and non -governmental organsiations (Basamalah et al, 2005)[16] all over the world and India is no exception to the same.

The research methodology adopted in this study paper is the descriptive analysis using the secondary data which is collected from published reports of companies, Global Reporting Initiatives (GRI) reports, newspapers, articles, magazines, journals websites etc., with the objective of reviewing the existing provisions about the preparation of sustainability reporting by Indian companies.

There are clear differences exists among the three reporting regimes are concerned. As far as Financial reporting (FR) is concerned it is mandatory all over the world irrespective of nature of business with established principles, rules, and guidelines both local and international where as the environmental reporting (ER) and SR are concerned, the reporting rules have not been well established and followed all over the world. Mostly in certain advanced countries such as Canada, Japan, Germany ER made mandatory and SR is concerned it is still growing stage.d Mostly in the world GRI reporting framework is being followed for SR and some of the Indian companies are using GRI framework for SR. The purpose, nature objective, reporting regimes are different for all the three

The roles of different institutions such as Ministry-Government of India, Regulatory Authority are different. The Ministry is having Mandating, facilitating, partnering and endorsing whereas the regular has communicating, facilitating, monitoring and penalizing. Unless the roles are performed in an efficient and effective manner the objectives of the SR could not be achieved.

The paper considers the selected GRI indicators from the point of economic, environmental and social. As far Economic aspects are concerned EC1 (Direct Economic Value generated and Distributed); EC2 (Financial implications and other Risks and opportunities for the organisaton's activities due to climate change) and EC8 Significant indirect economic impact, including the extent of impacts). With regard to environmental EN1 (Materials used by weight or volume), EN2 (percentage of materials used that are recycled input materials), EN3 (Energy consumption within the organisaton), EN5 (energy intensity) EN6, Reduction of energy consumption, EN8 (Total water withdrawal by source), EN9 (water source significantly affected by withdrawal of water), EN10 (percentage and total volume of water recycled and reused), EN15 (Direct Greenhouse Gas emissions), EN18 (Greenhouse gas emission intensity), EN19 (reduction of greenhouse gas emissions), EN21 (NOx, Soxx and other significant air emissions), EN23 Total weight of waste by type and disposal method) . With regard to social is concerned LA1 (total number and rates of new employee hires and employee turnover by age group, gender and region) LA2 (Benefits provided to full time employees that re not provided to temporary or part time employees by significant locations of operations.

This paper critically analyzes SR practices in India with reference to selected GRI sustainability reporting indicators relating to economy, environment and society considering three sectors namely Mining, Oil & Gas and Chemical & Pharmacy which are aligned and having high impact on environment with a sample size of 10 companies in each sector which are listed in Bombay Stock Exchange (BSE). This paper adds value to the existing knowledge by identifying critical roles of different institutions that are concerned with the sustainability reporting and suggest ways and means improve the sustainability practices in India.

Keywords: Sustainability, Sustainability Reporting, Global Reporting Initiative (GRI), Performance, Stakeholder

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A Study of Status and Challenges of Financial Inclusion Among Women in Gujarat

Dr. Mukesh Pal[1] and Dr. Yogesh C. Joshi[2]
[1]Research Scholar,
G.H. Patel Postgraduate Institute of Business Management,
Sardar Patel University, Vallabh Vidyanagar–388120, Gujarat, India
[2]Dean, Faculty of Management,
Director and Professor, G.H. Patel Postgraduate Institute of Business Management,
Sardar Patel University, Vallabh Vidyanagar–388120, Gujarat, India
E-mail: [1]mukesh_pal@rediffmail.com, [2]joshiyogesh_2000@yahoo.com

Abstract—To achieve desired economic growth, participation of women in economic activities is very important for any country. As per the Gender Inequality Index (2017), released by the United Nations Human Development Report, India stood at 127th position out of 189 countries based on various key indicators like reproductive health, education and women labor force participation. Similarly, merely 13.72 per cent of small enterprises were run by women as per the ministry of small and medium enterprises (MSME report, 2011). According to the World Bank, Global Findex database (2017), in India, there were 76 percent of women having a bank account in formal financial institutions, however, the majorly of women still relied upon family and friends for their credit requirement (30 percent) and only few women (5 percent) able to borrow from financial institutions. Gender-based discrimination is also one of the biggest challenges in India. There are some research studies revealed that need of sufficient financial literate higher among the women than men because of typically women have fewer financial resources than men, lower market participation, lower and unstable earnings, discontinuous careers for caring activities etc. (Kaneria, 2012). Likewise, it is scientifically evident that women live longer on average than men (Ginter *et al.,* 2013); hence they need to manage resources well and for longer periods to improve access to economic/financial opportunities. Additionally, women are less income earners and gender differences prevailed in labor markets (chithra *et al.,* 2013). Similarly, women are less likely to be the formal owners of land, property and other assets due to archaic land laws that make it difficult for women to offer land/property as collateral while accessing credit from financial institutions and hence women farmers and entrepreneurs have less access to credit than their male counterparts (Federal Ministry for Economic Corporation and Development, UK, 2013).

Despite rapid economic growth, the contributions of women in the Indian economy remain very low and remain persistent. In order to prompt poverty reduction and gender equity, there is an essential requirement for using development resources to increase financial access for women. Hence it becomes imperative to understand the role of women from the economic perspective and opportunities and challenges they faced for their economic empowerment. The timely and appropriate access to financial services at a reasonable cost is important not only in upbringing disadvantaged and poor section of society but also helps to contribute significantly to employment generation.

The present study is aimed to analyze women's experience with banks on availing of credit facilities. Furthermore, in the absence of formal bank credit, what are the alternate source of credit they relied upon for their credit requirements and reasons for selecting such credit source is also studied. Study further explores relationship between socio-economic factors' influence in the choice of a specific source of credit. To understand the dynamics of women participation in formal financial system and their borrowing habits, we have collected convenient sample of 774 women respondents from ten districts of Gujarat and women participants were interviewed face to face with the help of structured questionnaire to study the current borrowing habits, experienced of availing credit from banks, reasons for loan denial by banks, if any and various alternate source of credit being used such as friends, relatives, local money lenders, co-operative society, NGOs, Microfinance institutions and banks etc. Further probing has been done in order to understand the key factors for selecting particular alternate source credit by women participants.

The study concludes that majority of women participants had never applied for loans from the bank. On the other hand, insufficient or lack of steady income of women, non-availability of required documents and incurred previous loan were the most critical reasons for denial of loans by banks. The Majority of women respondents fulfilled their credit requirements through relatives and friends. Loan facilities availed through Banks had gone up due to various government subsidies loans and credit facilities disbursed direct transfer to bank account. Still, many women relied upon the local moneylender for their credit requirements. It was observed that local money lenders charged exorbitant rates of interest on loans. Although the study is undertaken on limited samples of women participants

in Gujarat, the findings of the study provide valuable insight on credit access patterns and key reasons for choosing informal source of alternate credit; it provides useful information for policymakers and financial institutions to design the tailor made financial service offerings.

Keywords: Financial Inclusion, Women Empowerment, Financial Institutions, Gujarat

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A Qualitative Study of Stressed Power Projects in India

Vineet Kumar Jain
Ph.D. Scholar,
School of Petroleum Management,
Pandit Deenadayal Petroleum University, Gandhinagar, Gujarat, India
E-mail: vineet.jphd18@spm.pdpu.ac.in/ vineet.jain104@gmail.com

Abstract—While the Indian economy is witnessing a steady growth, the amount classified as stressed asset in bank's credit portfolio is on the rise. This is a matter of concern for Banks, Reserve Bank of India as well as Government of India. Time and again, Reserve Bank of India has emphasized that there is a need for timely recognition and reporting of stressed assets to reduce economic costs and to address the vulnerabilities in a proactive and timely manner. Power sector is availing approximately 17% of the overall corporate debt disbursed by financial sector and also one of the most significant contributor in creation of stressed assets ("NPAs likely to come down by this fiscal, but assets over Rs. 1 lakh crore still not recognised as bad loans - The Financial Express," n.d.).

Since 2001, the Indian power sector has undergone various structural and regulatory changes like bailout of state electricity boards, landmark electricity act 2003, and creation of independent regulatory bodies and implementation of reforms to improve the performance of power distribution utilities in India. Issues like lack of availability of fuel is causing stress in power generation companies. Thermal power plants are big concern and require immediate support to make them viable (SABHA, 2018). The power distribution companies have become the weakest link and require focused efforts and state intervention to make them viable again (Khurana & Banerjee, 2014). It is also found that the progress in the performance of the distribution utilities is not as per expectation and they have not been able to perform as expected (Kishore & Lakshmi, 2018). It is also found that under recovery of power cost is also one of the major area of concern and tariff reforms are required for improving the health of the power sector (Huenteler, Dobozi, Balabanyan, & Banerjee, 2017).

Some studies have found that because of commercial losses, un-targeted subsidies, widespread theft, government intervention in tariff setting etc. have contributed to the sustained financial losses for distribution companies (Veluchamy, Sunder, Tripathi, & Nafi, 2018). Some studies have analyzed the performances of individual electricity board, Karnataka (Rajkumari & Gayithri, 2018), Orissa (Kundu & Mishra, 2012) and Maharashtra (Totare & Pandit, 2010). However most of the studies are based on literature review and does not cover the perspective of all stakeholders. Inspite of implementation of UDAY scheme, the situation is not improving. In this context, it is important that qualitative analysis is conducted in present economic environment.

The present study is aimed to understand massive financial stress in power sector, reasons for this stress and way forward to handle this stress in context of present status of Indian economy. To understand financial stress in Indian power sector, we decided to adopt qualitative approach in this research study. A convenient sampling of 20 executives, who possess an average of ten years' experience in banks, financial institutions, consulting companies, power companies, forensic audit firms in India were interviewed either face-to-face or on telephone by using open-ended questions. These questions focused on present status of power sector, reasons of financial stress, debt serving capacity, government policy, corporate governance, and availability of raw material, power purchase agreements, capacity utilization, frauds and common modus operandi and effect of renewable sources of energy. The interviews also covered questions on expected interventions required from Government of India, banks etc. to manage stress in power sector. The verbatim responses on interview questions were recorded by field investigators in structured questionnaire sheets. These responses of participants were coded into specific theoretical categories by using qualitative content analysis and thematic analysis. This has helped us to identify different factors causing stress in power sector, importance of these factors as pointed out by different executives and important interventions required to manage this stress. The analysis revealed many interesting findings about power sector and factors causing stress in power sector. For example, delayed payments from state controlled power distribution companies, fuel supply issues, coal block cancellation, lack of Power Purchase Agreement, Inability of the promoter to infuse the equity & working capital, availability of the transmission and distribution network, regulatory and contractual issues were cited as most dominant reasons of stress in power producer companies. Similarly operational inefficiency, skewed tariffs, power procurement issues were most dominant reasons of stress in power distribution companies. Respondents of our study also shared many other perspectives e.g. hidden cost of natural resources like water usage by thermal power plant, possibility of stress for at least a decade in power sector, higher subsidy to coal based power plant than renewable energy etc.

Many of the respondents agreed that power sector stress can be resolved if some big policy measures are implemented. The performance improvement of distribution sector is the most crucial aspect and rethinking tariff design, development of robust power procurement markets, improving service quality etc. can significantly reduce stress in distribution companies. Some of the other important recommendations are separation of meters for agriculture and non-agriculture purpose, alternate financing mechanism etc. For improving the health of power generation companies assured coal linkage, timely payment from distribution companies, and flexibility in power purchase agreements are some of the important suggestions. The findings of this study may provide many insights to policy makers, financial institutions, and investors for creating an enabling environment for power sector and helping it to come out of stress. Although study is based on limited sample of executives but these findings may be generalized as these people were selected from different background and professions having significant understanding of their area of operation in power sector.

Keywords: Stressed Project, Qualitative Analysis, Indian Power Sector, Fraud

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SECTION–VIII

MARKETING MANAGEMENT

Brand Engagement through Emotions in Soft Drinks Industry with Respect to Gujarat State

Ravi Rajai[1] and Prof. (Dr.) Vasudev Modi[2]
[1]Research Scholar, Department of Commerce,
Maharaja Krishnakumarsinhji Bhavnagar University, Bhavnagar
[2]Professor, Department of Commerce,
Maharaja Krishnakumarsinhji Bhavnagar University, Bhavnagar
E-mail: [1]ravi_rajai@rediffmail.com, [2]vmodi@mkbhavuni.edu.in

Abstract—Emotion is a basic human instinct and is a decent & unique tool for corporates to use to attract a new audience and create brand engagement. It is almost like a committed relationship, between corporate and target audience, as long as the company is delivering a positive experience for the target audience, brand loyalty should remain. An emotional bond must be developed between the consumer and the product for a brand to be successful. Emotion is a mental state derived from ones intuitive feelings, which arise from reasoning, knowledge and cognitive appraisals of events or thoughts. Emotion may trigger actions depending on its nature and the reason for the person having emotion. The study focuses on effective use of emotions in brand communication which helps in creating and enhancing brand engagement. It was found that, the emotional brand communication can divert the attention of the consumers more effectively than just rational brand communication and helps in creating a long lasting and strong brand engagement in highly competitive era.

Keywords: Brand Communication, Brand Engagement, Emotions, Emotional Appeals, Emotional Branding

INTRODUCTION

The purpose of emotional appeal is to build and inflame the consumer's emotion. A brand or product may make a consumer feel proud, excited, or confident. An ad may create feelings of amusement, disgust, or wonder. Emotions can be defined as strong relatively uncontrolled feelings that affect our behavior. Emotions do play a very important role in behavior of consumers. Emotion is a term frequently and familiarity used as synonymous with feelings. For instance an individual, feeling a trust of good quality, may decide to buy a chocolate for himself and his friend. Many times consumers are indulge in excessive shopping when overwhelmed by depression or togetherness. It is essential for companies to correspond by their product and relate to their customers emotionally; otherwise product can be merely a product and nothing else. Emotional Branding also consider brand name which influence consumers decision making process.

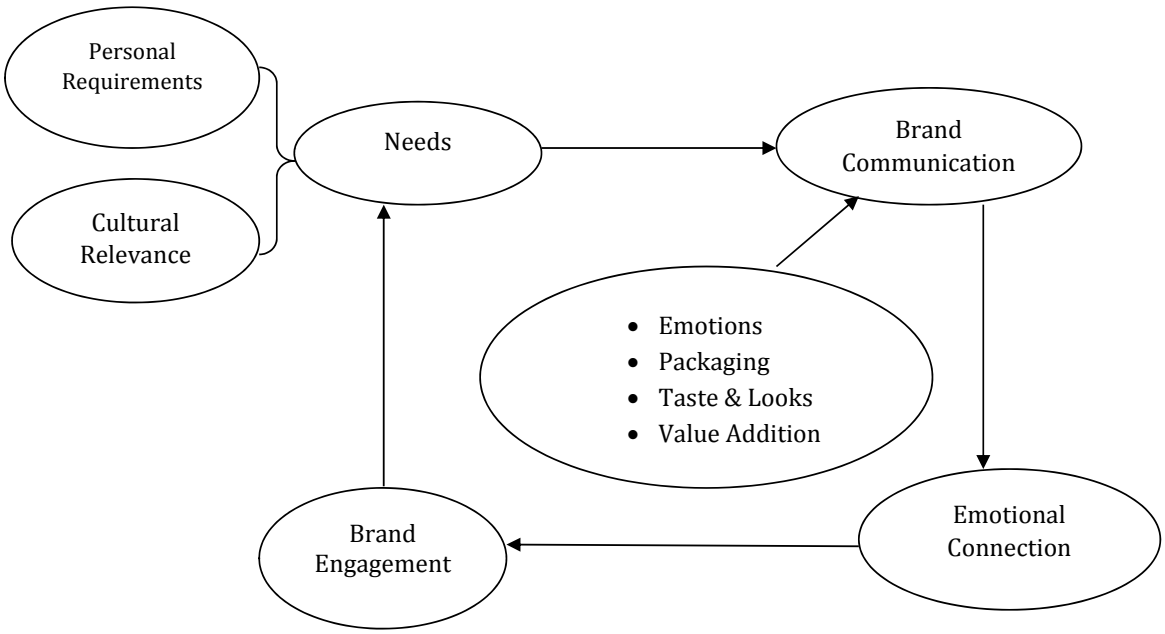
Usually branding starts when company design's a product with great feature and capabilities better than what their competitors are offering. The company then has a "position" in a product distinct category against competitors. The problem increases when neither of the groups has made efforts to create emotional bond between the customers and the company and its product. Emotional branding is the fine approach that clarifies the values of the company to the customers (Marken, 2003).

Brand engagement is a process of forming an emotional or rational attachment between the consumers and the brand. Consumers use brands to distinguish a company's offering from those of other companies. This information allows them to make efficient judgments of quality, suitability, value for money and can prompt quick buying decisions and their behaviour. Consumers use brands to create and display self-image and identity. Consumers can interact with the brand and even co-create it. Consumers form relationships with the brand and consequently the company that they find satisfying. Brand engagement is the process of providing branded communications and experiences that add value to consumers' lives and foster relationships between brands and consumers. In other words, every consumer touch point with the brand should reaffirm the brand promise and whenever possible, open the doors to establish a long-term relationship that extends beyond a single purchase. Thus brand engagement helps to build a long lasting and strong relationship with the consumer.

Brand engagement is a measure of the length of time consumers spend interacting with a brand. Brand engagement is a measure of how consumers perceive the brand, how well has the brand been communicated, and whether the experience of brand stands up to the promises it makes. The increase in market value is due to conformity of change in advertising patterns to marketing strategies and advertisement campaigns of the companies. Companies inventing new emotions in advertising formulate positive response to changes in most cases. Although advertising cannot produce lasting effect on market value, making change in the emotional content signifies management tendency to influence market and develop in the media. Today media has enabled brands to put a human face and voice to a brand, leading to an influx of communications that aim to evoke an emotional reaction or behavior from audiences. Advertising and media should be more about emotion. In the higher level of the funnel for brand engagement, the emotion is the key, and information is less relevant.

LITERATURE REVIEW

Marc Gobe' in his book Emotional Branding – the new paradigm states with reference to importance of advertisement slogan which switched from "just communication" to "a dialogue between the corporate and consumer" redefines the role of brand to a personal level and creates a maximum influence on the consumer. Brands must recognize that their emotional identity is not only a result of ads and products, but also corporate policy and stances.



Source: Brandjam, Humanizing Brands through Emotional Design

Marc Gobe' in his book Brandjam – humanizing brands through emotional designs states with reference to a washing soap advertisement slogan which switched from "fighting dirt" to "dirt is good and liberating" repurposes the role of a brand in consumers life from a negative to a positive experience. Commerce is basically about selling and marketing products and services but consumers are all about desires and aspirations. A consumer is constantly looking for brands which can be associated with their personalities. Consumer sometimes associate brand labels to express their identity to others. Hence it is very important for a businessman to psychologically connect with the consumer and effectively convey the brand message. Emotions help in establishing this connection and sustaining brand loyalty. Once this brand loyalty is created it plays a major role in decision making process regarding purchase. Emotional branding is thus less about companies and more about the consumers which establishes strong brand engagements.

Korgaonkar and Moschis (1982) elaborated the in their study that the more the expectations before the purchase, the more will be the favorable evaluation in products which involve high consumer involvement.

Mowen and Minor (1998) studied the importance of emotions as an important component of attitude in their research. The emotional aspect has gain importance over the years and more and more studies are being carried out by keeping in mind the emotions in the purchases of customers.

Kotler (1973) states that "emotional branding is the effort to design buying environments to produce specific emotional effects in the buyer that enhance his purchase probability."

Yoo and MacInnis, (2005) identified Emotions acts as a leveraging force in the attachment of consumers to brands and Emotions are a strong means of captivating experience-driven consumer attachment to brands.

Werner Krober (2001) found that, emotional branding plays a deep effective impact in saturated markets. The consumer's preference for a brand is mainly created by the emotional brand experience.

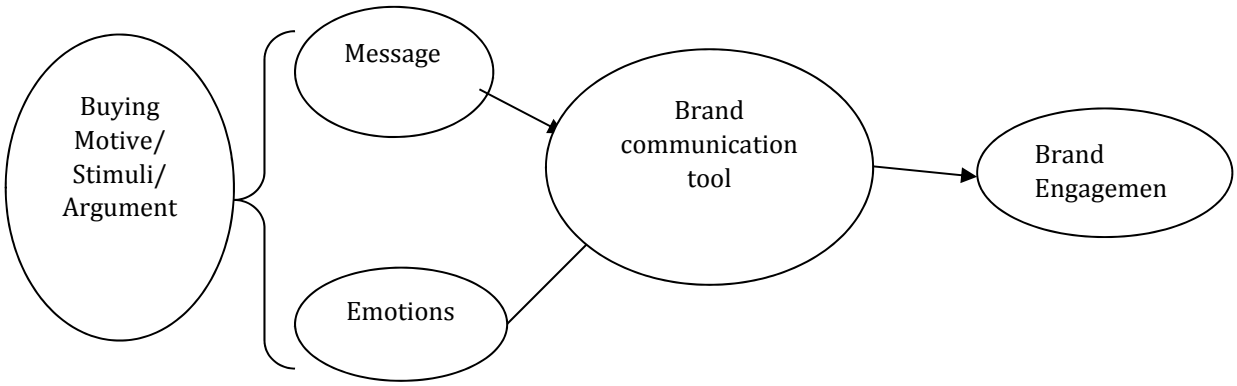
Westbrook and Oliver (1991) showed in their study that "the most satisfied consumers experienced the emotions and felt positively surprised and positive emotions generate a high satisfaction level positively influence the word-of-mouth recommendation, repurchase planning and cross selling potentials."

Mohit Jamwal and Vishal Soodan in their paper the Emotional Branding as a tool for Dissonance Reduction (2014) says that branding with emotions touches a chord with attacking views and in turn, makes a perfect association with the product.

Malar Krohmer Hoyer & Nyffenegger in their paper Emotional Brand Attachment and Brand Personality (2011) stated that "in the modern era of high level competition it is very important for business to develop a high level of psychological bonds with the consumer known as emotional brand connections which help business to gain competitive advantage."

Mohit Jamwal and Vishal Soodan in their paper the Emotional Branding as a tool for Dissonance Reduction (2014) says that branding with emotions touches a chord with attacking views and in turn, makes a perfect association with the product.

Many people believe that emotional or funny ads are playful and ineffective as they are not strong enough to show the rational side of the brand product. A rational consumer will take a decision based on comparative performance of the rival brands on specific characteristics and so emotions in brand communication have no effect on purchase decision. However studies have shown that use of emotions can be an effective and powerful means of persuasion and justifying brand personality. Humans are capable of vast array of emotions with man subtle variations. Once the buying motive becomes clear marketers can develop a message based on that stimuli. An emotional touch can be added to that message which helps in perusing consumer easily.



Emotion helps in directing attention. Instinctive emotional responses can make people notice brands and advertising. But the emotional response alone is not enough because temporary attention is not the same as a lasting memory. And marketing's role is to create, shape, and reinforce memories that will motivate consumers to behave in a certain way — for example, to try a brand, to be willing to pay a premium for it, or to remain loyal to it over time. Thus and marketer can use emotion as a motivational factor to attract consumer or it can combine it up with message and make and emotional appeal in brand communication and still divert the mind of the consumer. The advantage of emotion is that it makes the brand communication message more strong and effective for its audience.

Zeitlin and Westwood (1986) observe three functions of emotions in advertising, "emotions as benefits, emotions which communicate benefits and emotions which influence the consumers' attitudes."

Su, Maridos & Reynolds in their paper "Emotional and cognitive involvement of consumers with hotel brands on social networking sites"(2019), suggests that both emotional and cognitive can enhance consumers hotel brand attitude and practitioners should turn their attention to the emotional and cognitive responses their SNSs provoke in consumers, rather than simply on the number of likes, shares and comments they induce.

Bill Merrilees in their paper "Interactive brand experience pathways to customer – brand engagement & value co – creation" (2016) suggested that different facets of brand experience and different facets of interactivity are entailed for each brand type. The different interactive experience pathways between functional and hedonic brands imply different engagement and co-creation strategies by firms. Generally, a richer set of engagement options are relevant to the hedonic brand. However functional brands can extend their repertoire of engagement tools by borrowing inspiration from the hedonic brands.

An effective brand engagement and brand connection of the product depends upon 3 key features for its connection with the external world. First is the Brand Name second, Brand logo and third is the Brand slogan or tagline. Brand name gives the product an identity which can be registered and legally protected. Logos are the graphical designs which either talk about the product or manufacturer or any of the component of the product. These logos generally remain unchanged for a long period of time. Sometimes minor changes are done in the color style or layouts of these logos as per the requirements of the time. The only remaining thing is Slogan which company changes from time to time as per its requirements. With the change in climatic, economic, environmental, social, political or any other changes in the society the company also changes its slogans. Thus slogans become more effective and flexible way of brand engagement in modern ever changing business environment. More over Brand name and logo have very limited content and so many a times they fail to give complete information about the brand. On the other hand a slogan is a set of limited words accompanied by emotions, music, jingles, brand ambassador etc. and hence gives much clear recognition about the product. This recognition, instead, provides brand awareness and brand image through recognition, recall and favorite associations in relation to the brand. This recognition, instead, provides brand awareness and brand image through recognition, recall and favorite associations in relation to the brand. Thus emotions in advertising act as a hook whereby the customer grasps the concept of a brand, and intensify everything that makes the brand distinct and involves high level of brand engagement.

Soft drink Companies have been making use of such emotional appeals over the period of time to attract the consumers. Since the starting of Cola War, Coca – Cola Inc. & Pepsi Co. have been portraying various emotions in their advertisements from time to time to seek consumers attention. The products in these markets are more or less homogeneous which makes it product differentiation inevitable. An emotional attachment helps the brands to stand out and hence they don't just go unnoticed easily. As a result, advertising tends to rely more on sentiments to attract consumers' attention and interest. Emotions are said to move across borders better than information. Coca-Cola's advertisements & campaigns always show people around the world sharing their happiest times - love, laughter, and celebration along with a product of Coke.

L.K. Mathur (1995), in his research paper "The effect of advertising slogan changes on the market value of firm", suggested that with the changes in marketing environment when a company changes its advertising slogans it has a positive effect on the market value of the firm and brand engagement of the consumers.

Soft drink Companies have been making use of such emotional slogans over the period of time to attract the consumers. Since the starting of Cola War, Coca – Cola Inc. & Pepsi Co. have been portraying various emotions in their advertisements from time to time to seek consumers attention. The products in these markets are more or less homogeneous which makes it product differentiation inevitable. An emotional attachment helps the brands to stand out and hence they don't just go unnoticed easily. As a result, advertising tends to rely more on sentiments to attract consumers' attention and interest. Emotions are said to move across borders better than information. Coca-Cola's advertisements & campaigns always show people around the world sharing their happiest times - love, laughter, and celebration along with a product of Coke.

Emotional appeal is one of the important marketing tools to support characteristic for product to be outstanding and well known. Coke always uses emotional slogans to remind the customer recognition toward the Coke' brand. Coke's slogan plays role to stimulate customer feeling to desire and coke product. Coca – Cola Slogan in 2009 marketed with a slogan "Open Happiness". This slogan which was used in advertising campaigns can be taken as that people have happiness and enjoyable time while drinking Coke. Coca-Cola as a brand was emotionally connecting with its customer through personalization and creating a highest level brand engagement.

Mayureshnikam and Vishal V. Patil (2008), in their research paper "Marketing Strategy of Coca – Cola" stated that the unique feature of Coke's strategy is that they tend to change their tag lines & slogans, which ensures that the target audience is interested in the product and they feel that the company is doing some innovation.

Coca-Cola felt the new way of brand engagement with its customers was through personalization and, therefore, designed the campaign called "Share a Coke" in such a way that it encourage personalization in a prospective way. Consumers like to self-express themselves creatively through storytelling and staying in touch with its friends and as a result, the campaign leveraged on this kind of consumer behaviour. Moreover, Coca-Cola wanted to engage with its customers and at the same time promote its own brand name. Thus the Slogan which was associated with the campaign of sharing a coke with near dear ones mainly focused on two objectives of the company. The first objective was obviously increasing the sales and the second one was personally connecting with the customers. Due to this campaign the not only achieved both the objectives but wanted the consumers to experience their brand. As always said a happy customer always adds to the brand equity of the company. Under this campaign the customers of Coca Cola shared their experience with the company and also shared coke with their friends, families and relatives. This created a chain of sharing and thus the campaign brought the desired change in the company's marketing operations which further ended up in high level brand engagement.

With the extensive use of emoji's in online & Social media's to express their feelings Pepsi used some of such emoji's in its advertisements which made customers easy to recall and seeing them brought smile on their faces. People were encourage sending their own designs of emojis to Pepsi's Twitter account which helped enhancing the interactivity with the audience and contributed a polishing to Pepsi's advertisement campaign.

Thums-up on the other hand promoted itself as a strong Refreshing drink emphasizing on masculinity, happiness, satisfaction & adventure emotions in its campaigns. These emotions were also portrayed in its taglines as "Thums-up taste the thunder" or "Aaj kuch toofani karte hai". Thums-up chose these emotional slogans for brand communication because of the high cola content which gives it a bit hard & different taste than other cola products offered by the rival companies so customers generally don't wish to leave the product easily. This helped to enhance the brand engagement of the target customers of the company.

RESEARCH GAP

The paper describes the effective use of emotions in brand communication and its influence on brand engagement.

RESEARCH METHODOLOGY

There is a constant increase in the use of emotions and sentiments in brand communication process under various themes and ways. Thus the research focuses on where the use of emotions in brand communication process is effective or not and secondly after viewing such emotional advertisement whether there is an increase in the brand engagement of the consumer or not. For this reason the research design of the study was descriptive, as it describes data and characteristics associated with the population consuming cola based soft drinks. The study was conducted in Gujarat State with reference to soft drinks**.** To accomplish the objectives of the study, both primary and secondary data's were collected. Primary Data Primary data is that data which is collected by well-structured questionnaire which comprised of close ended as well as open ended questions. Secondary data is the data collected from various books, magazines and journals. The sample size was 450 respondents which were collected from Gujarat State. A convenient sampling technique was used to collect data. The study is in context of consumers of cola based soft drinks (Coca – Cola & PepsiCo.) of Gujarat State. A total of 410 respondents (61.33% males & 38.67% female) responded to the questionnaire from various areas of Gujarat.

RELIABILITY OF SCALES

A Croncbanch's alpha was calculated to study the reliability of the scale which valued at 0.964. This shows that the scales used for the research are reliable and show no sign of any bias. Further if any item on scale is deleted the scale still is valid and consistent, was also calculated and checked using the same alpha values.

Case Processing Summary

		N	%
Cases	Valid	410	100.0
	Excluded[a]	0	.0
	Total	410	100.0

a. Listwise deletion based on all variables in the procedure.

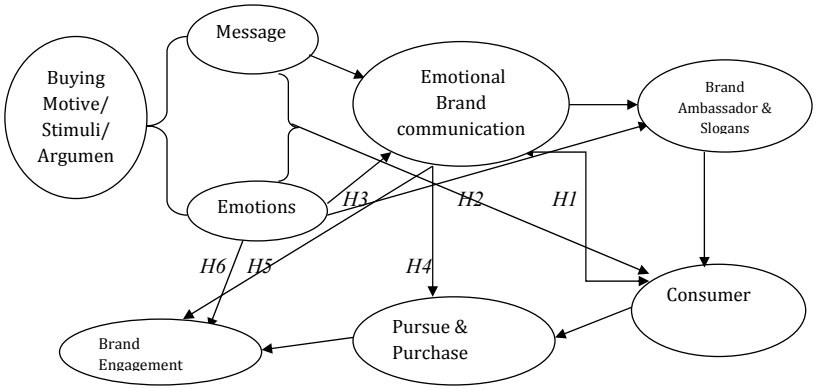
Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha based on Standardized Items	N. of Items
.964	.966	5

Item Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correction	Squared Multiple Correction	Cronbach's Alpha if Item Deleted
Emotional connection with product	6.40	8.177	.889	.904	.960
Purchase action	5.94	7.403	.870	.793	.961
Frequency of viewing advertisment	6.17	7.177	.931	.873	.951
Brand ambassador justifies the emotion	6.34	7.574	.916	.925	.953
Incase if product is unavailable what you do	6.13	7.544	.909	.856	.954

HYPOTHESES OF THE STUDY



1. **H_0:** There is no effect of use of emotional slogans on consumers.

   H_1: There is effect of use of emotional slogans on consumers.

The study was focusing on the effect of emotional slogans on consumer. Out 410 Respondents, 61.33% responded that they see the emotional slogans more than once a day, 20% replied that they see at least once a day and 18.67% see it every alternate day. This shows that most of the consumers do watch and get connected with the product due to emotional appeals in slogans & advertisements. A one way Anova test showed following results.

Descriptives

Emotional connection with product

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
More than once a day	251	1.00	.000	.000	1.00	1.00	1	1
Daily atleast once	82	1.39	.491	.054	1.28	1.50	1	2
Alternate days	77	2.43	.498	.057	2.32	2.54	2	3
Total	410	1.35	.623	.031	1.29	1.41	1	3

ANOVA

Emotional connection with product

	Sum of Squares	df	Mean Square	F	Siq.
Between Groups	120.450	2	60.225	638.833	.000
Within Groups	38.369	407	.094		
Total	158.820	409			

Multiple Comparisons

Emotional connection with product
Tukey HSD

(I) Frequency of Viewing Advertisment	(j) Frequency of Viewing Advertisment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
More than once a day	Daily atleas once	-.390*	.039	.000	-.48	-.30
	Alternate days	-1.429*	.040	.000	-1.52	1.33
Daily atleas once	More than once a day	.390*	.039	.000	.30	.48
	Alternate days	-1.038*	.049	.000	-1.15	-.92
Alternate days	More than once a day	1.429*	.040	.000	1.33	1.52
	Daily atleas once	1.038*	.049	.000	.92	1.15

*The mean difference is significant at the 0.05 level

On the basis of one way Anova test, F value for (2,407) was 638.833 and the p value was 0.00 which is less than 0.05. Applying Tukey HSD test the p value is still remains less than 0.05. Hence null hypothesis is rejected which means there is an effect of emotional slogans on consumers.

2. **H_0:** Consumer doesn't feels the emotions of emotional slogans in brand communication.

   H_1: Consumer feels the emotions of emotional slogans in brand communication.

The study was focusing on feeling of emotions of emotional slogans in brand communication process. The respondents were clearly affected by emotional slogans but what type of impact it created on consumers was still a matter of subject. A correlation was established between viewing of advertisements, getting emotional connection with the brand and purchase actions using Karl Pearson's two tailed correlation test and the results were as follows.

Correlations

		Frequency of Viewing Advertisment	Emotional Connection with Product	Purchase Action
Frequency of viewing advertisment	Pearson Correlation	1	.847*	.859*
	Sig. (2-tailed)		.000	.000
	N	410	410	410
Emotional connection with product	Pearson Correlation	.847*	1	.772*
	Sig. (2-tailed)	.000		.000
	N	410	410	410
Purchase action	Pearson Correlation	.859*	.772*	1
	Sig. (2-tailed)	.000	.000	
	N	410	410	410

*Correlation is significant at the 0.01 level (2-tailed).

There is a strong correlation between frequency of viewing advertisement, emotional connection with the product and purchase actions. All the correlations being closer to 1 are strong and positive and so null hypothesis is rejected. This means that consumers do feel emotional slogans in brand communication. However it is also seen that just merely emotional connection with brand is not enough to pursue consumers to make a purchase and so purchase actions are also motivated by other mediators but still emotional slogans is a strong and positively affecting mediator that helps in proper communication of emotional message.

3. **H_0:** Brand Ambassador does not justifies the emotions in brand communication.

   H_1: Brand Ambassador does justifies the emotions in brand communication.

Correlations

		Frequency of Viewing Advertisment	Emotional Connection with Product	Brand Ambassador Justifies the Emotion
Frequency of viewing advertisment	Pearson Correlation	1	.847	.879*
	Sig. (2-tailed)		.000	.000
	N	410	410	410
Emotional connection with product	Pearson Correlation	.847*	1	.949*
	Sig. (2-tailed)	.000		.000
	N	410	410	410
Brand ambassador justifies the emotion	Pearson Correlation	.879	.949*	1
	Sig. (2-tailed)	.000	.000	
	N	410	410	410

*Correlation is significant at the 0.01 level (2-tailed).

A correlation was tried to establish between the frequency of viewing advertisements, getting connecting emotionally with the product and if the brand ambassador if it justifies the emotion that is shown in the advertisement. It was found out through Karl Pearson's two tailed correlation that the correlation between Frequency of viewing advertisement and feeling the emotions in the advertisement was 0.847 while the correlation between the Emotional connection with the product and the justification of emotion by the brand ambassador was 0.897. Thus there is a positive correlation between all the three. Since the correlation is closer to 1 it can be said that the correlation is a strong positive one. Thus the null hypothesis H_0 is rejected and Alternate Hypothesis H_1 is accepted. Thus the brand ambassadors justified the emotions portrayed in the advertisements which increases the viewership of the advertisement and helps in establishing an emotional attachment with the brand product.

4. **H_0:** There is no positive correlation between emotional brand communication & purchase

   H_1: There is a positive correlation between emotional brand communication & purchase

Correlations

		Frequency of Viewing Advertisment	Emotional Connection with Product	Purchase Action
Frequency of viewing advertisment	Pearson Correlation	1	.847*	.859*
	Sig. (2-tailed)		.000	.000
	N	410	410	410
Emotional connection with product	Pearson Correlation	.847*	1	.772*
	Sig. (2-tailed)	.000		.000
	N	410	410	410
Emotional connection leads to purchase	Pearson Correlation	.859*	.772*	1
	Sig. (2-tailed)	.000	.000	
	N	410	410	410

*Correlation is significant at the 0.01 level (2-tailed).

It was found out through Karl Pearson's two tailed correlation that the correlation between Frequency of viewing advertisement and feeling the emotions in the advertisement was 0.847 while the correlation between the Emotional connection with the product and that emotional connection leading to purchase was 0.772. Thus there is a positive correlation between all the three. Since the correlation is closer to 1 it can be said that the correlation is a strong positive one. However it is clear that just merely a strong emotional bonding helps to notice the brand but that bonding may not really lead to purchase. At this point where company uses factors like brand ambassadors as mediators to literally create an impactful bond with the consumers that would lead to purchase. Thus the null hypothesis H_0 is rejected and Alternate Hypothesis H_1 is accepted. Thus there is a positive correlation between emotional brand communication & purchase.

5. **H_0:** Emotional brand communication does not increases brand engagement.

   H_1: Emotional brand communication does increases brand engagement.

Correlations

		Frequency of Viewing Advertisment	Emotional Connection with Product	Purchase Action	Incase if Product is Unavailable What You Do
Frequency of viewing advertisment	Pearson Correlation	1	.847*	.859*	.900*
	Sig. (2-tailed)		.000	.000	.000
	N	410	410	410	410
Emotional connection with product	Pearson Correlation	.847*	1	.772*	.796*
	Sig. (2-tailed)	.000		.000	.000
	N	410	410	410	410

Table (Contd.)...

...Table (Contd.)

		Frequency of Viewing Advertisment	Emotional Connection with Product	Purchase Action	Incase if Product is Unavailable What You Do
Emotional connection leads to purchase	Pearson Correlation	.859*	.772*	1	.872*
	Sig. (2-tailed)	.000	.000		.000
	N	410	410	410	410
Incase if product is unavailable what you do		.900*	.796*	.872*	1
		.000	.000	.000	
		410	410	410	410

*Correlation is significant at the 0.01 level (2-tailed).

After viewing emotional advertisements and making purchase decision if the product is unavailable the reactions of consumers were analyzed. It was found out through Karl Pearson's two tailed correlation that the correlation between Frequency of viewing advertisement and feeling the emotions in the advertisement was 0.847 while the correlation between the Emotional connection with the product and that emotional connection leading to purchase was 0.772. Further what would a customer do if the product was not available at the place of purchase would he opt for an another drink or go to next destination or may not prefer to drink at all, most of the respondents replied that they would prefer to go to next destination and if the product was not available even there than they would not prefer to but the optional product. This shows that there is a strong brand loyalty with the product. A correlation between viewing of advertisement and the reaction if the product was not available came up to be very strong at 0.90. Thus there is a positive correlation between all the four. Since the correlation is closer to 1 it can be said that the correlation is a strong positive one. However it is clear that just merely a strong emotional bonding helps to notice the brand but that bonding may not really lead to purchase. At this point where company uses factors like brand ambassadors as mediators to literally create an impactful strong emotional bond with the consumers that would lead to purchase and increase the brand loyalty of the consumers. Thus the null hypothesis H_0 is rejected and Alternate Hypothesis H_1 is accepted. Thus there is a positive correlation between emotional brand communication & purchase which leads to brand engagement.

6. **H_0:** There is no effect of use of emotions on consumers brand engagement.

   H_1: There is effect of use of emotions on consumers in brand engagement.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Frequency of viewing advertisment	1.58	410	.788	.039
	Emotional connection with product	1.35	410	.623	.031
Pair 2	Purchase action	1.80	410	.784	.039
	Emotional connection with product	1.35	410	.623	.031
Pair 3	Incase if product is unavailable what you do	1.62	410	.732	.036
	Emotional connection with product	1.35	410	.623	.031

Paired Samples Statistics

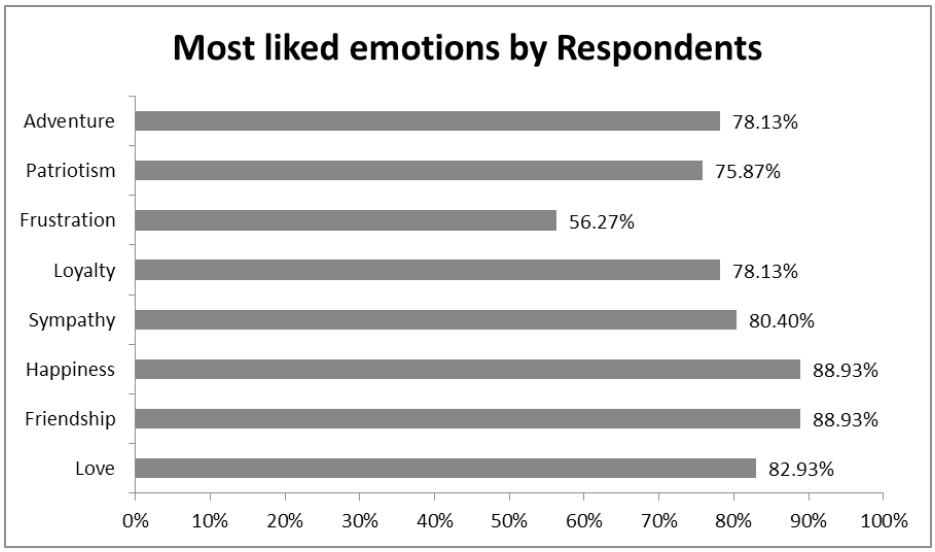
		N	Correlation	Sig.
Pair 1	Frequency of viewing advertisment and Emotional connection with product	410	.847	.000
Pair 2	Purchase action and Emotional connection with product	410	.772	.000
Pair 3	Incase if product is unavailable what you do and Emotional connection with product	410	.796	.000

Paired Samples Test

		Paired Differences					t	df	Siq. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Frequency of viewing advertisment Emotional connection with product	.229	.421	.021	.188	.270	11.030	409	.000
Pair 2	Purchase action Emotional connection with product	.454	.498	.025	.405	.502	18.429	409	.000
Pair 3	Incase if product is unavailable what you do Emotional connection with product	.271	.445	.022	.228	.314	12.322	409	.000

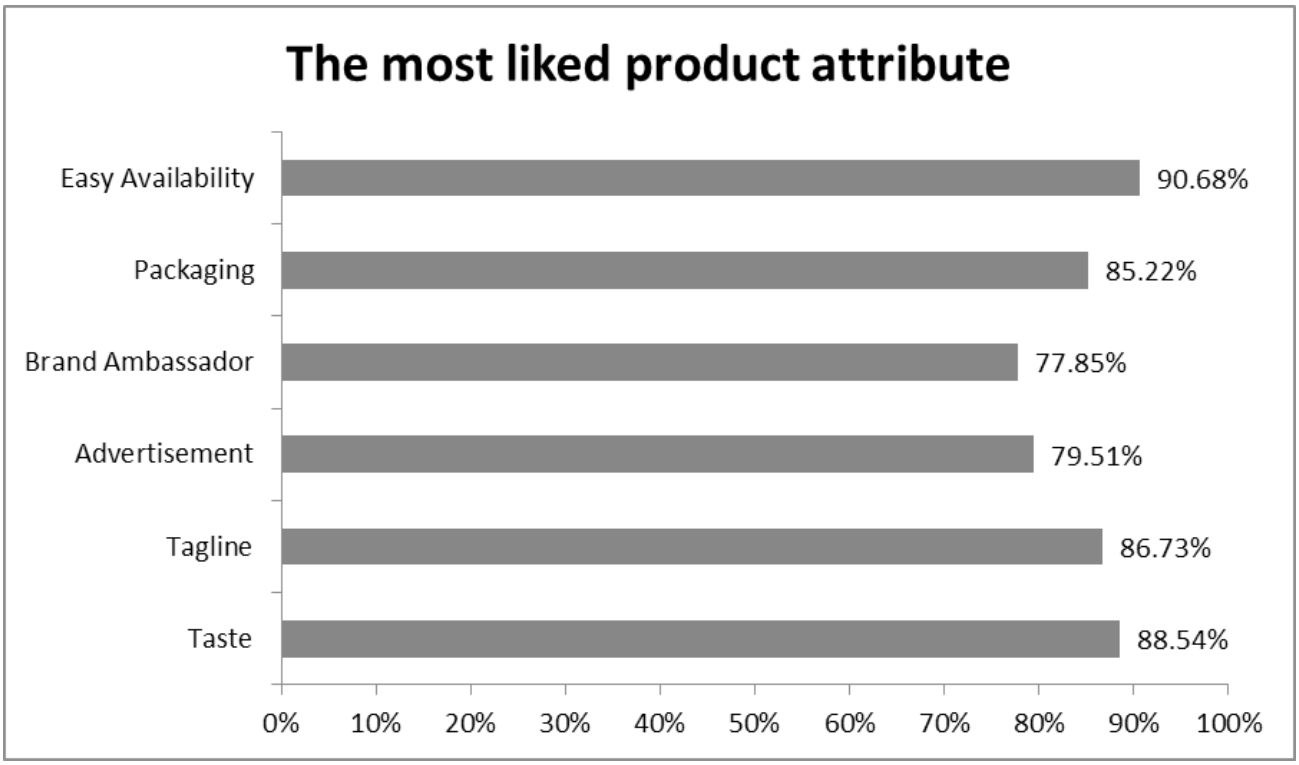
A paired t – test was carried out between Frequency of viewing advertisement and emotional connection with the product which was 0.847 while the correlation between the Emotional connection with the product and purchase action was 0.772. The reaction of a customer if the product was not available at the place of purchase will the customer opt for an another drink or go to next destination or may not prefer to drink at all, most of the respondents replied that they would prefer to go to next destination and if the product was not available even there than they would not prefer to but the optional product and the emotional connection with the product was 0.796. This shows that there is a strong significance connection between emotional connection with the product and brand loyalty as $p<0.001$. Thus, the null hypothesis ($H_{0)}$ is rejected and the Alternate Hypothesis ($H_{1)}$ is accepted. Thus there is a significant effect of use of emotions on brand engagement.

The respondents were as asked to rate various types of emotions which they like the most on a Five (5) point Likert Scale, Response score of friendship & happiness scored highest 88.93%, whereas frustration & Patriotism scored the least i.e. only 75.87% & 56.27% respectively. This showed that no emotion in brand communication goes unnoticed. The level of affecting may vary depending on the product and consumer but effective use of emotions in advertisements does help to grab the attention of the viewer and effectively convey the brand message.



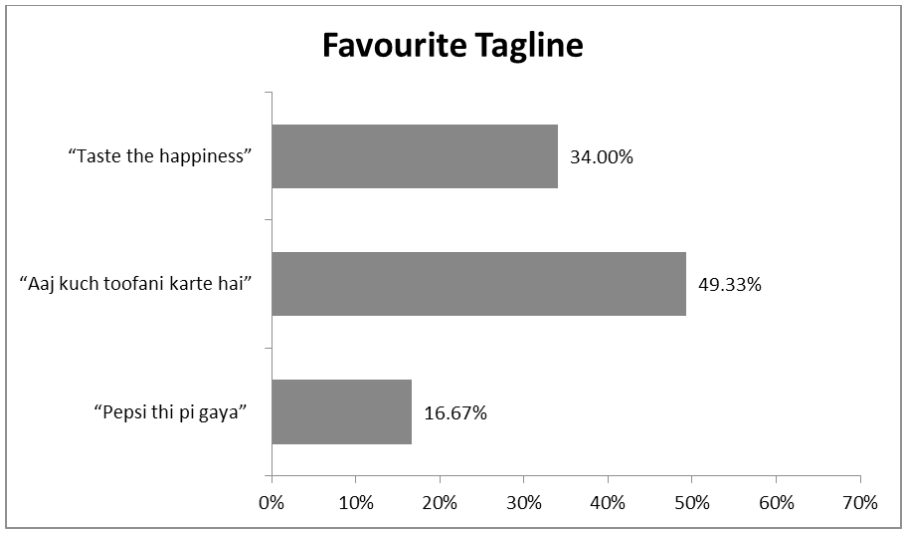
Source: own elaboration

The respondents were as asked to rate on a Five (5) point Likert Scale, various attributes of the product which they like the most regarding their cola based soft drink, Response score of Easy availability was scored 90.68%, Taste scored 88.54%, Tagline& Slogan scored 86.73%, Packaging was 85.22%, Advertisement was 79.51% and Brand Ambassador was 77.85% respectively. This showed that taglines and slogans in brand communication don't go unnoticed. The level of affecting may vary depending on the product and consumer but effective use of emotions in slogans and taglines does help to grab the attention of the viewer and effectively convey the brand message. Emotional Slogan helps to enhance the product attribute and makes the brand communication and brand message more consumer centric. When the slogan matches with the personality traits of consumer the automatically get attracted towards it. But again for effective delivery of brand message through slogan and emotional appeals a strong brand ambassador justifying the both is a must requirement in advertisement.



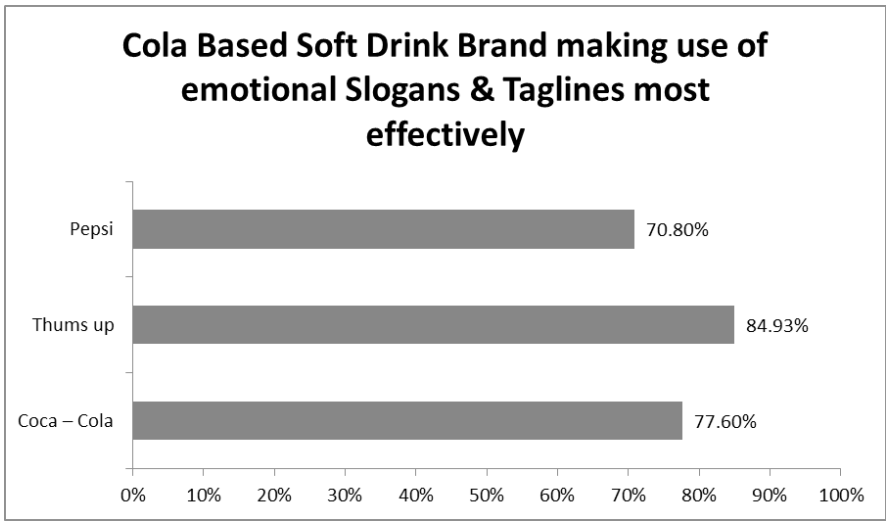
Source: own elaboration

The respondents were then inquired to rate their favorite slogan of Cola based soft drinks. The slogan of Thumps – Up "*Aaj kuch Toofani karte hai*" scored highest marks and was liked by 49.33%, followed by Coca cola's slogan "*Taste the happiness*" with 34.00% and lastly Pepsi's slogan *"Pepsi thi pi gaya"* with a score of 16.67%. The reason Thump – up scoring highest was the slogan was a complete combination of fun, thrill, adventure, excitement, refreshment and was highest energetic. This is what the exactly personality trait of today's youth is. No doubt it was highest scored slogan. On the other hand Coca cola's slogan was more of family oriented, sentimental, caring, love and affection filled. Out of the 3 slogans Pepsi's slogan fell comparatively bland and simple and so it was least scored. However, the slogan of Pepsi does match with the situation shown in advertisement. Thus it creates a situational gimmick but still it was least accepted slogan from the above three.



Source: own elaboration

Further ahead when the respondents were asked about which soft drink brand makes the best use of emotional slogans and Taglines as a part of their marketing strategy; Thumbs up scored 84.93% followed by Coca cola with 77.60% and last was Pepsi with 70.80%. They also agreed that the brand ambassadors of these products justify the emotions portrayed in the advertisement most effectively.



Source: own elaboration

FINDINGS & DISCUSSIONS

The study was in context of consumers of cola based soft drinks (Coca – Cola & PepsiCo.) from Saurashtra Region of Gujarat State. A total of 410 respondents (61.33% males & 38.67% female) responded to the questionnaire from various areas of Saurashtra Region. Out of 100% respondents 37.33% were in the age group of 18 – 24 years, 26.67% between 24 – 30 years, 20.00% between 30 – 35 years and remaining 16.00% were 35 years & above age. In the same way out of 100% respondents 32.00% Respondents were students, 26.67% were service class, 11.33% were businessmen, 18.67% were professional and remaining 11.33% were stay at home or housewife. From Income wise bifurcation , 30.67% Respondents earned less than Rs.5000 per month, 17.33% were earning between Rs.5000 – 10000 per month, 25.33% were earning between Rs. 10000 – 15000 per month, 10.67% were earning between Rs. 15000 – 2000 per month and remaining 16.00% were earning Rs. 20000 & above per month.

From the above data analysis in both the case Null hypothesis is rejected i.e. alternative Hypothesis is accepted.

Following are the outcomes of analysis:

1. Consumers are affected by the use of emotional slogans in brand communications
2. Viewing of the emotional slogans merely in advertisement does increase brand loyalty of consumers.
3. A proper brand ambassador helps to justify and convey the emotional brand message appropriately.
4. There is a positive correlation between emotional brand connection and purchase and brand ambassadors helps to make this bond more stronger.
5. Emotional brand communications with the help of slogans and brand ambassadors helps to increase the brand loyalty of the consumers.
6. Effective use of emotions helps to create strong brand loyalty and brand engagement.

Using of emotions in advertisement is now gaining strength to connect with the consumers. As products start turning more and more homogeneous, the emotional attributes of a brand become essential for differentiation. As a consequence, advertising tends to rely more on sentiments to attract consumers' attention and interest. Emotions are said to move across borders better than information. Using emotions in advertisement may not compel consumer to purchase the product but it surely helps in creating a brand image. It was found that it's not just mere emotions that compelled consumers to purchase the product. However the emotions in slogans were strong enough to catch the attention of the consumers and make them think about the product. Thus, an emotional slogan does affect the purchase decision of consumers. Emotional branding helps in connecting with the mind and heart of the consumers and leaves a deep impact on consumers thought. Emotional appeals in brand communication process make brand recalling more easy and effective with the help of appropriate brand ambassadors. Thus brand ambassadors will help in proper communication of the emotional brand message.

FUTURE SCOPE OF STUDY

Use of effective emotions that matches with the brand attributes is one of the most important points of concern of the emotional branding. An equally strong brand ambassador should be selected which actually can match the emotion to be portrayed for making the emotional bond more strong. The effect of positive and negative emotions on consumers can still be worked out. Emotions in long run turn out into sentiments which help in creating a sentimental value of the product and further stronger brand engagement. So future research can still focus on how these sentimental brands can be created and how strongly will they influence the consumers brand engagement are the areas of further explorations in the subject matter.

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Customers' Satisfaction and Future Expectations in Indian Retail Sector

Prof. (Dr.) Vasudev Modi[1] and Dr. Nehal Shah[2]
[1]Professor, Department of Commerce,
Maharaja Krishnakumarsinhji Bhavngar University, Bhavnagar
[2]Associate Professor, Gandhinagar Institute of Technology,
MBA Section, Gandhinagar
E-mail: [1] vmodi@mkbhavuni.edu.in, [2]nehalshahmaba@gmail.com

Abstract—The Indian retail sector has witnessed robust growth during the last couple of years which could mainly be attributed to the establishment of international quality formats modified to suit the Indian purchase behavior; entry of several domestic and international players; development of retail-specific properties; improvement in retail processes, developing and implementing new technologies and turnaround in operations of some existing retailers. The purpose of study is to examine and analyze customer's awareness level, level of agreement as well as disagreement, level of satisfaction and their future expectations related to technologies used in the retail stores in the cities covered under study. From the study it was found that out of total (960) customers surveyed, more than 70.2% were highly aware of the technologies used in retail stores across the major cities of Gujarat state, followed by more than 65.4% of customers were highly satisfied with the performance of technologies such as internet shopping, in-stores announcement as well as security arrangements and the future expectations of Customers 'were: "Hassle free shopping", "Reduction in waiting time", "Comparison of QR code", "Ease of locating product" and "Proper parking management". More over to above criteria, 62.9% of customers believed that because of technology "Retailer will be able to give better customer service at an affordable price."

Keywords: Customer, Future Expectations, Indian Retail Sector, Satisfaction, SEM

INTRODUCTION

Organized retailing is almost a decade old industry in India with an overall market share of more than 3%. Currently, the estimated total sales of organized retailers are more than Rs.175 billion. The sector has witnessed robust growth during the last two years which could mainly be attributed to the establishment of international quality formats modified to suit the Indian purchase behavior; entry of several domestic and international players; development of retail-specific properties; improvement in retail processes, developing and implementing new technologies and turnaround in operations of some existing retailers, etc.

India is like a "Hot Spot" or "On Radar Screen" for retailing business for global giants. This growth in organized retail is being driven by a number of structural, social, and demographic and macro-economic factors as well.

Today, retailers need for more information and better tools to analyze the information and to make quick and better decisions. Information technology promises to deliver all these things that are providing data, as soon as it is required and tools to process data. Investments in technology are expensive and technology needs vary, depending on the size of the business and the forward and backward linkages that the retailer is able to seize. The technological footprint that a retailer creates is a strong indicator of his ability to leverage people and managerial talent.

The Indian retailing industry has been witnessing some exciting developments. Some of such key developments are as follows:

Emergence of Region-Specific Formats: With organized retail penetrating beyond metros, the retail industry has witnessed the emergence of stores with different sizes and formats.

Emergence of Discount Formats: Larger discount formats are now emerging as major competitors to both unorganized and organized retailers. This has resulted on account of penetration of organized retail into the lower strata of income groups and consumer demand for increased value-for-money.

Entry of International Players: Over the years, a number of well-known international brands have capitalized on the opportunities available in the sector by executing licensing agreements with Indian players.

Development of Malls: The establishment of malls has increased dramatically and funds for such products are being earmarked for non-metros as well.

Improvement in Retail Operating Efficiencies: Existing retail players are taking steps to improve the internal operations of their businesses and are implementing ERP and planning support systems.

Improving Profitability and Retail Revenues: Most of the retail players in the country are experiencing improved profitability, which is also expected to improve their credit profile in the industry.

LITERATURE REVIEW

The reforms in the retail sector coupled with the emergence of new technologies are enabling new competitors to enter the retail and services market quickly and efficiently.

Indian retail outlets are going for the adoption and implementation of technology in a big way. However, much is still to be achieved. The results shows that implementation of technology in retail outlets is in its nascent stage—only a small number of retail outlets offer web-based technological services to customers and the full benefits of Information Technology are still to be realized by many retail outlets.

The retail sector in India is facing unprecedented competition as there exists traditional retail outlets as well as tech equipped retail outlets across the major cities of Gujarat State.

Samridhi Tanwar *et al.* (2008) paper represented that India's Organized Retail Sector is the *sunrise* industry, representing the unique and diversified needs of customers.

Rohita Kumar Mishra (2009) dealt with study of benchmarking in retailing and compares the performance of some selected retail stores. This study was an application of Data Envelopment Analysis (DEA) to assess the relative efficiency of the retail stores. The data for this study was collected from 25 retail stores of Sambalpur district of Orissa with a structured questionnaire and interviewing customers and retailers.

It indicated that retailer can take the non-discretionary inputs like location, manager's experience and others to measure the benchmarking. Retailers must be aware about good customer service, so that they not only enhance and attract retail customer but also customer delight can be achieved which is an asset to the company.

Tom Lemke & Ray Stone (2012) demonstrated main three technology adoption affecting factors: number one reason to implement new technology is to respond to a direct competitor who has or may soon be able to win customers with it.

Anita Priscilla J. & Dr. Shanthi (2010) revealed that customer satisfaction and customer loyalty are becoming increasingly important factors in modern retailing compare to a market characterized by slow growth and intense competition.

Catering to consumer needs and moods requires lot of study and research. Without an innovative outlook, it might become very tough for the retailers to compete and survive in the coming years. The products offered, the store format, the pricing, and the services provided definitely influence the consumers to a great extent. But with the right use of consumer behaviour with the relevant innovative strategies will help the Indian retailers to satisfy customers and build a long lasting relationship.

PROPOSED MODEL FOR CUSTOMERS

The researchers have diagrammatically represented the proposed model of Customers based on combination of Motivational and Efficiency Factors. Also these all factors suggest their effectiveness for the usage of the different technologies in the retail stores. This model is shown in Figure No. 1.

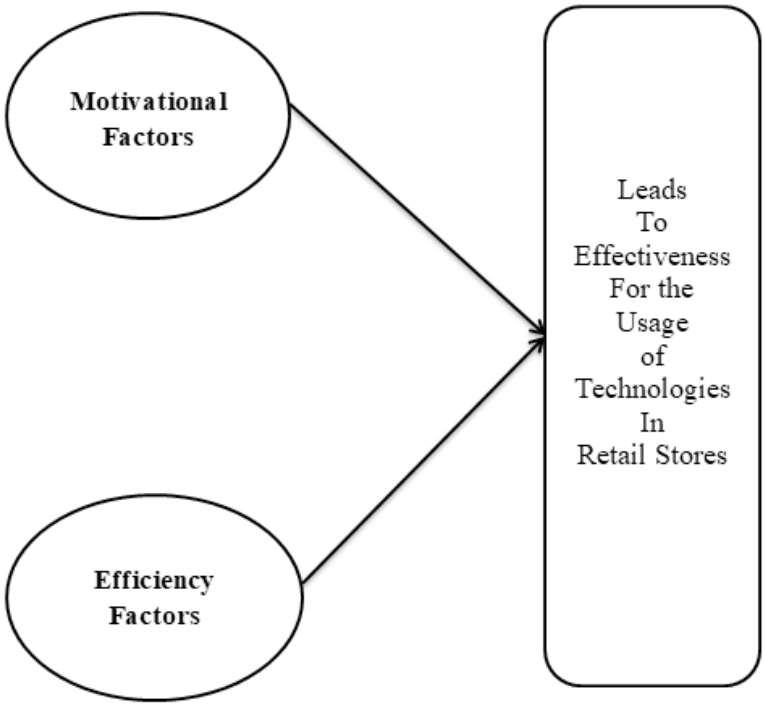

Fig. 1: Proposed Model for Customers

RESEARCH METHODOLOGY

SELECTION OF RESEARCH PROBLEM

From the existing literature review it was found that there is a need to do study on Customers' Satisfaction and future expectations in Indian Retail Sector with special focus to Gujarat State..

OBJECTIVE FOR THE STUDY

To examine and analyze customer's awareness level, level of agreement as well as disagreement, level of satisfaction and their future expectations related to technologies used in the retail stores in the cities covered under study.

RESEARCH DESIGN

The research design for this study is descriptive research design.

A "Pilot Test" was conducted on the preliminary questionnaire to assess its comprehension and the average completion time. The questionnaire was filled up by the 65 customers' across Ahmedabad City.

FROM CUSTOMER'S PERSPECTIVE

1. The first feedback from the customers surveyed is about the level of their awareness with respect to the types of technologies used in the retail stores across Ahmedabad city.

Table 1: Awareness towards Various Technologies

Level of Awareness	Types of Technology Used in Retail Stores
High (4 -5)	On line retailing, Vending machine, E-payment, Video surveillance
Medium (3)	RFID
Low (1-2)	QR code, Kiosk, In store Announcement, Self-billing counter

2. The second feedback revealed the motivational factors behind the use of technology in retail stores across the Ahmedabad city.

Table 2: Motivational Factors behind use of Technology in Retail Stores

Level of Agreement	Attributes of Technology Used in Retail Stores
Strongly Agree (5)	Technology saves the cost, Technology provides real time information, and Technology facilitates to get better customer service.
Agree (4)	Technology saves the time.

3. The third feedback is about the customers shopping behavior vis-à-vis the technologies used in the retail stores across the Ahmedabad city.

Table 3: Customers Shopping Behaviour

Statements	Level of Agreement
I like to shop from internet.	Neutral
I like to shop where proper queue management is available.	Agree
I like to shop where lighting and interior is impressive.	Neutral
I like to shop where billing process is quick and fair.	Strongly agree
I like to shop where varieties of merchandises are available.	Strongly agree
I like to shop where varieties of merchandise are stacked in a proper way.	Agree
I like to shop where clear directional signage are available.	Agree
I like to shop where comfortable shopping environment is available.	Agree

4. The fourth feedback from the customers revealed their satisfaction level towards the technologies used in the retail stores across Ahmedabad city.

Table 4: Customer Satisfaction towards Technologies

Technologies used in Retail Stores	Level of Satisfaction
Credit Card payment	Highly Satisfied
Internet – shopping	Satisfied
Queue management	Satisfied
In store announcement	Satisfied
Parking Facility	Satisfied
Billing counter	Satisfied
Security Arrangement	Satisfied

DATA ANALYSIS AND INTERPRETATIONS

Demographic Detailing of Customers

The below table no. 5 summarizes the demographic detailing of 960 customers who were surveyed for knowing their perspectives about the technologies used in retail stores across the major cities of Gujarat state.

Table 5: Summary of Demographic Detailing of Customers

Demographic Parameters	Details of Customers Surveyed	
Gender	**672 Male Customers**	**288 Female Customers**
Age Group (Years)	Under 18 years: Year 18-24: Year 25-34: Year 35-44 : Year 45-54: Year 55-64: Year 65-74: More than 75 Years:	44 customers 160 customers 288 customers 156 customers 136 customers 84 customers 60 customers 32 customers
Educational Qualification	Primary school : 48 Diploma: 148 Post graduates: 292	High school: 168 Graduates: 304
Annual Family Income (RS.)	Less than Rs. 30,000: 30,000 to 59,999: 60,000 to 99,999: 1,00,000 to 1,99,999: 2,00,000 to 2,99,999: More than Rs. 3,00,000:	20 customers 12 customers 12 customers 44 customers 388 customers 484 customers
Occupation	Student: 164 Business class: 80 Home Maker: 188	Service Class: 460 Retired: 68

(*Source:* Primary Data)

Awareness Level of Customers' about the Different Retailing Technologies

The customers surveyed across the Gujarat state were asked about their awareness as to different retailing technologies such as Online Retailing, QR Code, RFID, Vending Machine, E-Payments, In-store Announcements, and Video Surveillance (CCTV) which exist in the retail stores. The awareness level was measured on the scale of very little extent (1), a little extent (2), Undecided (3), To Some Extent (4), To Large Extent (5).

Awareness of Customers towards Online Retailing

Table 6: Online Retailing

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Very Little Extent (1.00)	108	11.3	11.3	11.3
	A Little Extent (2.00)	80	8.3	8.3	19.6
	Undecided (3.00)	176	18.3	18.3	37.9
	To Some Extent (4.00)	384	40.0	40.0	77.9
	To Large Extent (5.00)	212	22.1	22.1	100.0
	Total	960	100.0	100.0	
	Mean score: 3.5333				

(*Source:* Primary Data)

Inference: The above table no. 6 revealed that out of 960 customers surveyed across Gujarat State, almost 62.1% of the customers were aware about online retailing as a technology used in the retail stores. This is also substantiated by the mean score of 3.5333.

Awareness of Customers towards QR Code

Table 7: QR Code

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Very Little Extent (1.00)	84	8.8	8.8	8.8
	A Little Extent (2.00)	108	11.3	11.3	20.0
	Undecided (3.00)	132	13.8	13.8	33.8
	To Some Extent (4.00)	392	40.8	40.8	74.6
	To Large Extent (5.00)	244	25.4	25.4	100.0
	Total	960	100.0	100.0	
	Mean score: 3.6292				

(*Source:* Primary Data)

Inference: The above table no. 7 revealed that out of 960 customers surveyed across Gujarat state, almost 66.2% of the customers were aware about QR Code as a technology used in the retail stores. This is also substantiated by the mean score of 3.6292.

Awareness of Customers towards RFID

Table 8: RFID

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Very Little Extent (1.00)	88	9.2	9.2	9.28
	A Little Extent (2.00)	128	13.3	13.3	22.5
	Undecided (3.00)	164	17.1	17.1	39.6
	To Some Extent (4.00)	316	32.9	32.9	72.5
	To Large Extent (5.00)	264	27.5	27.5	100.0
	Total	960	100.0	100.0	
	Mean score: 3.5625				

(*Source:* Primary Data)

Inference: The above table no. 8 revealed that out of 960 customers surveyed across Gujarat state, almost 60.4% of the customers were aware about RFID as a technology used in the retail stores. This is also substantiated by the mean score of 3.5625.

Awareness of Customers towards Vending Machine

Table 9: Vending Machine

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Very Little Extent (1.00)	128	13.3	13.3	13.3
	A Little Extent (2.00)	116	12.1	12.1	25.4
	Undecided (3.00)	196	20.4	20.4	45.8
	To Some Extent (4.00)	288	30.0	30.0	75.8
	To Large Extent (5.00)	232	24.2	24.2	100.0
	Total	960	100.0	100.0	
	Mean score: 3.3958				

(*Source:* Primary Data)

Inference: The above table no. 9 revealed that out of 960 customers surveyed across Gujarat state, almost 54.2% of the customers were aware about Vending Machine as a technology used in the retail stores. This is also substantiated by the mean score of 3.3958.

Awareness of Customers towards e-Payments

Table 10: e-Payments

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Very Little Extent (1.00)	108	11.3	11.3	11.3
	A Little Extent (2.00)	80	8.3	8.3	19.6
	Undecided (3.00)	176	18.3	18.3	37.9
	To Some Extent (4.00)	384	40.0	40.0	77.9
	To Large Extent (5.00)	212	22.1	22.1	100.0
	Total	960	100.0	100.0	
	Mean score: 3.5333				

(*Source:* Primary Data)

Inference: The above table no. 10 revealed that out of 960 customers surveyed across Gujarat state, almost 62.1% of the customers were aware about E-Payments as technology used in the retail stores. This is also substantiated by the mean score of 3.5333.

Awareness of Customers towards In-store Announcements

Table 11: In-Store Announcement

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Very Little Extent (1.00)	84	8.8	8.8	8.8
	A Little Extent (2.00)	108	11.3	11.3	20.0
	Undecided (3.00)	132	13.8	13.8	33.8
	To Some Extent (4.00)	392	40.8	40.8	74.6
	To Large Extent (5.00)	244	25.4	25.4	100.0
	Total	960	100.0	100.0	
	Mean score: 3.6292				

(*Source:* Primary Data)

Inference: The above table no. 11 revealed that out of 960 customers surveyed across Gujarat state, almost 66.2% of the customers were aware about In-store Announcement as technology used in the retail stores. This is also substantiated by the mean score of 3.6292.

Awareness of Customers towards Video Surveillance (CCTV)

Table 12: Video Surveillance (CCTV)

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Very Little Extent (1.00)	108	11.3	11.3	11.3
	A Little Extent (2.00)	80	8.3	8.3	19.6
	Undecided (3.00)	176	18.3	18.3	37.9
	To Some Extent (4.00)	384	40.0	40.0	77.9
	To Large Extent (5.00)	212	22.1	22.1	100.0
	Total	960	100.0	100.0	
	Mean score: 3.5333				

(*Source:* Primary Data)

Inference: The above table no. 12 revealed that out of 960 customers surveyed across Gujarat state, almost 62.1% of the customers were aware about video surveillance (CCTV) as technology used in the retail stores. This is also substantiated by the mean score of 3.5333.

Mean Score Statistics

Table 13: Mean Score Statistics

		Online Retailing	QR Code	RFID	Vending Machine	e-Payment	In-store Announcement	Video Surveillance (CCTV)
N	Valid	960	960	960	960	960	960	960
	Missing	0	0	0	0	0	0	0
Mean		3.5333	3.6292	3.5625	3.3958	3.5333	3.6292	3.5333

Inference: The mean is defined as the sum of a series of observations divided by the number of observations in the series. It is commonly used to describe the central tendency of variables.

With respect to the awareness level of the customers, Parameters with Mean > 3.00 signified the awareness level, whereas Mean = 3.00 implied an unbiased response and Mean < 3.00 indicated very low level of awareness.

As the mean score of the responses derived is more than 3 in the above table no. 13, the researcher deduces that the customers surveyed have awareness about the various technologies used in the Retail Stores situated across the Gujarat state.

Agreement Level of Customers about Attributes of Retailing Technologies Used in Retail Outlets

The customers surveyed across the Gujarat state were asked about their agreeableness about the attributes as to different retailing technologies such as Online Retailing, QR Code, RFID, Vending Machine, E-Payments, In-store Announcements, and Video Surveillance (CCTV) which exist in the retail stores. The agreeableness about the attributes as to different retailing technologies was measured on the scale of Strongly Disagree (1), Disagree (2), Undecided (3), Agree (4), Strongly Agree (5).

Use of Technology Saves the Cost and Provides Product at Cheaper Rate

Table 14: Use of Technology Saves the Cost and Provides Product at Cheaper Rate

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Strongly Disagree (1.00)	84	8.8	8.8	8.8
	Disagree (2.00)	108	11.3	11.3	20.0
	Undecided (3.00)	132	13.8	13.8	33.8
	Agree (4.00)	392	40.8	40.8	74.6
	Strongly Agree (5.00)	244	25.4	25.4	100.0
	Total	960	100.0	100.0	
	Mean score: 3.63				

(*Source:* Primary Data)

Inference: The above table no. 14 revealed that out of 960 customers surveyed across Gujarat State, almost 66.2% of the customers' showed their agreement level with respect to the attribute that **Use of technology saves the cost and provides product at cheaper rate**. This is also substantiated by the mean score of 3.63.

Implementation of Technology Saves the Time by Providing Real Time Information while Purchase

Table 15: Statement: Implementation of Technology Saves the Time by Providing Real Time Information while Purchase

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Strongly Disagree (1.00)	108	11.3	11.3	11.3
	Disagree (2.00)	80	8.3	8.3	19.6
	Undecided (3.00)	176	18.3	18.3	37.9
	Agree (4.00)	384	40.0	40.0	77.9
	Strongly Agree (5.00)	212	22.1	22.1	100.0
	Total	960	100.0	100.0	
	Mean score: 3.53				

(*Source:* Primary Data)

Inference: The above table no. 15 revealed that out of 960 customers surveyed across Gujarat state, almost 62.1% of the customers' showed their agreement level with respect to the attribute that **Implementation of technology saves the time by providing real time information while purchase**. This is also substantiated by the mean score of 3.53.

Technology Adoption Facilitates you to Get Better Customer Service

Table 16: Technology Adoption Facilitates you to Get Better Customer Service

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Strongly Disagree (1.00)	76	7.9	7.9	7.9
	Disagree (2.00)	108	11.3	11.3	19.2
	Undecided (3.00)	136	14.2	14.2	33.3
	Agree (4.00)	392	40.8	40.8	74.2
	Strongly Agree (5.00)	248	25.8	25.8	100.0
	Total	960	100.0	100.0	
	Mean score: 3.654				

(*Source:* Primary Data)

Inference: The above table no. 16 revealed that out of 960 customers surveyed across Gujarat state, almost 66.6% of the customers' showed their agreement level with respect to the attribute that **Technology adoption facilitates you to get better customer service.** This is also substantiated by the mean score of 3.654.

Technology in Retail Stores has Reduced Customers' Queries

Table 17: Technology in Retail Stores has Reduced Customer's Queries

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Strongly Disagree (1.00)	216	22.5	22.5	22.5
	Disagree (2.00)	151	15.7	15.7	38.2
	Undecided (3.00)	215	22.4	22.4	60.6
	Agree (4.00)	239	24.9	24.9	85.5
	Strongly Agree (5.00)	139	14.5	14.5	100.0
	Total	960	100.0	100.0	
	Mean score: 3.01				

(*Source:* Primary Data)

Inference: The above table no.17 revealed that out of 960 customers surveyed across Gujarat state, almost 39.4% of the customers' showed their agreement level with respect to the attribute that **Technology in Retail Stores has reduced customers' queries.** This is also substantiated by the mean score of 3.01.

Technology in Retail Stores has Reduced Paper Work and Chances of Errors

Table 18: Technology in Retail Stores has Reduced Paper Work and Chances of Errors

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Strongly Disagree (1.00)	142	14.8	14.8	14.8
	Disagree (2.00)	239	24.9	24.9	39.7
	Undecided (3.00)	200	20.8	20.8	60.5
	Agree (4.00)	210	21.9	21.9	82.4
	Strongly Agree (5.00)	169	17.6	17.6	100.0
	Total	960	100.0	100.0	
	Mean score: 3.03				

(*Source:* Primary Data)

Inference: The above table no.18 revealed that out of 960 customers surveyed across Gujarat state, almost 39.5% of the customers' showed their agreement level with respect to the attribute that **Technology in Retail Stores has reduced paper work and chances of errors.** This is also substantiated by the mean score of 3.03.

Technology in Retail Stores Provides Timely and Better Cost Effective Solutions

Table 19: Technology in Retail Stores Provides Timely and Better Cost Effective Solutions

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Strongly Disagree (1.00)	218	22.7	22.7	22.7
	Disagree (2.00)	152	15.8	15.8	38.5
	Undecided (3.00)	183	19.1	19.1	57.6
	Agree (4.00)	194	20.2	20.2	77.8
	Strongly Agree (5.00)	213	22.2	22.2	100.0
	Total	960	100.0	100.0	
	Mean score: 3.03				

(*Source:* Primary Data)

Inference: The above table no. 19 revealed that out of 960 customers surveyed across Gujarat state, almost 42.4% of the customers' showed their agreement level with respect to the attribute that **Technology in Retail Stores provides timely and better cost effective solutions.** This is also substantiated by the mean score of 3.03.

Technology in Retail Stores Reduces Time of Managing Inventory

Table 20: Technology in Retail Stores Reduces Time of Managing Inventory

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Strongly Disagree (1.00)	125	13.0	13.0	13.0
	Disagree (2.00)	251	26.1	26.1	39.2
	Undecided (3.00)	231	24.1	24.1	63.2
	Agree (4.00)	259	27.0	27.0	90.2
	Strongly Agree (5.00)	94	9.8	9.8	100.0
	Total	960	100.0	100.0	
	Mean score: 3.02				

(*Source:* Primary Data)

Inference: The above table no.20 revealed that out of 960 customers surveyed across Gujarat state, almost 36.8% of the customers' showed their agreement level with respect to the attribute that Technology in Retail Stores reduces time of managing inventory. This is also substantiated by the mean score of 3.02.

Mean Score Statistics

Table 21: Mean Score Statistics

		Product at Cheaper Rate	Saves the Time	Better Customer Service	Reduce Customer Queries	Reduce Chances of Errors	Timely and Cost Effective Solution	Reduce Time of Managing Inventory
N	Valid	960	960	960	960	960	960	960
	Missing	0	0	0	0	0	0	0
Mean		3.63	3.53	3.654	3.01	3.03	3.03	3.02

Inference: The mean is defined as the sum of a series of observations divided by the number of observations in the series. It is commonly used to describe the central tendency of variables.

With respect to the agreement level of customers about attribution of retailing technologies, Parameters with Mean > 3.00 signified the awareness level, whereas Mean = 3.00 implied an unbiased response and Mean < 3.00 indicated very low level of agreement.

As the mean score of the responses derived is more than 3 in the above table no. 21, the researcher deduces that the customers surveyed have positive agreement level about attributes of retailing technologies used in the Retail Stores situated across the Gujarat state.

Satisfaction Level of Customers' towards Retailing Technologies Used in Retail Outlets

The customers surveyed across the Gujarat State were asked about their satisfaction level towards different retailing technologies such as Credit Card Payments, Internet Shopping, In store Announcements, and Security Arrangements which exist in the retail stores. The satisfaction level towards different retailing technologies was measured on the scale of Highly Dissatisfied (1), Dissatisfied (2), Neutral (3), Satisfied (4) and Highly Satisfied (5).

Satisfaction Level of Customers with Respect to Credit Card Payments

Table 22: Credit Card Payment

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Highly Dissatisfied (1.00)	108	11.3	11.3	11.3
	Dissatisfied (2.00)	80	8.3	8.3	19.6
	Neutral (3.00)	176	18.3	18.3	37.9
	Satisfied (4.00)	384	40.0	40.0	77.9
	Highly Satisfied (5.00)	212	22.1	22.1	100.0
	Total	960	100.0	100.0	
	Mean score: 3.5333				

(*Source:* Primary Data)

Inference: The above table no. 22 revealed that out of 960 customers surveyed across Gujarat state, almost 62.1% of the customers' showed their satisfaction towards Credit Card Payments used in the retail stores. This is also substantiated by the mean score of 3.533.

Satisfaction Level of Customers with Respect to Internet Shopping

Table 23: Internet Shopping

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Highly Dissatisfied (1.00)	84	8.8	8.8	8.8
	Dissatisfied (2.00)	108	11.3	11.3	20.0
	Neutral (3.00)	140	14.6	14.6	34.6
	Satisfied (4.00)	384	40.0	40.0	74.6
	Highly Satisfied (5.00)	244	25.4	25.4	100.0
	Total	960	100.0	100.0	
	Mean score: 3.62				

(*Source:* Primary Data)

Inference: The above table no. 23 revealed that out of 960 customers surveyed across Gujarat state, almost 65.4% of the customers' showed their satisfaction towards Internet Shopping as a technology used in the retail stores. This is also substantiated by the mean score of 3.62.

Satisfaction Level of Customers with Respect to In-store Announcements

Table 24: In-store Announcements

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Highly Dissatisfied (1.00)	100	10.4	10.4	10.4
	Dissatisfied (2.00)	80	8.3	8.3	18.8
	Neutral (3.00)	164	17.1	17.1	35.8
	Satisfied (4.00)	388	40.4	40.4	76.3
	Highly Satisfied (5.00)	228	23.8	23.8	100.0
	Total	960	100.0	100.0	
	Mean score: 3.587				

(*Source:* Primary Data)

Inference: The above table no. 24 revealed that out of 960 customers surveyed across Gujarat state, almost 64.2% of the customers' showed their satisfaction towards in-store Announcements as a technology used in the retail stores. This is also substantiated by the mean score of 3.587.

Satisfaction Level of Customers with Respect to Security Arrangements

Table 25: Security Arrangements

Scale		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Highly Dissatisfied (1.00)	92	9.6	9.6	9.6
	Dissatisfied (2.00)	116	12.1	12.1	21.7
	Neutral (3.00)	132	13.8	13.8	35.4
	Satisfied (4.00)	380	39.6	39.6	75.0
	Highly Satisfied (5.00)	240	25.0	25.0	100.0
	Total	960	100.0	100.0	
	Mean score: 3.583				

(*Source:* Primary Data)

Inference: The above table no. 25 revealed that out of 960 customers surveyed across Gujarat state, almost 64.6% of the customers' showed their satisfaction towards Security Arrangements as a technology used in the retail stores. This is also substantiated by the mean score of 3.583.

Mean Score Statistics

Table 26: Mean Score Statistics

		Credit Card Payment	Internet Shopping	In-store Announcement	Security Arrangements
N	Valid	960	960	960	960
	Missing	0	0	0	0
Mean		3.5333	3.62	3.587	3.583

Inference: The mean is defined as the sum of a series of observations divided by the number of observations in the series. It is commonly used to describe the central tendency of variables.

With respect to the satisfaction level of the customers, Parameters with Mean > 3.00 signified the awareness level, whereas Mean = 3.00 implied an unbiased response and Mean < 3.00 indicated very low level of awareness.

As the mean score of the responses derived is more than 3 in the above table no. 26, the researcher deduces that the customers surveyed were satisfied towards the various technologies used in the Retail Stores situated across the Gujarat state.

Future Expectations of Customers' Related to Retail Stores Environment

To know about the future expectations of the customers related to retail store environment. Based on the reviews and research gap researcher identified the traits of technology usage in retail stores such as Reducing waiting time, Ease of locating product, Hassle free shopping, Proper parking management and Comparing QR code with other retailers. Further the researcher tried to identify the agreement as well as disagreement level appropriately justified by mean score. The mean score of more than 1 revealed agreement level with the proposition / traits considered by the researcher in the study, while less than 1 revealed the disagreement level of the customers.

Technology in Retail Stores will Reduce Waiting Time

Table 27: Reducing Waiting Time

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Yes (1.00)	704	73.33	73.33	73.33
	No (2.00)	256	26.67	26.67	100.0
	Total	960	100.0	100.0	

(*Source:* Primary Survey)

Inference*:* The above table no. 27 revealed that out of 960 customers surveyed across Gujarat State, almost 73.3% of the customers' were of the opinion that Technology in retail stores will reduce waiting time in future. This is also substantiated by the mean score of 1.26.

Technology in Retail Stores Helps the Customers to Locate the Product Easily

Table 28: Ease of Locating Product

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Yes (1.00)	644	67.08	67.08	67.08
	No (2.00)	316	32.92	32.92	100.0
	Total	960	100.0	100.0	

(*Source:* Primary Survey)

Inference: The above table no. 28 revealed that out of 960 customers surveyed across Gujarat state, almost 67.0% of the customers' were of the opinion that Technology in retail stores helps the customers to locate the product easily in future. This is also substantiated by the mean score of 1.33.

Technology in Retail Stores Helps the Customers to Shop Hassle Free

Table 29: Hassle Free Shopping

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Yes (1.00)	720	75.0	75.0	75.0
	No (2.00)	240	25.0	25.0	100.0
	Total	960	100.0	100.0	

(*Source:* Primary Survey)

Inference: The above table no. 29 revealed that out of 960 customers surveyed across Gujarat state, almost 75.0% of the customers' were of the opinion that Technology in retail stores helps the customers to shop hassle free in future. This is also substantiated by the mean score of 1.25.

Technology in Retail Stores Helps in Proper Parking Arrangement

Table 30: Proper Parking Management

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Yes (1.00)	632	65.83	65.83	65.83
	No (2.00)	328	34.17	34.17	100.0
	Total	960	100.0	100.0	

(*Source:* Primary Survey)

Inference: The above table no. 30 revealed that out of 960 customers surveyed across Gujarat state, almost 65.8% of the customers' were of the opinion that Technology in retail stores helps in proper parking arrangement in future. This is also substantiated by the mean score of 1.254.

Technology in Retail Stores Helps in Comparing QR Code with Other Retailers

Table 31: Comparing QR Code with Other Retailers

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Yes (1.00)	712	74.17	74.17	74.17
	No (2.00)	248	25.83	25.83	100.0
	Total	960	100.0	100.0	

(*Source:* Primary Survey)

Inference: The above table no. 31 revealed that out of 960 customers surveyed across Gujarat State, almost 74.1% of the customers' were of the opinion that Technology in retail stores helps in comparing the QR code with other retailers in future. This is also substantiated by the mean score of 1.258.

Future Expectations of Customers' about the Services Provided by Retailers

To identify from the customer whether with the help of the upcoming and modern technologies in retail stores; will the retailer give better services to them at an affordable price? For getting the answer, the researcher identified the agreement as well as disagreement level appropriately justified by mean score. The mean score of more than 1 revealed agreement level with the proposition/ traits considered by the researcher in the study, while less than 1 revealed the disagreement level of the customers.

Will Retailer be Able to Give Better Customer Service at an Affordable Price?

Table 32: Will Retailer be Able to Give Better Customer Service at an Affordable Price?

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Yes (1.00)	604	62.92	62.92	62.92
	No (2.00)	356	37.08	37.08	100.0
	Total	960	100.0	100.0	

(*Source:* Primary Survey)

Inference*:* The above table no. 32 revealed that out of 960 customers surveyed across Gujarat state, almost 62.9% of the customers' were of the opinion that Technology in retail stores will help the retailers to give better customer service at an affordable price in future. This is also substantiated by the mean score of 1.3708.

Hypotheses Testing

Various Chi-square tests has been performed to know the dependency of various variables. The summary of various applied chi square is shown in Table no. 33.

Table 33: Summary of Chi-square Tests

Statement	Pearson Chi-square Value	Result
H_0: The association between the age group of the customers and their level of awareness towards technology used in retail stores is not significant. **H_1:** The association between the age group of the customers and their level of awareness towards technology used in retail stores is significant.	0.663	H_0 Accepted
H_0: The association between the ejucation level of the customers and their level of awareness towards technology used in retail stores is not significant. **H_1:** The association between the ejucation level of the customers and their level of awareness towards technology used in retail stores is significant.	0.473	H_0 Accepted
H_0: The association between the income level of the customers and their level of awareness towards technology used in retail stores is not significant. **H_1:** The association between the income level of the customers and their level of awareness towards technology used in retail stores is significant.	0.767	H_0 Accepted
H_0: The association between the occupation of the customers and their level of awareness towards technology used in retail stores is not significant. **H_1:** The association between the occupation of the customers and their level of awareness towards technology used in retail stores is significant.	0.577	H_0 Accepted

Confirmatory Model Fit Analysis through SEM

Confirmatory Factor Analysis (CFA) specifies a measurement model a prior to restrict the possible number of factors in the solution (Anderson & Gerbing, 1988). As seen from the result, confirmatory factor analysis provides strong support for the structure of various attributes of Motivational and Efficiency factors of Customers. A confirmatory factor analysis allows for a validity assessment of the measures used.

A Confirmatory Factor Analysis was run on a second data set to evaluate whether the new data confirmed the proposed structure of the Customers and Effectiveness of retailing technologies as determined in the exploratory stage of the research. AMOS 16 was utilized to perform a confirmatory factor analysis on the data set. Structural Equation Modelling (SEM) methodology using AMOS 16 was used as more rigorous statistical techniques to validate the proposed factor model indicated from the results of the exploratory factor analysis of the data set.

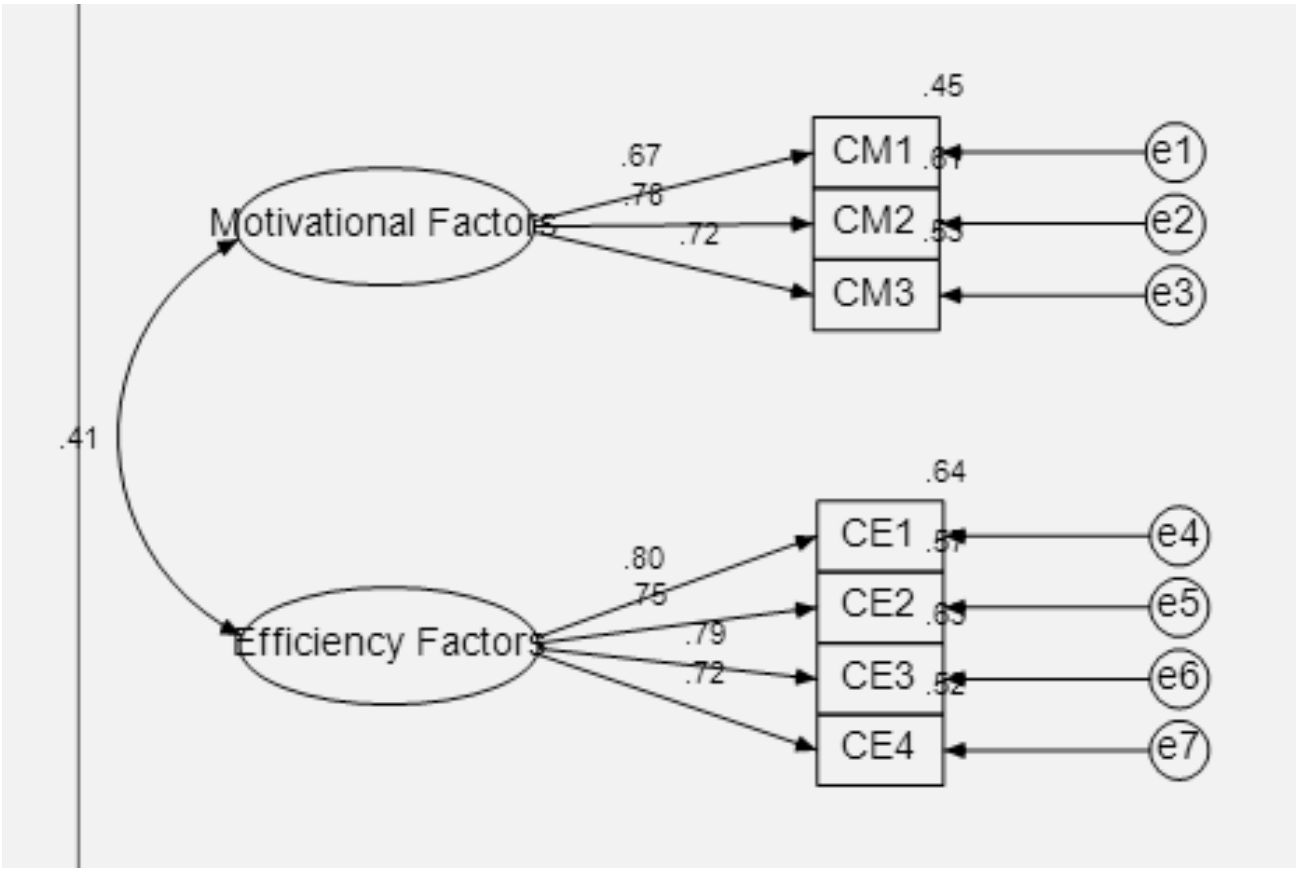

Fig. 2: Confirmatory Model Fit Analysis for Customers though SEM

In above Figure No. 2, following short terms have been used:

CM1 = Use of technology saves the cost and provides product at **cheaper rate**.

CM2= Implementation of technology **saves the time** by providing real time information while purchasing.

CM3= Technology adoption facilitates you to get **better customer service.**

CE1= Provides free flow of up to date information to customers thus **reducing customers' queries.**

CE2= Improving employee's efficiency by **reducing paper work and chances of errors**.

CE3= Technology provides **timely and better solutions** and thus **improving overall cost of store operations.**

CE4= Technology will track the stores activities and **reducing time of managing inventory.**

Model Fit Summary

Table 34: Fit Statistics of the Measurement Model

Fit Statistics	Recommended	Obtained
Chi Square	---	17.199
df	---	13.000
GFI	> 0.90	0.995
AGFI	> 0.90	0.989
NFI	> 0.90	0.993
CFI	> 0.90	0.998
TLI	> 0.90	0.997
RMSEA	< 0.05	0.018
RMR	< 0.05	0.003

Source: AMOS Output

In this analysis, Goodness of Fit index (GFI) obtained is 0.995 as against the recommended value of above 0.90. The Adjusted Goodness of Fit Index (AGFI) is 0.989 as against the recommended value of above 0.90 as well. The Normed Fit Index (NFI), Comparative Fit index (CFI), Tucker Lewis Index (TLI) are 0.993, 0.998, 0.997 respectively as against the recommended level of above 0.90.

RMSEA is 0.018 and is well below the recommended limit of 0.05, and Root Mean Square Residual (RMR) is also well below the recommended limit of 0.05 at 0.003. This can be interpreted as- the model explains the correlation to within an average error of 0.006 (Hu & Bentler, 1990). Hence the model shows an overall acceptable fit. **The model is an overall acceptable fit model.**

The confirmatory factor analysis showed an acceptable and excellent overall model fit and hence, the theorized model fits well with the observed data**.** It can be concluded that the hypothesized seven factors CFA model fits the sample data very well.

From the above model, following things were inferred for Motivational & Efficiency factor as shown in below table no. 35 & 36 respectively.

Table 35: Summary of Motivational Factor Statements

Latent Factor	Observed Variable	Statement	Factor Loading	Order of Importance
Motivational Factor	CM2	Implementation of technology saves the time by providing real time information while purchasing.	0.783	1
	CM3	Technology adoption facilitates you to get better customer service.	0.725	2
	CM1	Use of technology saves the cost and provides product at cheaper rate.	0.672	3

Table 36: Summary of Efficiency Factor Statements

Latent Factor	Observed Variable	Statement	Factor Loading	Order of Importance
Efficiency Factor	CE1	Provides free flow of up to date information to customers thus reducing customers' queries.	0.799	1
	CE3	Technology provides timely and better solutions and thus improving overall cost of store operations.	0.792	2
	CE2	Improving employee's efficiency by reducing paper work and chances of errors.	0.752	3
	CE4	Technology will track the stores activities and reducing time of managing inventory.	0.718	4

FINDINGS

Awareness Level

Out of 960 customers surveyed, more than 70.2% of customers were highly aware about in-store announcement, QR Code, Online Retailing, E Payments, and Video surveillance used as a technology in the retail stores. However 60.1% of customers were moderately aware about RFID and 54.2% of customers were least aware about Vending machine used as a technology in the retail stores.

Motivational Factors

Out of the three criteria surveyed for the motivation of 960 customers, the single most first important criterion chosen by 66.6% of customers was "Technology provides best service from store", followed by 66.2% of customers believed that technology will provide "Cost saving through cheaper rate of products" and lastly 62.1% utilized "Real time product information while purchasing".

Efficiency Factors

After analyzing all the four criteria for efficiency factors, 42.4% customers gave firstly importance to the statement that "Technology provides better solutions and hence improving overall cost of store operations".

39.4% of customers gave secondly equal importance to two criteria: one of which denotes that technology facilitated in "Reducing paper work and chances of errors" and other one denotes that "Technology provides free flow of up to date information thus reducing their queries".

The third criterion liked by 36.8% of customers was that "Technology helps in tracking the stores activities and reducing time of managing inventory."

Satisfaction Level

Out of 960 customers, more than 65.4% of customers were highly satisfied with the performance of technologies such as Internet Shopping, in-stores announcement as well as Security Arrangements while 62.1% of customers were moderately satisfied by Credit Card Payment as a technology used in retail stores.

Future Expectations

According to the chronological order as per the importance by the customers, their future expectations were: "Hassle free shopping", "Reduction in waiting time", "Comparison of QR code", "Ease of locating product" and "Proper parking management".

More over to above criteria, 62.9% of customers believed that because of technology "Retailer will be able to give better customer service at an affordable price."

Hypothesis Testing (through *Chi Square* Analysis)

Out of the four Hypothesis performed by researcher, the common conclusion was denotes that "The association between the *Age group, Education, Occupation and Income level* of the customers and their level of awareness towards technology used in retail stores is not significant".

Cluster Analysis

After having classified the respondents into five clusters, following conclusions were derived:

By doing Cluster analysis for all 960 customers across 4 cities of Gujarat State, table no. 35, reflects "*Commonality of Perceptions*" among customers of 4 cities across Gujarat state with respect to retailing technologies.

Table 37: Commonality of Perceptions through Cluster Analysis

Cluster No.	No. of Cases	No. of Cases in Each City	Mean Score	Commonality of Perceptions
1	213	53	4.13	Retailing technologies will have very huge impact on performance of stores
2	184	46	4.00	Retailing technologies will impact performance of retail stores
3	104	26	3.99	Retailing technologies are prospective in nature
4	276	96	3.87	Retailing technologies are futuristic in nature
5	183	45	3.63	Retailing technologies will not be prospective in nature

Source: SPSS Output

Confirmatory Model Fit Analysis through SEM

The models overall goodness of fit is shown in below table no. 38.

Table 38: Fit Statistics of the Measurement Model

Fit Statistics	Recommended	Obtained
Chi Square	---	17.199
df	---	13.0
GFI	> 0.90	0.995
AGFI	> 0.90	0.989
NFI	> 0.90	0.993
CFI	> 0.90	0.998
TLI	> 0.90	0.997
RMSEA	< 0.05	0.018
RMR	< 0.05	0.003

Source: AMOS Output

From the above table no. 38, it was concluded that the model showed an overall acceptable fit. **The model is an overall acceptable fit model**.

With the confirmatory model fit analysis of customers, it was evident that the customers were giving equal weightage for Motivational and Efficiency factors. Positive relations have been found between these factors and if enough importance were given to these factors then this customers could be loyal customers towards the retail store. Furthermore it will also ensure the effective usage of technologies adopted by the retail stores.

CONCLUSION

The overall conclusion of this study was based on the motivational & efficiency factors with respect to customers, which suggest the effectiveness of technology used in the retail stores.

From the entire study, the researchers' came to this point that, ICT innovations helped in creating customer loyalty and attachment in the comparison of the traditional format without ICT implementation. These all things became possible only because of having the huge bulk of information all the time and analysis of all those information to take necessary actions which was not possible in traditional format without adoption of ICT.

The most important aspect of IT innovations is that, it increases the level of customer satisfaction because all the time information is available to the customer and even for the retailer also. This aspect helps in creating customer awareness and helps in reducing time, money and efforts which the customer always want to get for their satisfaction. So, information technology innovations give boost up to the retail sale and the future of IT is definitely secure for retail growth. Hence retailers need to adopt and efficiently implement contemporary technologies in their retail area.

From the study it is concluded that ***customers*** were highly aware about various technologies but they were least aware about Vending machine. This research revealed that customers mainly prefer technology implementation because it provides them "better customer service at an affordable price". According to this research, customers were satisfied about various retailing technologies but they were still not satisfied by Credit payment technology as it creates privacy issues in the mind of customers. When researcher asked customers about future expectations, majority of customers preferred technology which will provide them "Hassle Free Shopping". So future technology need to facilitate this feature with utmost care. From this research, it is evident that Demographic profile of customers including age, gender, education, occupation & income do not play significant role in creating mind set of the customers towards retailing technologies implementation in retail stores.

Customer satisfaction about the technology used in retail stores increased when providers make decision making more convenient and ensure that the customer could easily take advantage of the benefits of the technology they seek. Providing convenient pre and post purchase support of customers was vital to enhance their satisfaction with the services. With the introduction of Data Base Management, proper Data Mining techniques and real time tracking of data with the use of ERP software gave immense power in the hand of retailers to take care of each and every customer. Software like Customer Relationship Management (CRM), Human Resource Information System (HRIS) and Spread Sheets helped retailer to identify most profitable customers out of all available list of customers.

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Uncovering Indian Consumers' Attitude towards Indian Products: The Indiscernible Drive of the Marketplace Infrastructure

Riddhish N. Joshi[1] and Dr. Yogesh C. Joshi[2]
[1]Ph.D. Scholar,
GH Patel PG Institute of Business Management,
Sardar Patel University, Vallabh Vidyanagar, Gujarat, India
[1]Assistant Professor, S.R. Luthra Institute of Management, Surat, Gujarat, India
[2]Dean, Faculty of Management,
Director and Professor,
GH Patel PG Institute of Business Management,
Sardar Patel University, Vallabh Vidyanagar, Gujarat, India
E mail: [1]riddhish2@gmail.com, [2]joshiyogesh_2000@yahoo.com

Abstract—India's political past stalwartly endorsed the 'Swadeshi movement' (support to indigenous manufacturers) leading the 'Be Indian, Buy Indian' nationalist motto that limited the entry of foreign products. Since 1991 when the process of economic liberalisation and globalisation was originated in the country, the Indian market has experienced a considerable transformation.

Indian consumers differentiate and discern luxury according to global image of the brand and fit with tradition and Indian consumers are obsessed with foreign brands. Western brands generate symbolic representation in Indian societies and that's why Indian consumers show preference for western brands (Eng & Bogaert, 2010). The changes that would have been implausible before ten years happened because of opening up of the market through the gales of liberalization. (Ashok, 2007). It's a well-known fact that though the quality of certain Indian companies' products being far superior, their Indian names make them lose out on a lot of potential customers (Bhattacharya, 2015).

In such scenario, while the market has seen entry of a number of foreign brands because of Government's initiative of "Make in India" and there has also been a flood of large number of nationally manufactured products on the retail shelves, it is really important to know the attitude of Indian consumer towards Indian products.

There are numerous studies conducted by several researchers. Some are stated here. Indian consumers have a positive bias towards local brands as they scored very high on nationalism and preference for indigenous manufacture but at the same time, they are not partisan against foreign brand as they assessed foreign brand higher on quality, status, esteem and technology (Kinra, 2006). In India, highly educated, middle class and culturally open consumers are less likely to buy domestic products while collectivist consumers are more inclined to buy domestic products. Age and gender are not found to influence intent to buy domestic products (Kumar, Fairhurst and Kim, 2011).

Consumers' decision whether to buy domestic brands or imported brands often comprises a predicament between ethnocentrism, quality/image judgments of domestic brands and conspicuous consumption and the study revealed that Chinese consumers' willingness to buy domestic products tends to be weaker when they judge them of being low quality or when they hold higher conspicuous consumption values (Lu Wang & Xiong Chen, 2004). Younger shoppers were established to have open and positive tendency towards overseas products (Schooler, 1971; Tongberg, 1972; Wall, Heslop and Hofstra, 1988).

Consumers with higher income level were having low probability to purchase domestic products (Wall and Heslop, 1986). No relationship was found between level of income and positive perception towards domestic products (Han and Terpstra, 1988) however attitude towards imported products was found to be directly related to level of income (Wall *et al.,* 1988). Older consumers were found more "Patriotic" as compared to younger consumers and females were found to be more patriotic and probability of buying imported products reduces with increasing level of patriotism (Han and Terpstra, 1988). Consumption patterns of foreign branded goods, attitudes, lifestyles and values affect the affluence level of each region. Mumbai and Delhi (affluent) consumers purchased significantly more jeans of foreign brands as compared to Bangalore (least affluent) consumers. Social attributes like brand names and latest fashion were more prominent among Bangalore consumers (Jin & Son, 2013).

The current study aims to study Indian consumers' attitude towards Indian products and to recognise its impact on intention to buy Indian products in South Gujarat. Efforts will also be placed to comprehend the role of demographic factors to determine their attitude towards Indian products.

To understand the status quo better, consumers' likeliness to buy Indian products in various twenty product categories i.e. refrigerator, chocolates, watch, water purifiers, oven/microwave oven, car, deodorant, ice cream, hair oil, pen, laptop/computer, smart phone, toothpaste, washing machine, bath soap, two wheeler, footwear, television, shampoo, air conditioners and the brands which they/their family are using or would like to use in above mentioned twenty product categories will also be discovered.

Descriptive research design will be used. Data will be collected through a structured questionnaire using non probability convenience sampling technique. Attitude towards Indian products and intention to buy Indian products will be measured using a seven point Likert scale with extremes being "Strongly Disagree" and "Strongly Agree".

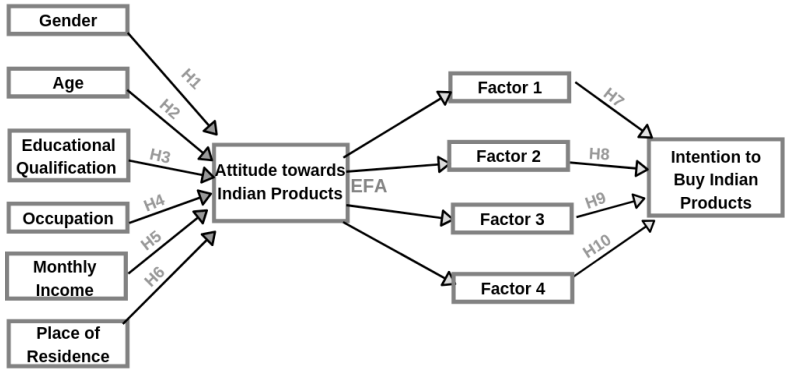

Fig. 1: Proposed Research Model

Likeliness to buy Indian brands in different product categories was measured using a seven point Likert scale with extremes being "Very Unlikely" and "Very Likely". Respondents will also be asked which brand, are they or their family using/would like to use in different product categories. Different demographic data of respondents will also be collected.

Based on literature review following research hypothesis are framed:

H1: Males have significantly negative attitude towards Indian products.

H2: Young consumer have significantly negative attitude towards Indian products.

H3: Consumer with higher educational qualification have significantly negative attitude towards Indian products.

H4: Salaried consumers have significantly negative attitude towards Indian products.

H5: Consumers with high monthly income qualification have significantly negative attitude towards Indian products.

H6: Consumers living in urban area have significantly negative attitude towards Indian products.

H7: There is a significant positive impact of factor1 of consumers' attitude towards Indian products on their intention to buy Indian products.

H8: There is a significant positive impact of factor2 of consumers' attitude towards Indian products on their intention to buy Indian products.

H9: There is a significant positive impact of factor3 of consumers' attitude towards Indian products on their intention to buy Indian products.

H10: There is a significant positive impact of factor4 of consumers' attitude towards Indian products on their intention to buy Indian products.

Structural Equation modelling will be used to assess the results. Various dimensions of attitude of consumers towards Indian products will be identified using exploratory factor analysis. Suitable results with discussion and conclusions will be presented.

Keywords: Buying Intention, Consumer Attitude, Domestic Products, Indian Products

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