CHAPTER 2

REVIEW OF LITERATURE

2.1 Overview

In the current chapter, the learnings from previous research work, carried out by various research scholars, companies, industry experts and practitioners in the IoT space, have been elaborated. Oil continues to remain earth's foremost fossil comprising 33% of the world's energy consumption. 'Oil and Gas' is used for powering vehicles, running industries, cooking food and has numerous other uses. It is expected that the global demand for energy would be more than 33 percent by 2035 with predominant of that being oil and gas (IBM, 2013). The Oil and Gas industry has to face numerous challenges such as lower prices of crude oil, lower production rates, volatility of demand and supply, growing upstream capital expenditure, economic downturn, competition for resources, rising costs, environmental legislations, burgeoning population, geopolitical changes, taxation, safety policies and aging workforce. Another key challenge faced by integrated Oil and Gas companies are sharing of operational information seamlessly across oilfields, refineries, pipelines, fuel outlets, logistics data across various units and locations etc. (IBM, 2013). Global warming, along with other environmental and health concerns present significant obstacles in accessing natural resources such as; crude oil, coal and gas. The evolution of digital technology has presented new opportunities and threats for most businesses (Willmott, 2013). Disruptive technologies are going to impact all sections of the economy (Manyika & McAfee, Why every leader should care about digitization and disruptive innovation, 2014). The world is going through a huge transformation from isolated devices to internet enabled things known IoT (Shukla & Sornalakshmi, 2013). By embracing digital transformation, firms can tap new opportunities and optimize their existing business operations (Denecken, 2014). Currently, 99 percent of physical objects still remain unconnected, thereby, creating a huge opportunity to connect people, process, data and things together through the IoT; these connections are expected to improve productivity, efficiency, customer experience and innovation (Bradley, Barbier, & Handler, 2013). IoT has wide applications in different areas, such as; remote monitoring of patients, control of traffic movement, smart parking, management of inventory, smart shopping at supermarket etc. The IoT environment is characterized by different interconnected devices (Sicari, Rizzardi, Grieco, & Coen-Porisini, 2014). IoT will be a significant cornerstone of a networked society in future which will impact our society, people's lives and operations of enterprises (Ericsson, 2014). Information technologies are playing a crucial role in the Energy industry than ever before (Perrons & Jensen, Data as an asset: What the oil and gas sector can learn from other industries about "Big Data", 2015). From an information technology perspective, the Oil and Gas industry faces a compelling value proposition to move towards cloud computing with a greater emphasis on data security. Significant investments in legacy infrastructure make full migration to cloud a challenging task (Perrons & Hems, 2013). The literature review was carried out from sources, such as, research articles, published reports, manuscripts, company annual reports etc. The following Table 2.1 depicts the details of the same:

Table 2.1: Reports and databases referred to and keywords being used

Keywords used	**Reports Published by**	**Databases**
• Internet of Things • Cloud Computing • Mobility	• McKinsey • Morgan Stanley • Deloitte • Gartner	• Elsevier • Taylor & Francis • Google-

• Digital Transformation • Connected Things • IoT applications • IoT in Oil and Gas • Smart device • Efficiency through IoT • Productivity through IoT • Cost savings through IoT • IoT security • IoT scalability • IoT in Downstream • Sensors	• Forrester • IDC • Ernst & Young • Cisco • SAP • Intel • Bosch • Accenture • Microsoft • Annual Reports of HPCL, BPCL and IOCL • IoT policy of Government of India	scholar • EBSCO • JSTOR

2.2 Introduction of Downstream Industry

The oil and gas value chain typically comprises of three main streams: upstream, midstream and downstream as shown in Figure 2.1. The downstream segment consists of companies engaged in refining, processing, marketing and transportation of petroleum products. The Refining sector involves separating crude oil into fractions and combining these fractions to make final products. All refineries perform three functions i.e. Refining, Conversion and Treatment. Primary distribution involves networks of product pipelines over large distances. Transportation of finished oil products from oil terminals to the end users is called Secondary Distribution.

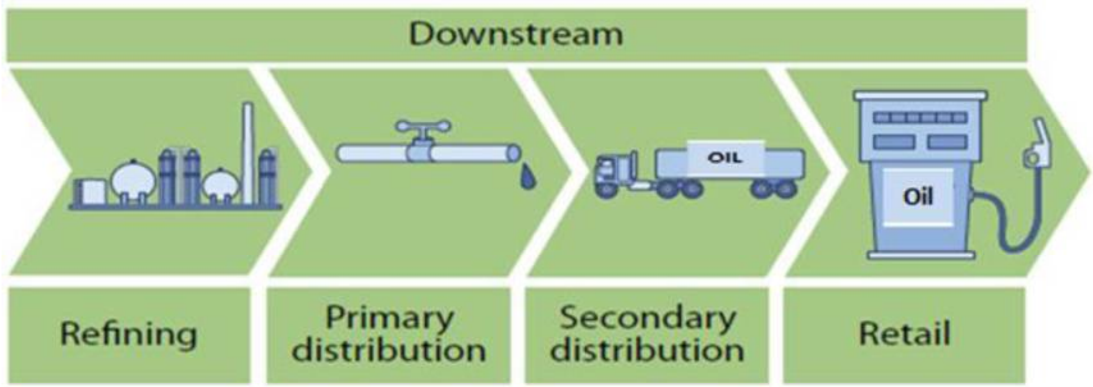


Figure 2.1: Downstream value chain (Kisker, Mendel, & Lisserman, August 13, 2010)

India accounts for around 17% of the world population and has more than 1.2 billion people. India ranks third in the world in terms of global energy consumption behind the US and China (BP, 2016). For 2014-15, the energy consumption for India was 638 Mtoe as shown in Figure 2.2. The country's economic growth has been rapid over the last few years and will be consuming more energy in future.

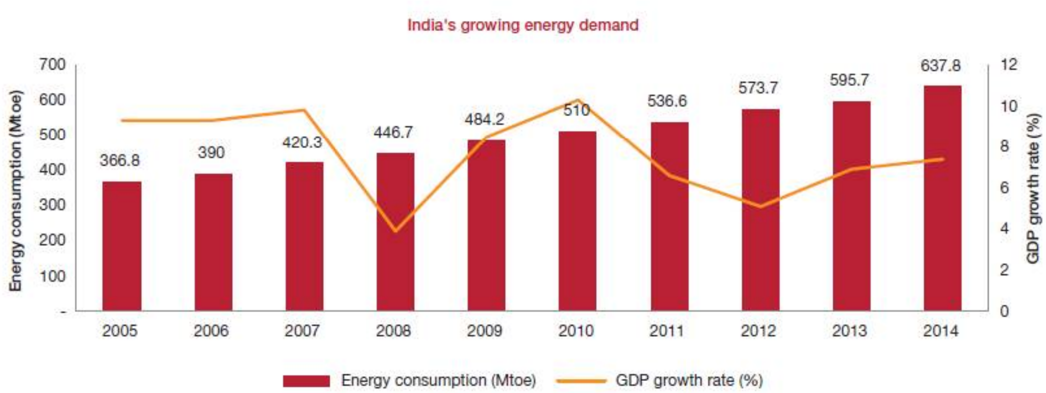


Figure 2.2: India's growing energy demand (PwC, 2015)

In terms of oil consumption, US had a share of 19.7% while China and India had 12.9% and 4.5% respectively (BP, 2016). In 2014, India's crude oil consumption was 3.849 million bpd as shown in Figure 2.3. It was 4159 million bpd in 2015 registering an increase of 8.1% (BP, 2016).

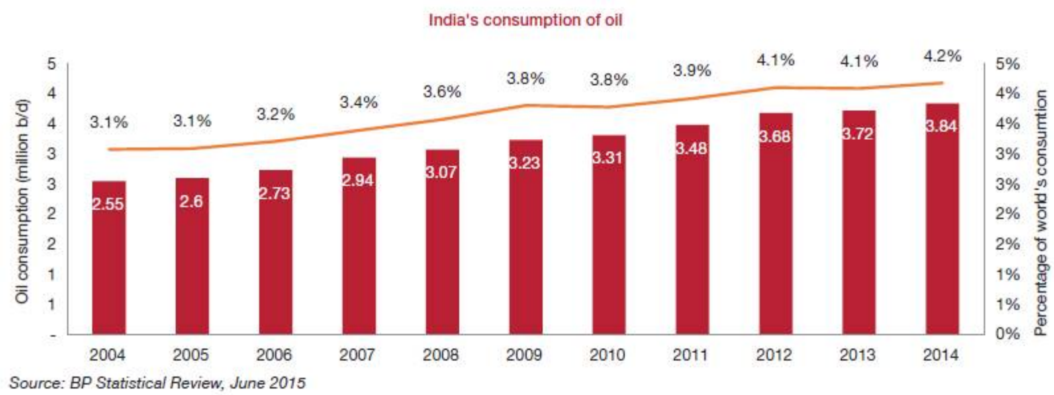
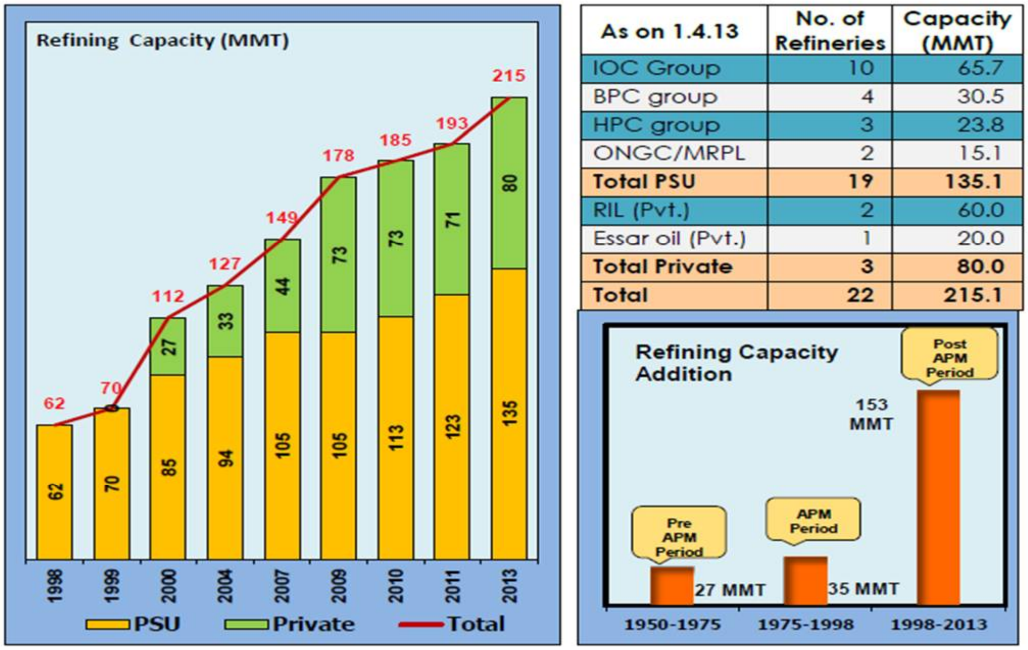


Figure 2.3: India's oil consumption over the years (PwC, 2015)

Currently, there are 22 operational refineries in India with 215 MMTPA of refining capacity. 19 refineries with 135 MMTPA of refining capacity are owned by the government owned companies (including Joint Ventures) while three refineries with 80 MMTPA of refining capacity are owned by the private companies. India's refining capacity growth (since 1998) is depicted in Figure 2.4 (Parikh, Singh, Garg, Barua, & Singh, October 2013).



As on 1.4.13	No. of Refineries	Capacity (MMT)
IOC Group	10	65.7
BPC group	4	30.5
HPC group	3	23.8
ONGC/MRPL	2	15.1
Total PSU	**19**	**135.1**
RIL (Pvt.)	2	60.0
Essar oil (Pvt.)	1	20.0
Total Private	**3**	**80.0**
Total	**22**	**215.1**

Figure 2.4: Growth of refining capacity in India since 1998 (Parikh, Singh, Garg, Barua, & Singh, October 2013)

The dominant players in India's downstream petroleum sector are the state owned OMCs which come under the jurisdiction of MoPNG. The OMCs in India's Downstream Petroleum Sector are given below:

- **IOCL –** IOCL is India's largest downstream oil company by sales with a turnover of ₹3,99,601 and net profit of ₹10,339 crores for the financial year 2015-16 (IOCL, 2016). With the commissioning of the Paradip refinery, IOCL has strengthened its leadership position in the refining sector. Its combined capacity is 80 MMTPA (includes its subsidiary CPCL) which is 35% of India's refining capacity (IOCL, 2016). It was ranked 161st in Fortune's prestigious 'Global 500' list for the year 2016 (Fortune Magazine, 2016). The Government of India holds 58.57% of the shares in IOCL, and is the largest promoter shareholder. IOCL operates 11 refineries and accounts for nearly half of the country's market share of petroleum products (IOCL, 2016).

- **BPCL –** BPCL is India's second largest downstream oil company by sales with a turnover of ₹219,253 and net profit of ₹8,463.98 crores for the financial year 2015-16 (BPCL, 2016). It was ranked 358th in Fortune's prestigious 'Global 500' list for the year 2016 (Fortune Magazine, 2016). The Government of India holds 54.93% (BPCL, 2016) of the shares in BPCL and is the largest promoter shareholder.
- **HPCL –** HPCL is India's third largest downstream oil company by sales with a turnover of ₹197,744.28 and net profit of ₹3,862.74 crores for the financial year 2015-16 (HPCL, 2016). It was ranked 367th in Fortune's prestigious 'Global 500' list for the year 2016 (Fortune Magazine, 2016). 51.1% of the shares in HPCL are owned by the Indian Government which is also the largest promoter shareholder.

The total number of retail oil outlets in India as on 31st March, 2016 is mentioned in Table 2.2 below (Ministry of Petroleum and Natural Gas, 2016). It is seen that IOCL, HPCL and BPCL together have a combined share of 94% of the total retail oil outlets in India. Hence, the scope of study was done for the three companies IOCL, HPCL and BPCL only. The Government of India owns these three companies, and is the major shareholder with more than 50 percent stake in each of these three companies (Ministry of Petroleum and Natural Gas, 2016). IOCL has 45.7% of the total oil outlets and is the largest player in the Indian market. HPCL comes second with 24.8% of the total oil outlets, while BPCL occupies the third position with 24% of the total fuel outlets (Ministry of Petroleum and Natural Gas, 2016). The private sector players such as Essar Oil, Reliance Industries and Shell together occupy the 'Others' category of 5.5% as shown in Figure 2.5.

Table 2.2: PSU Retail Outlets (Ministry of Petroleum and Natural Gas, 2016)

PSU Retail Outlets (As on 31st March, 2015)				
IOCL	**HPCL**	**BPCL**	**Total PSU Outlets**	**Total Retail Oil Outlets in India**
24,405 (45.7%)	13,233 (24.8%)	12,809 (24%)	**50,447 (94%)**	53,419

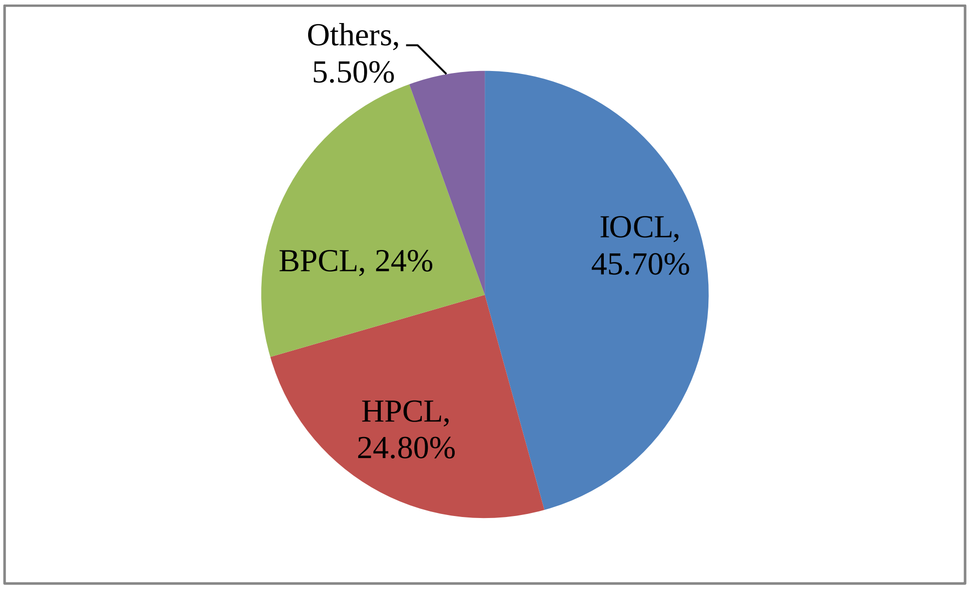


Figure 2.5: PSU Retail Outlets as on 31st March, 2015 (Ministry of Petroleum and Natural Gas, 2016)

2.3 Key Challenges for the Global Downstream Industry

Many Oil and Gas companies did not pay heed to efficient operations in their businesses when the price of oil was more than $100. With crude oil prices falling in 2014-15 there has been a shift for Oil majors from competitive forces to survival in the business. Increased efficiency along with lowering costs has now become a norm. The '2015 Global Economics and The Downstream Industry Report' (World Refining Association, 2015) shows the following:

- When asked about the 'Biggest Challenge you are currently facing globally', 37% of respondents said it was the drop and fluctuation in crude oil prices impacting global dynamics.
- When asked about the 'Key Challenges for the Downstream Industry' as shown in Figure 2.6, 15% of participants said that adopting technology to produce new products was a challenge.
- Innovation in technology has allowed refiners globally to remain economical in an ever increasing competitive market. Technology holds the key to cutting costs according to 42.86% of participants when asked the question 'What is the key to cutting costs?' as shown in Figure 2.7. Information technology can help downstream companies to streamline their business processes (Shih, Hsu, Zhu, & Balasubramanian, 2012).

Figure 2.6: Biggest challenge encountered by the downstream industry (World Refining Association, 2015)

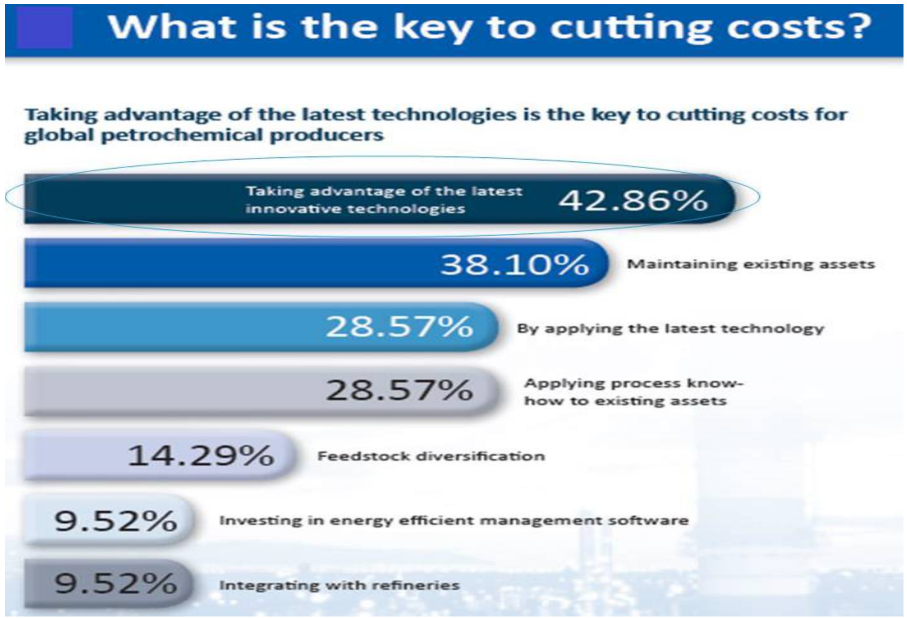


Figure 2.7: Key to cutting costs in the downstream industry (World Refining Association, 2015)

Other challenges faced by the downstream Oil and Gas companies include thin margins and increased pressure to manage costs. Volatility in supply of raw materials and the demand for petroleum products has necessitated the downstream companies to have greater insights and flexibility in the refining operations to remain profitable and competitive (IBM, 2013).

2.4 Key challenges facing IOCL, BPCL and HPCL

One of the significant challenges faced by these OMCs is to add refinery capacity to address the increasing demand of petroleum products by the huge Indian consumers. These OMCs also have to grow the exports of petroleum products (Clarke & Graczyk, 2010). Modernization and automation of retail oil outlets through adoption of digital technologies are important to having competitive advantage for the OMCs. Other challenges include higher operating margins and oil sales at the retail oil outlets. The OMCs also need to focus on customer satisfaction initiatives apart from increasing operational efficiency and employee productivity at their oil outlets.

2.5 What is IoT

The internet that was used for connecting devices is shifting to internet for connecting physical objects that have embedded identification and sensing capabilities. These physical entities can exchange information among themselves and with human beings (Miorandi, Sicari, Pellegrini, & Chlamtac, 2012). Our society is experiencing a rapid change from unconnected objects to internet-enabled connected objects capable of producing data which is examined to garner useful information (Intel). "Everything is being connected" in IoT is forcing citizens to reconsider their limits of imagination (Manu, 2014). There has been tremendous growth of internet users in the wireless environment (Chai, Choi, & Jeong, 2015). The phrase "IoT" was first provided by Kevin Ashton in 1999 who dreamt of an ecosystem where physical objects are interconnected with each other through the internet via ubiquitous sensors (Shin, A socio-technical framework for Internet-of-Things design: A human-centered design for the Internet of Things, 2014). IoT is the next big transformation which is going to revolutionize our lives. Ashton mentioned that human beings provided the information on the internet. However, the future looks promising where 'Things' can provide data themselves without having to depend on anyone, this will help provide real time information. In other words, IoT is the connection of the physical objects whereby they would be able to connect with each other and exchange data themselves. In the IoT ecosystem, sensors are augmented with capabilities of recognition, communication and identification, joining them to the internet (Guo, Zhang, Wang, Zhiwen, & Xingshe, 2013). IoT enables humans, animals and other devices to generate data and communicate themselves without the need for person to person or person to computer interaction (Siemens). Digital and physical objects can be linked together through the IoT by means of appropriate technologies (Miorandi, Sicari, Pellegrini, & Chlamtac, 2012). IoT is an ecosystem of physical entities interconnected with each other that contain technology embedded in them so that they can communicate with other devices or the external environment. The objects have distinct identifiable features that are joined to the dynamic global interconnected network (Reaidy, Gunasekaran, & Spalanzani, 2014). IoT enables connectivity for person-to-device and device-to-device communications (Nguyen, Laurent, & Oualha, 2015); it will also result in a deluge of new services (Schatz, Gladyshev, & Knijff, 2014). IoT is bringing in technical and cultural shift in the society where every device is “on” and connected to the internet (Burke, Quigley, & Speed, 2013). The convergence of IoT and social networks is set to happen in future (Atzori, Iera, Morabito, & Nitti, 2012). IoT is an enabler to firms to effectively respond to changing business needs through innovation and gain a competitive advantage (Sarrazin & Sikes, 2011). Figure 2.8 shows that IoT consists of the following three phases:

- The devices or sensors which are engaged in gathering data (includes identification of device),
- A system that gathers and examines this data for further processing and
- Moving data to the server for enablement of decision making. Various analytical tools along with Big data are commonly used for analyzing valuable information generated from data (GOI, 2015).

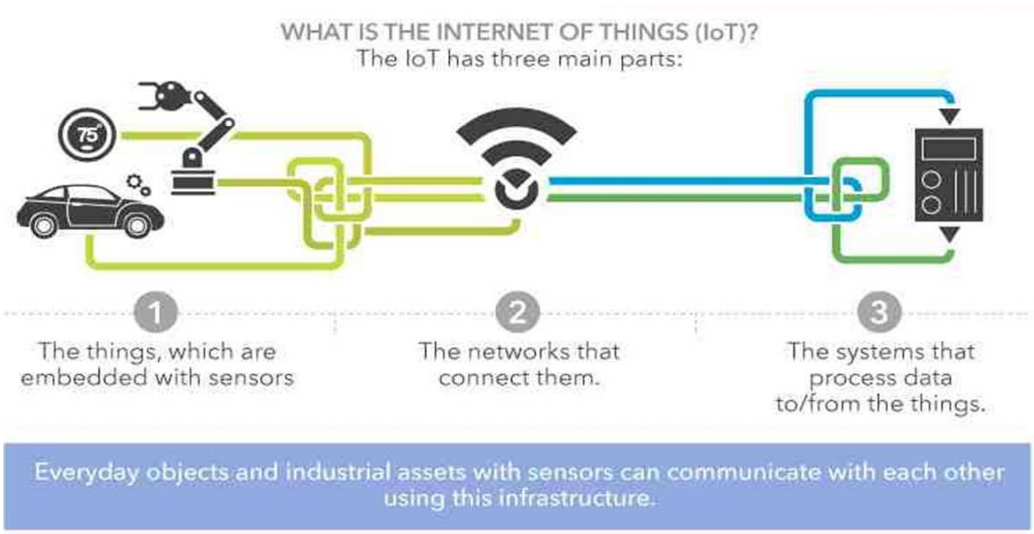


Figure 2.8: Components of IoT

Sensors are small low cost autonomous communicating objects that are able to adapt to its environment (Mitton & Simplot-Ryl, 2011). Sensors are predominantly wireless sensors consisting of many multifunctional sensor nodes (Sun, Zhang, & Li, 2011). Small sensors that can communicate with the ecosystem and can fulfill single simple tasks are known as "smart objects" (Gerdes, Bormann, & Bergmann, 2015). Smart objects have embedded intelligence and can communicate with each other (Patel & Cassou, 2015). The building block of the IoT is the smart object. Smart objects gather data from the ecosystem enabling the physical and digital world to converge. These smart objects are interconnected through internet to exchange data and information (Borgia, The Internet of Things vision: Key features, applications and open issues, 2014). Smart objects connect heterogeneous devices through Internet thereby enabling of remote interactions (Distefano, Merlino, & Puliafito, 2014). Examples of smart objects are temperature regulating devices, intelligent light switches etc.

There are different types of sensors are mentioned below:

- Position – A position sensor measures an object's position and the measurement can be in absolute or relative terms.
- Occupancy and Motion – An occupancy sensor detects the presence of people and objects in an area which is under surveillance while a motion sensor detects the movement of the same. The main difference between the two is that signals are generated from occupancy sensors though people and objects are stationary with no movement while motion sensors generate signal when there is movement of the same.
- Pressure – A pressure sensor measures the force applied by liquids or gases.
- Flow – A flow sensor measures the rate of flow of fluid.
- Light – A light sensor detects the presence of light.
- Acoustic – An acoustic sensor measures the sound level and converts it into digital or analog data signals.
- Temperature – A temperature sensor measures the quantum of heat or cold in the system
- Biosensor – A biosensor detects biological elements like cells, enzymes, antibodies etc.
- Chemical – A chemical sensor measures the quantum of chemicals in the system.
- Humidity – A humidity sensor measures the quantum of water vapor in the air or mass.
- Radiation – A radiation sensor detects the radiations in the surrounding environment (Holdowsky, Mahto, Raynor, & Cotteleer, 2015).

The term "Thing" in IoT terminology could be a patient with an artificial heart implant, an animal with a transponder chip embedded, a vehicle with devices to caution the driver when fuel in the tank is less or the pressure in the tyre is low (Shin, A socio-technical framework for Internet-of-Things design: A human-centered design for the Internet of Things, 2014). Things can be physical objects with sensors embedded in them and having memory and data processing capabilities. Such systems of embedded sensors allow them to quickly adapt to changing environments (Kiritsis, 2010). Connected objects can be used to monitor people, animals and surroundings (Manyika, et al., The Internet of Things: Mapping the value beyond the hype, 2015). IoT connects objects with the internet and enables exchange of information between things. Adoption of IoT can result in "things" becoming an integral part of the businesses and everyday activities (Samani, Ghenniwa, & Wahaishi, 2015). Objects enabled with sensors can transmit data and make real time decisions (Mashal, Alsaryrah, Chung, Yang, Kuo, & Agrawal, 2015). Objects can autonomously communicate on social networks and publish information of interest for selected communities of people automatically (Atzori, Carboni, & Iera, 2013). The IoT realizes its potential where millions of autonomous embedded objects such as sensors, home appliances, wearables etc. can cooperate and exchange data using the internet protocol based networks (Karatza & Mavromoustakis, 2013). As IoT becomes ubiquitous, it has enabled "things" to become smarter, reliable and autonomous (Dimosthenis Kyriazisa, 2013). The Internet of Everything (IoE) ecosystem is enabled by the IoT (Noronha, Moriarty, O'Connell, & Villa, 2014). IoT can enable persons along with objects to be joined together virtually at remote places also (Psannis, S., & A., 2014). IoT supports heterogeneity of devices and involves exchange of data among heterogeneous sources; wireless technologies enable smart objects to get interconnected. IoT is about exchanging and analyzing huge amount of data that can be churned into useful information. IoT can also track the location of connected objects and has application in logistics (Miorandi, Sicari, Pellegrini, & Chlamtac, 2012). IoT enables devices to exchange information autonomously without any human intervention (Al-Karaki, Morabito, Chen, & Oliveira, 2014). The data generated from IoT contains personal details such as health parameters, location etc. and therefore its security are of importance (Liu, Yang, Zhang, & Chen, 2015). IoT also enables critical applications to be run across the network (Peoples, Parr, McClean, Scotney, & Morrow, 2013). In the area of intelligent control and management, IoT reliably transmits and intelligently processes information (Chunquan & Shunbing, 2012). The full potential of IoT can be realized when cloud computing can be adopted. Cloud computing is synonymous with virtual modes of calculation and archival with no intervention by anyone (Borgia, The Internet of Things vision: Key features, applications and open issues, 2014). Processing, storage, and analysis of data can be performed in the cloud on a real time basis (Antonic, Marjanovic, Pripuzic, & Zarko, A mobile crowd sensing ecosystem enabled by CUPUS: Cloud-based publish/subscribe middleware for the Internet of Things, 2015). IoT data can be hosted on Cloud for saving costs and handling high volumes of data.

The internet technology has connected people across boundaries while the next revolution is going be the interconnection between objects (Gubbi, Buyya, Marusic, & Palaniswami, 2013). Figure 2.9 shows that IoT is being termed as the fourth industrial revolution; the first, second and third industrial revolutions being the steam engines, mass production and the internet technology respectively (Bosch). The IoT industrial revolution enables the physical and digital worlds to converge cutting across all layers thereby transforming the way industrial operations are run (SAP, 2014). (Bosch, 2014) has termed the fourth IoT revolution as the seamless combination of internet with the physical entities.

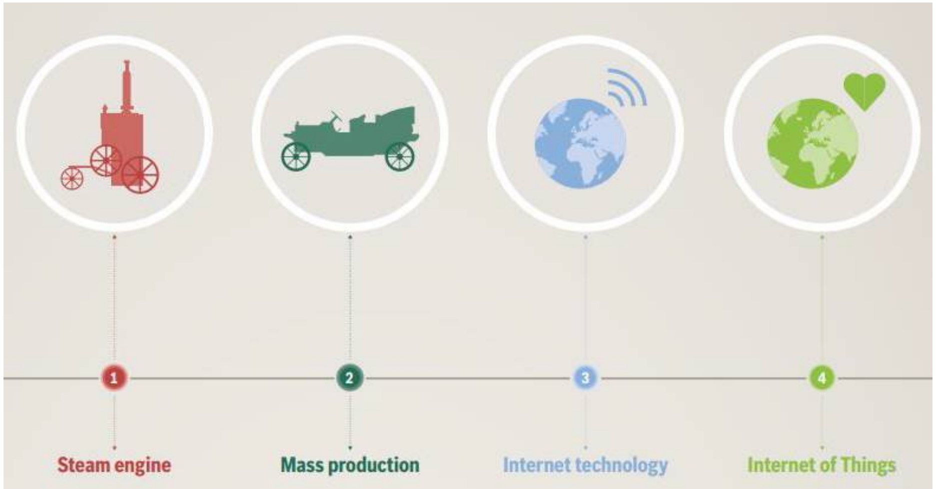


Figure 2.9: Fourth Industrial Revolution (Bosch)

Numerous initiatives are underway on IoT across the world among nations with collaboration between industry, academia and government (Shin, A socio-technical framework for Internet-of-Things design: A human-centered design for the Internet of Things, 2014).

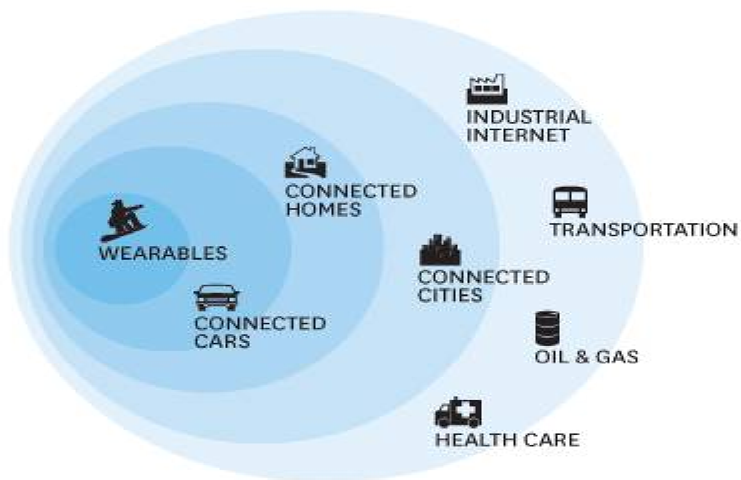


Figure 2.10: The IoT landscape (Jankowski, Covello, Bellini, Ritchie, & Costa, 2014)

The enterprise value from IoT can be fully realized when connected sensors can exchange data and communicate with other systems. The adoption of IoT is increasing exponentially due to increased competitive, technological and societal pressures (Lee & Lee, 2015). The challenges for IoT adoption include standardization of protocols, migration to IPv6, optimization of networks, cybersecurity threat and regulatory (Joshi & Kapania, 2013).

2.6 Benefits of IoT

The current industrial economy is moving towards a digital economy whereby firms are leveraging the IoT as a means to deliver faster growth (Purdy & Davarzani, 2015). As industry boundaries blur and service innovations are on the rise, customers are looking for greater personalization and mobility from services (D'Emidio, Dorton, & Duncan, 2015). Over the next few years, connected smart objects, cloud and predictive analytics will combine to deliver new connected intelligence that will revolutionize firms to offer innovative digital services to customers (Accenture and Fjord, 2015). Some of the benefits that IoT provides are as follows:

- **Cost savings:** Improved asset utilization has provided significant cost savings to organizations. IoT provides real time visibility into the assets of businesses apart from running preventive maintenance.
- **Efficient processes:** Human intervention can be minimized through the use of sensors apart from improved operational efficiency. Smart sensors and open standards are changing the maintenance strategies to condition based predictive maintenance (Slaughter, Bean, & Mittal, 2015).
- **Improved productivity:** IoT improves employee productivity through automation of manual processes (Reddy & Benedict, 2014)
- **Increased revenue:** IoT can help companies to provide new products, services and additional streams of revenue apart from utilizing their existing infrastructure innovatively.

Value creation happens within an IoT ecosystem across all stakeholders (Bilgeri, Brandt, Lang, Tesch, & Weinberger, 2015). The potential benefits of IoT across various different industries and key associated resultant changes are mentioned in Figure 2.11 below.

Industry	Key Change	Potential Benefits
Automotive and Transportation	Real-time driving behavior, traffic and vehicle diagnostics.	Improved customer experience, reduced pollution, increased safety and additional revenue streams.
Healthcare	Remote monitoring of staff and patients ability to locate and identify status of equipment.	Improved employee productivity, resource usage and outcomes that result in efficiency gains and cost savings.
Manufacturing	Quick response to fluctuations in demand; maximized operational efficiency, safety and reliability, using smart sensors and digital control systems.	Enhanced agility and flexibility, reduced energy consumption and carbon footprint.
Retail	Stock-out prevention through connected and intelligent supply chains.	Ability to predict consumer behavior and trends, using data from video surveillance cameras, social media, Internet and mobile device usage.
Supply Chain	Real-time tracking of parts and raw materials, which helps organizations preempt problems, address demand fluctuations and efficiently manage all stages of manufacturing.	Reduced working capital requirements, improved efficiencies and avoidance of disruptions in manufacturing.
Infrastructure	Smart lighting, water, power, fire, cooling, alarms and structural health systems.	Environmental benefits and significant cost savings with better utilization of resources and preventive maintenance of critical systems.
Oil and Gas	Smart components.	Reduced operating costs and fuel consumption.
Insurance	Innovative services such as pay-as-you-go insurance.	Significant cost savings for both insurers and consumers.
Utilities	Smart grids and meters.	More responsive and reliable services; significant cost savings for both utilities and consumers resulting from demand-based and dynamic pricing features.

Figure 2.11: Use of IoT in various industries and potential benefits (Reddy & Benedict, 2014)

IoT is used in intelligent transportation, traffic control, home automation, intelligent fire control, monitoring of industrial machines, elderly and patient care etc. (Li & Yu, 2011). There are many applications of IoT across various sectors as shown below:

- Wearables and smart watches are used for entertainment, fitness, location, tracking, communication and sending mails (Weinberg, Milne, Andonova, & Hajjat, 2015).
- Smart cities are used for lighting of streets, traffic control, surveillance, detection of pipeline leak, e-meters at residential houses and centralized system control (Weinberg, Milne, Andonova, & Hajjat, 2015).

- Healthcare devices are used for treating patients remotely, asset tracking of hospitals, telemetry of ambulances and access control (Weinberg, Milne, Andonova, & Hajjat, 2015).
- Smart Manufacturing devices are used for flow optimization, tracking of assets, monitoring of real-time inventory, employee safety and predictive maintenance (Weinberg, Milne, Andonova, & Hajjat, 2015).
- Automotive devices are used for in-vehicle infotainment, replacement of wires, telemetry and predictive maintenance (Weinberg, Milne, Andonova, & Hajjat, 2015).
- Building and home automation devices are used for access control, light and temperature control and predictive maintenance (Weinberg, Milne, Andonova, & Hajjat, 2015). IoT has made home automation popular and smarter through wireless technologies (Shen, Liu, & Palesi, 2015).
- Telematics in automotive insurance leads to accurate risk pricing (Meunier, et al., 2014).
- Remote monitoring of equipment in mining, Rio Tinto generates more than $300 million in cost savings through autonomous and intelligent mining; process optimization in factories; smart lighting at residential locations (Meunier, et al., 2014).

The cumulative estimated cost savings due to implementation of IoT in five industries over 15 years due to a 1% reduction in fuel, capital expenditures and inefficiencies (Reddy & Benedict, 2014), are mentioned in Figure 2.12 below.

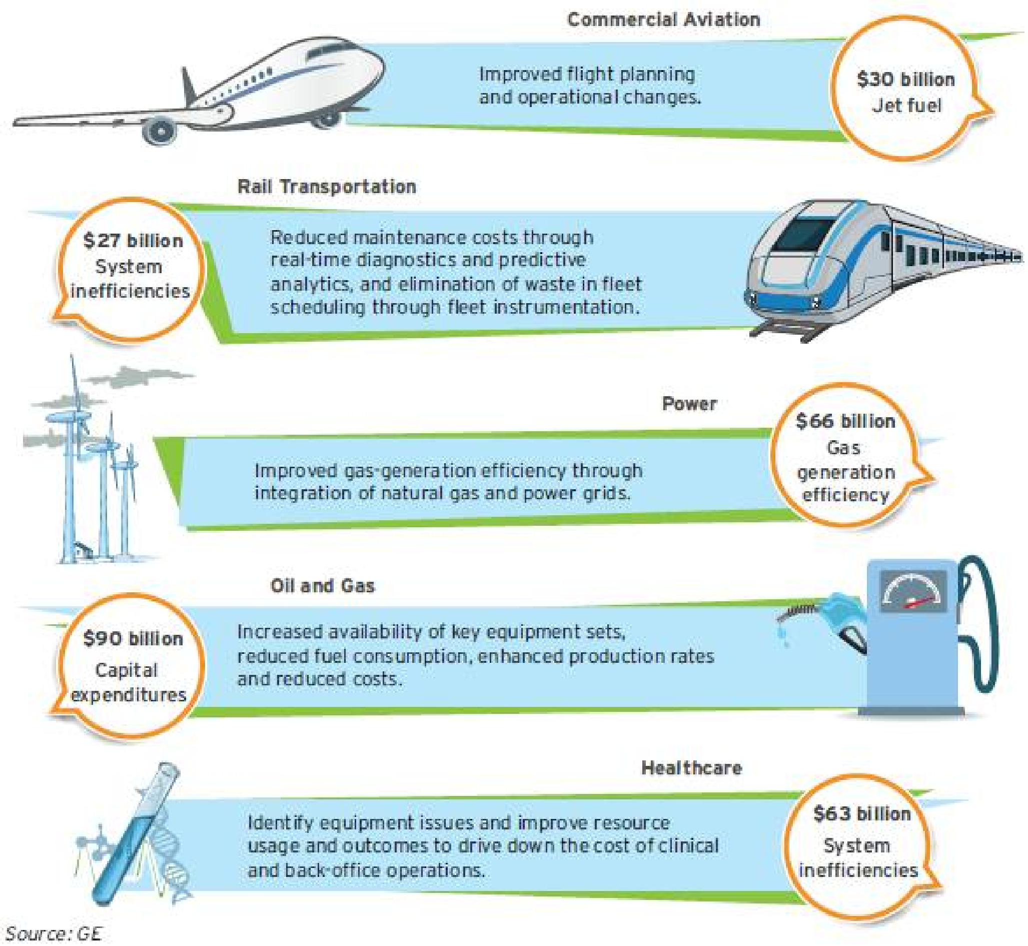


Figure 2.12: How IoT generates value - estimated cost savings (cumulative) in 5 industries over 15 years propelled by a 1% reduction in fuel, capital expenditures and inefficiencies (Reddy & Benedict, 2014)

A few examples of value accrued to various companies through IoT are as follows:

- Verizon deployed a few hundred sensors in its 24 datacenters connected wirelessly and was able to save around 55.1 million kWh every year. This reduced the emission of greenhouse gases by 66.1 million pounds annually (Jankowski, Covello, Bellini, Ritchie, & Costa, 2014).

- AT&T has tied-up with Audi, GM, Tesla, and Volvo and has enabled vehicles to act as Wi-Fi hotspots (Jankowski, Covello, Bellini, Ritchie, & Costa, 2014).
- Sensors have been installed by Rockwell Automation on oil rig equipment's that transfer data to the decision makers through digital dashboards at the command center. Various parameters at the rig such as pressure, temperature, flow-rates are measured instantly through the smart sensors. IoT has enabled preventive maintenance, predictive analytics and equipment health on a real time basis (RTInsights Team).
- IoT enabled fleet tracking technologies are being used by John Deere for cutting costs and improving supply efficiency (Lee & Lee, 2015).
- A new wristband known as MagicBand from Disney has embedded RFID chips and is used as an entry card that connects with Disney's system (Lee & Lee, 2015).
- Kroger's Retail Site Intelligence is a new IoT based video analytics system that helps consumers experience satisfactory shopping by enabling to locate the articles they wish to purchase (Lee & Lee, 2015).
- In 2014, Ford and Intel jointly developed the connected car environment known as Mobile Interior Imaging which incorporates improved privacy controls, identifies drivers and adjusts features based on the user's preference. The in-car experience can be further personalized by displaying information on the dashboard specific to the driver's calendar music, contacts etc. With the integration of the customer value propositions in the connected car environment, Ford has been able to get another revenue stream (Lee & Lee, 2015).
- A next generation monitoring instrument known as Healthsense eNeighbor® which has been developed by Humana remotely monitors the various changes in the user's daily activity through the help of sensors. Predictive analytics helps provide alerts necessary interventions and prevents adverse event escalations (Lee & Lee, 2015).

- An electronic toothbrush Oral-B Pro 5000 developed by Proctor & Gamble records brushing habits and provides smarter personalized oral care routine. It provides tips on mouth care apart from news snippets. Consumers have enhanced oral care through this innovation. The results show usage of electric toothbrush increases the brushing time to 2 minutes and 16 seconds from 60 seconds when compared to a manual toothbrush (Lee & Lee, 2015).
- Macy's has deployed shopkick's shopBeacon technology in its stores in the US. It provides users with personalized messages such as offers, rewards and department-level deals through the shopkick app. This has allowed for increased customer engagement with shoppers apart from higher customer satisfaction and increased revenues. Other US retail giants namely JCPenny, Target and American Eagle Outfitters started using shopBeacon in 2014 by partnering with shopkick (Lee & Lee, 2015).
- IoT sensors installed in home appliances enable them to be monitored through a smartphone or tablet. Using the Verizon Home Monitoring and Control network, consumers can alter the room temperature; adjust brightness of lights, monitor systems apart from receiving security alerts (Lee & Lee, 2015). It uses the wireless technology suitable for home automation appliances. This innovative concept of smart home utilizes IoT control systems.
- Social networks have emerged as important media of online communication among people, few systems have come up that can connect smart objects with social networks. A health monitoring system, known as SenseFace, can capture data from the personal smart devices of consumers. It thereafter publishes it on the community list of social networks of interest (Mashal, Alsaryrah, Chung, Yang, Kuo, & Agrawal, 2015).

- The Nest thermostat helps in monitoring and recording of temperature conditions within a house to optimally manage the temperature (Weinberg, Milne, Andonova, & Hajjat, 2015). Home appliances such as laundry machines, refrigerators and air conditioning systems can be remotely controlled through the help of IoT (Gubbi, Buyya, Marusic, & Palaniswami, 2013).
- The Fitbit products help in monitoring of physical activities, such as, heart rate and calories burned (Weinberg, Milne, Andonova, & Hajjat, 2015).
- Smart pill containing microchip can communicate with other devices and can provide real time information about its journey through a consumer's body. The physician can accordingly suggest dynamic changes in treatment to the patient (Weinberg, Milne, Andonova, & Hajjat, 2015). Through the ubiquitous healthcare, a home monitoring system can be created for the elderly and others, residing at far flung areas, that enables them to be monitored remotely thereby reducing the costs related to hospitalization (Gubbi, Buyya, Marusic, & Palaniswami, 2013).
- Smart sensors provide energy consumption patterns through collection of real-time energy consumption data (Shrouf & Miragliotta, 2015).
- Sensors in a smarter trash can detect how much and what type of trash it contains and whether noxious fumes are emanating from the trash. (DeFeo, Energy Harvesting and the Internet of Things, 2015).
- Intelligent street lighting enabled by IoT helps to automatically report the lighting failures, thereby, saving significant costs and time. Lights are automatically dimmed during low traffic hours, thereby, saving energy and enhanced during high traffic hours and also in problematic neighborhoods for improving safety (DeFeo, Energy Harvesting and the Internet of Things, 2015).
- Washing machines allow the users to make payment in terms of per unit load, stables can keep continuous track of individual cattle and accordingly adjust their schedules related to milking and feeding;

greenhouses can monitor the crop parameters that grow within its premises and accordingly adjust their internal temperature (Dijkman, Sprenkels, Peeters, & Janssen, 2015).

- Sensors installed at various locations in a city coupled with intelligent traffic lights can be used to monitor traffic, manage traffic jam, alert drivers on critical situations and propose them alternate routes on a real time basis (Borgia, The Internet of Things vision: Key features, applications and open issues, 2014).
- Sensors placed on critical parts of machinery of Oil and Gas rental equipment provider sent real time alerts to central technicians whenever any equipment related issues developed who would thereafter do remote troubleshooting. The site visits decreased substantially by 50 percent, thereby, saving fuel costs (Openshaw, Hagel, Wooll, Wigginton, Brown, & Banerjee, 2014).
- Wearable glasses can enable workers present at remote locations to receive work related instructions from colleagues. This helps real-time collaboration; remote personnel can assist in repairs and offer guidance during safety events (Accenture, 2014). Digitization is enabling virtual collaboration of people using tools for remote work thereby reducing the physical flow of people (Manyika, et al., 2014).
- BMW AG is working on the concept of connected cars whereby gas stations would be able to provide customized offerings to drivers based on their proximity (SAP, 2014).
- A large credit card firm partnered with a retailer to provide personalized real-time discount offers to consumers through a mobile app. The customers' locations are determined through their smartphones, their profiles are mapped to their purchasing history and preferences and accordingly personalized discount offers are generated by the app. The firm has also partnered with social-media players to obtain the preferences of customers to refine the discount offers. This has helped the firm to

increase the relationship with retailers apart from retaining digital savvy customers (D'Emidio, Dorton, & Duncan, 2015).

2.7 Use of IoT in the Oil and Gas Industry

The emergence of IoT, as the next disruptive technology, revolutionizes the oil and gas industry, business opportunities that are untapped can be monetized through the IoT solutions. According to IDC, 40% of Oil and Gas companies and Oilfield Service Providers will have to co-innovate with IT firms on domain related technical projects, driven by the penetration of smart sensors (Parker, Bigliani, Ditton, Feblowitz, & Niven, 2015). Organizations serving the Oil and Gas sector have a great opportunity for improving the operational efficiency in their businesses through the use of IoT services. This digital transformation requires the interlinking of process, data, people and things in the Oil and Gas value chain. When Oil and Gas companies integrate the Information Technology (IT) and Operational Technology (OT), elements of their business then IoT can bring about improved efficiency and cost savings. The integration of IT-OT technologies is essential for retaining competitive advantage and operational efficiencies. (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015).

With the new normal of lower crude oil prices, IoT is aiding the Oil and Gas companies to manage their supply chains and assets (Slaughter, Bean, & Mittal, 2015) as shown in Figure 2.13. Upstream companies can monitor various rig parameters remotely through smart sensors. These sensors generate huge amount of data that enable real time decision making (Lee & Lee, 2015). Digital oil fields, employing sensors in oilfield equipments, enable real time optimization and higher levels of business performance (McAvey, Eriksen, & Steenstrup, 2014). Data Security is an important priority in the Oil and Gas sector, steps need to be taken to build layers of defense in the IoT network environment (Perrons &

Hems, 2013). Midstream companies can analyze volumes of data throughout their networks using augmented sensors. Downstream companies can have insight into their supply chain operations and target new technology savvy customers through the use of IoT (Slaughter, Bean, & Mittal, Connected Barrels - Transforming Oil and Gas strategies with the Internet of Things, 2015). IoT also facilitates real-time insights into operations of downstream companies, thereby, helping to control costs and optimize performance of assets; it can aid to improve safety and regulatory compliance and reduce environmental impact. For example: if a tanker with a specific type of crude suddenly becomes available, the integrated oil refinery can use real-time information through IoT on price, demand of products and refinery capacity to perform "what-if" scenarios and decide if the production operations need to be changed to refine that crude (IBM, 2013).

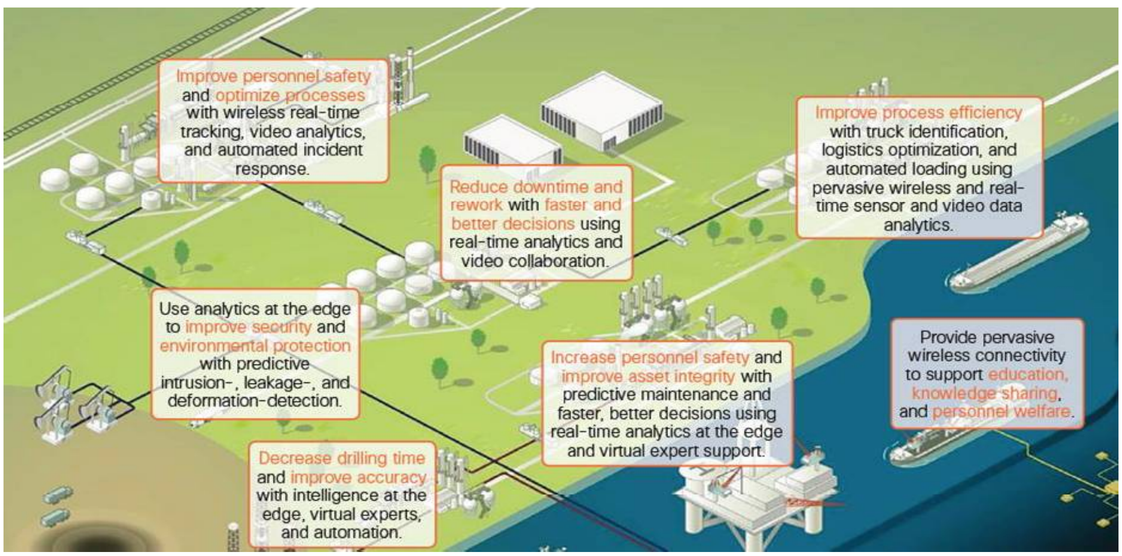


Figure 2.13: Oil and Gas Industry primed for Digital Transformation (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015)

2.8 Use of IoT at Global Retail Oil Outlets

An automobile major has partnered with an ERP company to develop a solution that enhances a driver's fueling experience. The prototype provides drivers information on the dashboard about the nearest gas station, driving directions of shortest route along with related traffic information from customer location (SAP). The customer enters the amount of fuel on the Mobile App, scans a QR code at the fuel outlet and the amount is automatically debited without the customer having to pay cash or using the debit or credit card. These connected car prototypes of tomorrow, which are enabled through IoT, will change the industry dynamics, whereby, fuel retailers stand to gain from increased sales at their oil outlets and convenience stores.

An American gas station cum convenience store chain is extensively using IoT to provide information, such as, offers on the consumers' apps, thus, bringing in personalized experience for its users. The users' history of smartphone purchases can be tracked and through the use of predictive analytics, relevant discount offers are sent to users while they are still at the gas stations for refueling. IoT has enabled the connection of users' smart phones to gas stations apart from providing loyalty points to users. IoT usage at the convenience store provides information on customer habits and buying preferences, optimized inventory and enhanced revenue through increased sales. The CEO of the convenience store chain mentioned that 71% of the customers, who used to come for refueling, never used to come inside the convenience store earlier. IoT enabled offers are bringing more fuel customers in the convenience stores thereby increasing the sales and revenue of the convenience stores substantially. It is a win-win situation for both the consumers and the stores as consumers would save time and money (Microsoft).

A US company is turning Gas pumps into intelligent kiosks (internet connected transaction stations) to drive revenue and improve efficiency. IoT has enabled this company to sell usage-based policies at Retail Oil Outlets in the US. IoT has made it easy for insurers to implement lower-cost mileage-based policies as it has reduced insurance premiums through usage-based and group offers. IoT has enabled consumers to pay motor vehicles fees at Gas stations and to gain new revenue streams for fuel retailers (Verdeva).

Using the principle of IoT, an Oil and Gas Supermajor based out of Europe has installed real-time tracking devices at its service stations to customize the assets to operate during working hours. IoT is also used to track the power consumption, regulation of traffic at the service stations apart from providing weather related information. Its service stations are being made more energy efficient through the use of IoT (TOTAL).

2.9 Potential of IoT

According to Gartner, IoT is expected to generate USD 300.1 billion revenue across industries by 2020. It is predicted that IoT would enable to link 28.1 billion devices by 2020 (GOI, 2015) up from 0.9 billion in 2009 (Lee & Lee, 2015). Mckinsey has predicted that IoT related systems would have an impact of $11 trillion annually in 2025 across nine areas as shown in Figure 2.14. The range will depend on various factors, such as, declining technology costs and the level of acceptance by the customers. Of these nine areas, the greatest potential impact of IoT use is likely to come from factories – around $3.7 trillion per year in 2025, the next would be cities – as much as $1.7 trillion annually in 2025 (Manyika, et al., The Internet of Things: Mapping the value beyond the hype, 2015).

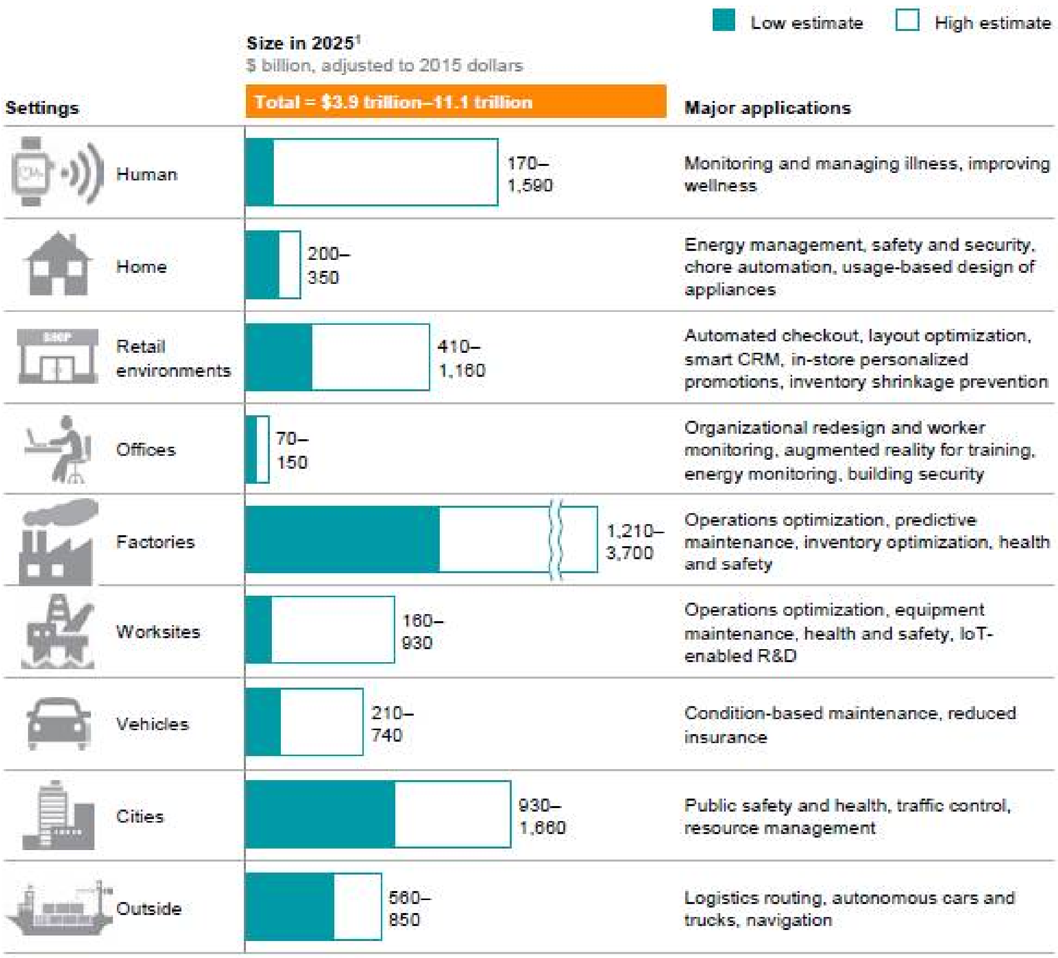


Figure 2.14: Potential economic impact of IoT in 2025 (Manyika, et al., The Internet of Things: Mapping the value beyond the hype, 2015)

IDC has predicted that spending on connectivity-related technologies will increase by 30% in the next few years (Parker, Bigliani, Ditton, Feblowitz, & Niven, Worldwide Oil and Gas 2015 Predictions, 2015). As shown in Figure 2.15, IDC has predicted the revenue accrual from IoT across different geographies in 2020 to be as follows:

- $ 2.6 trillion – Asia Pacific
- $ 2.1 trillion – Western Europe
- $ 1.89 trillion – North America

- $ 217 billion – Central & Eastern Europe
- $ 114.4 billion – Middle East & Africa
- $ 76.3 billion – Latin America

Figure 2.15: Estimates for worldwide IoT revenue by 2020 (Lund, Turner, MacGillivray, & Morales, 2015)

Figure 2.16 depicts the revenue accrual from IoT across different regions between 2013 and 2020.

	2013	2014	2015	2016	2017	2018	2019	2020	2013–2020 CAGR (%)
Asia/Pacific	600.3	729.5	881.8	1,056.9	1,287.6	1,605.9	2,027.2	2,602.6	23.3
Central and Eastern Europe	57.9	69.0	81.9	96.4	115.0	140.0	172.9	217.1	20.8
Latin America	37.5	42.5	47.2	51.5	56.7	62.9	69.4	76.3	10.7
Middle East/Africa	56.2	63.7	70.8	77.2	85.1	94.4	104.1	114.4	10.7
North America	667.9	775.5	892.7	1,016.8	1,168.8	1,363.2	1,608.0	1,922.1	16.3
Western Europe	507.7	612.1	737.1	880.9	1,069.2	1,325.8	1,667.0	2,132.8	22.8
Total	1,927.5	2,292.3	2,711.5	3,179.7	3,782.4	4,592.2	5,648.6	7,065.3	20.4

Figure 2.16: Worldwide IoT revenue by region, 2013-2020, $billion (Lund, Turner, MacGillivray, & Morales, 2015)

Use of IoT by the Oil and Gas sector can increase the global GDP by up to 0.79% or $816.1 billion by the year 2025 (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015).

2.10 Enablers of IoT

The following have enabled the growth of the IoT across nations:

- Low cost sensors – Prices of sensors have come down to below 60 cents from $1.30 in the last decade (Jankowski, Covello, Bellini, Ritchie, & Costa, 2014).
- Low cost bandwidth – The bandwidth has declined by nearly 40 times in the last decade (Jankowski, Covello, Bellini, Ritchie, & Costa, 2014).
- Smartphones – Smartphones have become the personal gateway to IoT, becoming a mode for the connected home, connected vehicle and connected objects (Jankowski, Covello, Bellini, Ritchie, & Costa, 2014).
- Low cost wireless – Wireless cost has declined substantially in the last decade (Jankowski, Covello, Bellini, Ritchie, & Costa, 2014).
- IPv6 – Ipv6 which is the new Internet Protocol (IP) standard is now supported by prominent networking equipments. IPv6 is intended to replace IPv4 (Jankowski, Covello, Bellini, Ritchie, & Costa, 2014). IPv6 allows for more address capacity as compared to IPv4 thus allowing for more devices to be connected to the internet (Bradley, Barbier, & Handler, 2013).
- Interoperability – Interoperability is crucial between systems to capture maximum IoT value (Holler, Tsiatsis, Mulligan, Karnouskos, Avesand, & Boyle, 2014). In the long term, there could be mandates from standard bodies related to framing of IoT standards (Holdowsky, Mahto, Raynor, & Cotteleer, 2015).
- Big data – Predictive analytics is an enabler to decipher useful information from huge volume of unstructured data. (Manyika, et al., 2015). Predictive Analytics uses current and historical facts to predict what will happen next (Holler, Tsiatsis, Mulligan, Karnouskos, Avesand, & Boyle, 2014)

2.11 Challenges on IoT Adoption

As IoT is a new emerging technology, firms need to have a clear business case and strategy for IoT adoption (Ramanathan, 2015). The behavioral challenge could be that customers need to trust IoT based systems. Lower cost sensors and interoperability of IoT devices are essential ingredients for wider adoption of IoT. As the amount of data gathered through billions of devices is huge, there would be concerns among citizens and firms about the privacy of personal information. IoT service providers need to plug any potential data security breaches apart from providing transparency for data collection and usage to the consumers and firms. Regulatory approvals would be required for specific IoT applications, for example – self driving cars. The ownership rights to data generated by numerous interconnected smart objects would require to be sorted out. As devices and physical assets have embedded intelligence in IoT, firms need to have the mindset to adapt themselves to new business models and processes (Manyika, et al., The Internet of Things: Mapping the value beyond the hype, 2015). Another technical challenge is to make the heterogeneous smart objects interact seamlessly with each other (Efremov, Pilipenko, & Voskov, 2014). The complexity of IoT solutions would necessitate organizations to seek assistance and build relationships with a range of vendors to have the right partner ecosystem in place (Noronha, Moriarty, O'Connel, & Villa, 2014) as shown in Figure 2.17.

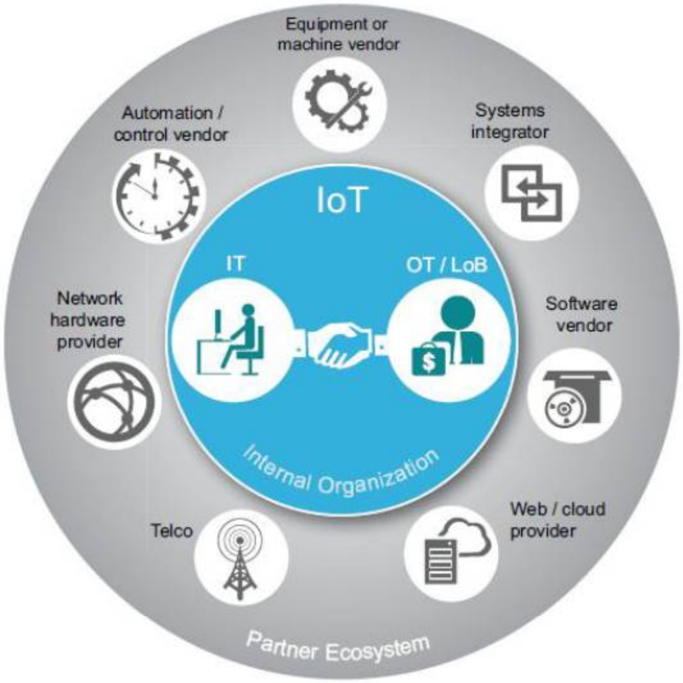


Figure 2.17: Success of IoT implementation necessitates an ecosystem of internal and external partnerships (Noronha, Moriarty, O'Connel, & Villa, 2014)

2.12 Outcomes of a few Surveys on IoT

The key findings of a Forrester survey (Forrester, 2015) on IoT in 2015 are as follows:

- Increased IoT adoption delivers better customer experiences
- 75% of businesses do not yet have leadership support to navigate the complexities of IoT deployments
- Numerous firms have unutilized the potential of IoT for transforming business models
- The majority of the firms believe that IoT will enable them to solve their business problems

- Customer experiences empowered by IoT can deliver significant business improvements

Oil and Gas companies believe that IoT is an enabler of providing competitive advantage to them in today's turbulent market. Cisco did a survey of Oil and Gas leaders and the majority of the respondents perceived IoT as a connected technology can automate between 25% to 49.5% of manual tasks (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015) as shown in below Figure 2.18.

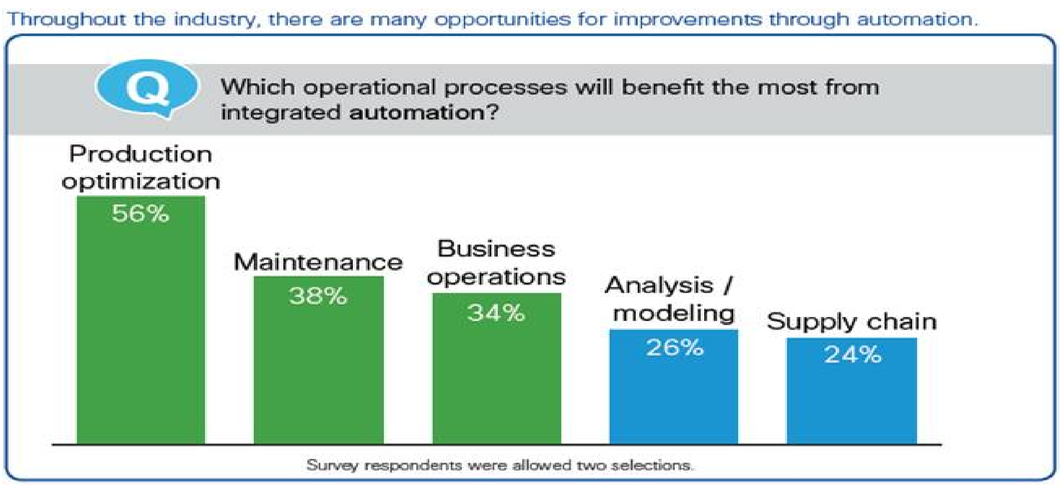


Figure 2.18: Automation of manual processes through IoT in the Oil and Gas industry (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015)

When it was asked of the Oil and Gas leaders as to which parameter (data, process, people or things) required the maximum attention for effective IoT usage, 48% of respondents indicated "Data" as most important while 28% of respondents ranked "Process" as the second most important parameter. 17% of respondents ranked "People" as the third important parameter while 7% of the leaders ranked "Things" as the least important as shown in Figure 2.19. These leaders value the importance of IoT that enables to derive useful insights from data for driving business and operational efficiency (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015).

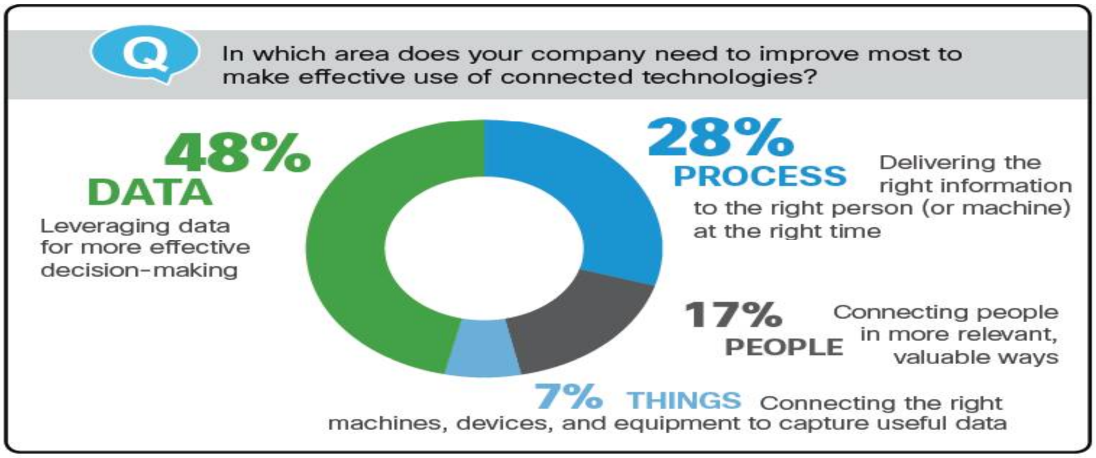


Figure 2.19: Areas to be improved the most for effective use of IoT solutions in Oil and Gas firms (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015)

Cisco's Oil and Gas survey also mentions that steps are necessary for a stronger IT-OT linkage. This includes changes in processes, adoption of new technologies and optimum use of resources. 58.9% of the users believe that their organizations' IT (Information Technology) and OT (Operation Technology) strategies are not aligned closely as shown in Figure 2.20. Most of the Oil and Gas organizations have not yet integrated their IT strategies with their OT strategies (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015).

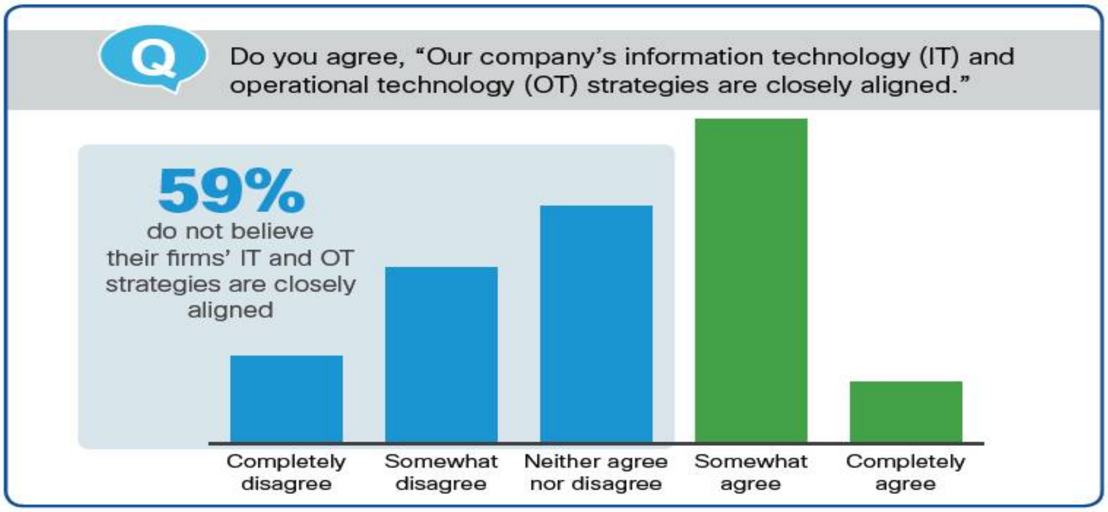


Figure 2.20: Alignment of IT and OT strategies of Oil and Gas companies (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015)

Participants of Cisco's Oil and Gas Leaders survey in 2015 ranked "data analytics" as the foremost driver for the huge investment in IoT as it improves business outcomes. They gave the second rank to "improved operational efficiencies" when asked about growth drivers in connected technologies. "Increased productivity" was ranked third by them as it helps in improving the operating margins of the business (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015) as shown in Figure 2.21.

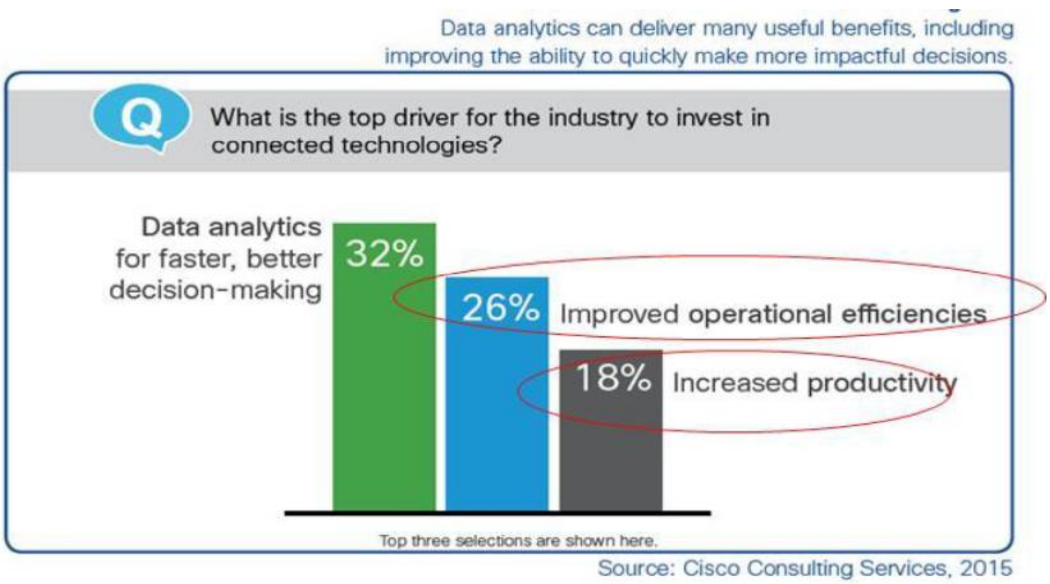


Figure 2.21: Top driver for Oil and Gas companies to invest in IoT (Moriarty, O'Connell, Smit, Noronha, & Barbier, A New Reality for Oil and Gas, 2015)

2.13 Research Papers Containing Business Model for IoT

There has been a growing importance of the internet in business model innovation since the 1990s (Fleisch, Weinberger, & Wortmann, 2014). Literature review was done on the basis of the keyword 'Business model for IoT'. The papers having content on 'Business model for IoT' were identified; this led to eight Research papers as mentioned in Table 2.3.

Table 2.3: Names of eight research papers containing an actual business model for IoT

#	**Authors and Research Papers**	**Tool used**	**Emphasis of Research Paper**
1	*"Business models for the*	Used	Presented a framework for

	Internet of Things" (Dijkman, Sprenkels, Peeters, & Janssen, 2015)	Osterwalder's Business Model Canvas tool (Osterwalder & Pigneur, 2009)	developing business models for IoT applications using Osterwalder's Business Model Canvas tool (Osterwalder & Pigneur, 2009)
2	*"A holistic approach to visualizing business models for the internet of things"* (Sun, Yan, Lu, Bie, & Thomas, 2012)	Used Business DNA Model which is partly based on Osterwalder's Business Model Canvas tool (Osterwalder & Pigneur, 2009)	Mentioned the Business DNA Model - a business model framework on the basis of Design, Needs, and Aspirations. It is partly based on Osterwalder's Business Model Canvas tool (Osterwalder & Pigneur, 2009)
3	*"Business Models for the Internet of Things"* (Bucherer & Uckelmann, 2011)	Used Osterwalder's Business Model Canvas tool (Osterwalder & Pigneur, 2009)	Focused on value and revenue creation on IoT using Osterwalder's Business Model Canvas tool (Osterwalder & Pigneur, 2009)
4	*"Analysis of the Business Model Innovation of the Technology of Internet of Things in Postal Logistics"* (FAN & ZHOU, 2011)	Did not use any tool, leveraged the industry chain structure in the area of Postal Logistics	Analyzed the use of the IoT technology in postal logistics with emphasis on profitability

5	*"Business Model for drug supply chain based on the Internet of Things"* (Liu & Jia, 2010)	Used e3-value methodology	Analyzed the use of the IoT technology for developing a business model with emphasis on economic value creation
6	*"Research on Business Model of Internet of Things Based on MOP"* (Li & Xu, 2013)	Used MOP (Multiple Open Platform)	Analyzed the use of the IoT technology for developing a business model with emphasis on technology, policy, strategy and industry
7	*"Development of foundation models for Internet of Things"* (Chen, TSENG, & LIAN, 2010)	Used Markov model	Analyzed the use of the IoT technology for developing a business model with emphasis on processing, modeling and detection of events
8	*"Business Models for the Internet of Things Environment"* (Glova, Sabol, & Vajda, 2014)	Used e3-value methodology	Analyzed the use of the IoT technology for developing a business model with emphasis on Value-based approach. It focused on Health Care Services and applied the e3-value concept

The key components covered by the 'Business models for IoT' in these eight Research papers were identified as shown in Table 2.4.

Table 2.4: Key components covered by the Business Models for IoT in eight research papers

#	Components	R.M. Dijkmana, B. Sprenkelsa, T. Peeters, A. Janssen (2014)	Sun, Yan, Lu, Bie, and Thomas (2012)	Bucherer and Uckelmann (2011)	Fan and Zhou (2011)	Liu and Jia (2010)	Huan Li and Xu (2013)	Lei CHEN, TSENG, Xiang LIAN (2010)	Jozef Glovaa,Tomas Sabola, Viliam Vajdaa (2014)
1	Key partners								
2	Key activities								
3	Key resources								
4	Value propositions								
5	Customer relationships								
6	Channels								
7	Customer segments								
8	Cost structure								
9	Revenue streams								

The Table 2.4 shows that three of the eight research papers on 'Business Models for IoT' cover all the nine building blocks/components and are based on the Business Model Canvas tool (Osterwalder & Pigneur, 2009). When developing the IoT business model for Indian Public Sector Retail Oil Outlets, the Business Model Canvas tool (Osterwalder & Pigneur, 2010) is taken as the beginning point, because three of the eight business models on IoT that the researcher found in the literature review were based on the Business Model Canvas tool (Osterwalder & Pigneur, 2009). In addition, the Business Model Canvas tool (Osterwalder & Pigneur, 2009) is based on the results of multiple studies of business models.

2.14 Business Models

New digital upstarts are threatening the business models of traditional service providers; they should innovate or would be left behind (D'Emidio, Dorton, & Duncan, 2015). The use of digital technology has led to the emergence of disruptive business models (Willmott, Want to become Agile? Learn from your IT team, 2015). Digital represents a new way of doing business and engaging with customers (Dorner & Edelman, 2015). The extensive use of the internet and new disruptive technologies has shortened the products life cycle thereby giving rise to innovative and digital business models which are bound to change over a period of time (Glova, Sabol, & Vajda, 2014). (Meunier, et al., 2014) predicts that IoT could be driving potential changes in business models in future with significant opportunity for many industries. Innovations on business models are an important task of any business (Berre, Man, Lew, Elvesæter, & Ursin-Holm, 2013). (Pereira & Caetano, 2015) mentions that the business model is an instrument for depicting and reporting of organizational strategies that contribute to the understanding of defined projects. A business model is an instrument that contains a set of parameters that help in representing the ways of doing business for an organization. It depicts the organizational value provided to certain customer segments and associated partners for generating new streams of revenue and improved operating margins (Osterwalder & Pigneur, 2009). The Business Model Canvas tool (Osterwalder & Pigneur, 2009) is the most widely adopted Business Model in the current dynamic and changing business environment. It is used for development, elaboration and visual depiction of business models. It is made up of nine building blocks that describe how an organization conducts its business to generate revenue and its association with the various stakeholders.

The below Figure 2.22 elaborates each building block apart from visual depiction of the business model canvas.

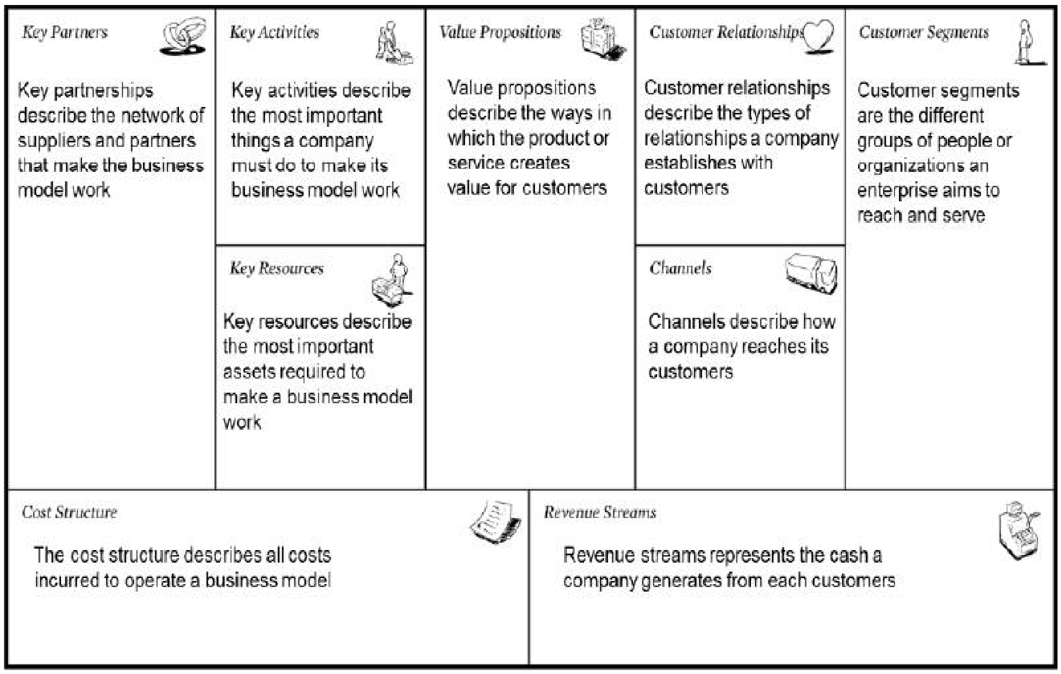


Figure 2.22: Business Model Canvas (Osterwalder & Pigneur, 2009) *and descriptions of the building blocks*

The nine building blocks (Osterwalder & Pigneur, 2009) are as follows:

- **Customer Segments**: the various classes of consumers having similar attributes
- **Value Proposition**: the solutions offered to cater to the needs of the respective consumer groups
- **Channels**: the mode of communication with respective consumer groups to propogate value

- **Customer Relations**: the different modes of engagement used by an organization with the various consumer groups
- **Revenue Streams**: various levers used by an organization to generate revenue from each consumer group
- **Key Resources**: various assets used by an organization to provide value to the different consumer groups
- **Key Activities**: different actions undertaken by an organization to remain competitive, generate revenue and provide value to the consumer groups
- **Key Partners**: different modes of engagement with the partners, suppliers and other stakeholders to provide value to the consumer groups
- **Cost Structure:** various costs involved to make the business model operational

2.15 Use of Osterwalder's Business Model Canvas Tool (Osterwalder & Pigneur, 2009)

One of the strengths of the Business Model Canvas tool (Osterwalder & Pigneur, 2009) is that the depicted ontology on business model is taken from older business model ontologies broken down into nine building blocks. These nine blocks combined together focus on all the attributes of business model elaborated by previous scholars. It uses a visualization template for designing and communicating business models thereby making the usability of the tool higher.

Moreover, it is the most widely adopted Business Model in the current dynamic and changing business environment. When developing the IoT business model for Indian Public Sector Retail Oil Outlets, the Business Model Canvas tool (Osterwalder & Pigneur, 2010) is taken as the beginning point, because three of the eight business models on IoT that the researcher found in the literature review were based on the Business Model Canvas tool (Osterwalder & Pigneur, 2009). In addition, the Business Model Canvas tool (Osterwalder & Pigneur, 2009) is based on the results of multiple studies of business models.

2.16 Summary of Literature Review

Eight themes emerged from Literature Review pointing to the Research Gaps as mentioned in Table 2.5 and leading to the need for Research as follows:

Theme 1 is 'Business Model for IoT'. The inference is that the Business Model can be depicted through various modes at both organizational and industry level. The commonly used ways to represent a Business Model at organizational level are the Four-Box Business Model, Strategy Map, Value Chain and the Business Model Canvas (Osterwalder & Pigneur, 2009). The widely used means of representing a Business Model at industry level are the Four-Box Business Model, Strategy Map, Value Chain and Business Model Canvas (Osterwalder & Pigneur, 2009). Among them, the 'Business Model Canvas' tool and Value Chain are extensively used for academic and practical purposes. The 'Business Model Canvas' tool depicts a visual representation of the elements involved, it can be printed on paper or pasted on a chart paper for wider collaboration among individuals.

Theme 2 is 'Automation of manual processes through IoT'. It can be inferred that IoT can automate around 50 percent of all manual tasks. The gap identified from the literature for this theme is that it does not mention as to what metrics IoT can be most effectively applied by organizations in India to generate profitable business outcomes and competitive advantage.

Theme 3 is 'Business benefits accrued through IoT'. It is inferred from the literature that the parameters on which companies can benefit from adoption of IoT are increased employee productivity and operational efficiency, cost efficiencies, supply chain optimization, improved customer experience, supply chain visibility, improved delivery process, risk management and faster decision making. The gap from the literature is that it does not mention about the benefits of refueling experience and customer relationship through IoT.

Theme 4 is 'Interlinking of Process, People, Things and Data'. Literature review on this theme mentions that adoption of IoT is required for next generation digital revolution – when process, data, people and things are stitched together in the Oil and Gas chain which also includes the IT and OT aspects of business operations. The gap identified from the literature is that the performance of systems and processes through IoT in the Retail Oil Outlets is not known.

Theme 5 is 'Digital Enabling variables that help in increasing productivity and efficiency'. Literature review for this theme mentions that a few of the variables identified were IoT applications, interoperability, IoT data, wearables, Interoperability, predictive maintenance, distinctive data, software platforms, sensor data, operational efficiency, IT-OT convergence, adoption of IoT, data analytics, automation, connected things, data deluge, co-innovate, platform, modeling, simulation, connectivity, capital efficiency, operational technology, operating cost, social media, digital oilfield, Cloud and mobility. The gap identified from the literature is that these variables were identified from industries such as Healthsciences, Telecom, Consumer Packaging, Financial Services, Energy and Utilities; however no study was found in the Indian Retail Oil Outlets.

Theme 6 is 'Digital technologies through IoT in Oil and Gas'. Literature review for this theme mentions about the important aspects involved for the development and sustenance of IoT technologies. It also highlights about how IoT can impact our work and home lifestyles to an intelligent and smarter ecosystem. The gap identified is that the literature does not mention about IoT adoption against business pain points applicable for Indian Public Sector Retail Oil Outlets.

Theme 7 is 'Implementation of IoT in Indian Industries'. Literature review mentions about the suggested implementation of various digital technologies through IoT in India across industries. It also refers to improved productivity, higher efficiency and disruptive innovation through IoT in India. The gap identified from the literature is the digital enabling factors which will help increase employee productivity and operational efficiency in Indian Public Sector Retail Oil outlets

Theme 8 is 'Theoretical Premise: Thing Theory'. Literature review mentions about the Thing Theory which is about linking people to intelligent environment. The Thing Theory mentions about the interrelation between devices, human beings and technologies and how they can be practically operationalized. The research gap identified for this theme is as to how Processes can be connected to Things, People and Data within integrated IoT.

Table 2.5: Themes, Research Gaps and Research Problem

Themes	Findings	Gaps	
Business Model for IoT	There are various ways to represent a business model both at enterprise level and industry level	No studies on IoT business model focused on Indian Public Sector Retail Oil Outlets are available	The researcher could not find any appropriate IoT Business model appropriate for Indian Public Sector Retail Oil Outlets
Automation of manual processes through IoT	Half of all manual processes could be automated through IoT	What metrics on IoT be most effectively applied by Indian Public Sector Retail Oil Outlets to generate significant returns & a sustainable competitive advantage	
Business benefits accrued through IoT	Increased employee productivity and Operational efficiency, cost efficiencies, Improved customer experience, risk management, faster decision making, are the business benefits that can accrue through IoT	Refueling experience and Customer Relationship through IoT is not known	
Connection of People, Process, Data and Things	Digital Transformation requires adoption of IoT – the networked connection of people, process, data and things	Performance of systems and processes through IoT in Retail Oil Outlets is not known	
Digital Enabling variables that help in increasing productivity and efficiency	A few of the identified variables were automation of manual processes, asset optimization, generation of new revenue stream, sensor and hardware producers and customer experience	These variables were identified from industries such as Transportation, Healthcare, Retail, Manufacturing, Energy & Utilities but no study was found in Indian Retail Oil Outlets	The digital enablers which will help increase employee productivity and operational efficiency in Indian Public Sector Retail Oil Outlets are not known
Digital technologies through IoT in Oil and Gas	Combination of disruptive digital technologies particularly IoT has profound impact on business performance	IoT adoption against specific operating and financial pain points applicable to Indian Public Sector Retail Oil Outlets is not known	
Implementation of IoT in Indian Industries	IoT in India brings about improved productivity and efficiency, risk management, realtime decision making and new waves of innovation	The digital enabling variables which will help increase employee productivity and operational efficiency in Indian Public Sector Retail Oil Outlets is not known	
Thing Theory: The Thing Theory does not mention about the interrelation of Processes with People, Data and Things within integrated IoT	**Research Problem** - *"What is the interrelation of Processes with People, Data and Things within integrated IoT ?*		

2.16 Variables Identified from Literature Review

29 key digital enabling variables were identified from Literature review for increased operational efficiency and employee productivity in Global Retail Oil outlets which are mentioned in Appendix A.

2.17 Concluding Remarks

Several research papers, journals, reports and books were reviewed as part of the literature review. This chapter focused on the downstream industry in India, key challenges for the downstream industry, the number of Retail Oil Outlets of IOCL, HPCL and BPCL; the importance, benefits and potential of IoT; use of IoT in the Oil and Gas industry and at Global Retail Oil Outlets. The chapter highlighted the business benefits accrued to the Global Oil and Gas companies due to the implementation of IoT. It also touched upon the business models and the importance of Business Model Canvas tool (Osterwalder & Pigneur, 2009). It was found that the Business Model Canvas (Osterwalder & Pigneur, 2009) tool is the most widely used Business Model in the current business environment and leverages on the previously presented business model ontologies. The research gap deduced from the literature review was the digital enablers that can enhance employee productivity and operational efficiency in Indian Public Sector Retail Oil Outlets. The researcher was unable to find any IoT Business Model appropriate for Indian Public Sector Retail Oil Outlets. Numerous theories were studied, and the most applicable theory for the study was found to be the Thing theory. The research gap from the Thing Theory highlighted absence of the connection of Processes with People, Data and Things within integrated IoT. The next chapter mentions about the research design and methodologies used in the research work.