IoT Business Model Change in the Industrial Sector

Technology and Business Management, 30 Credits

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ABSTRACT

The industrial domain is experiencing relatively a higher growth rate than other Internet-of-Things (IoT) market domains. Much as a lot is said about its technological capabilities and applications, less has been said about the business side, and specifically how business models for IIoT are changing currently. This paper seeks to explore how industrial IoT business models are changing the key drivers in the now. Some of the key finding include the fact that this change is expressed most within the value proposition, collaborations and partnerships, new skill sets, internal departmental convergences etc. The key drivers are mainly both technologically and market driven with mostly reasons of IIoT adoption being cost cutting and efficiency in operations. It is also found out that standardization and regulations also play a key role but only to arbitrate (issue like privacy security, ownership interoperability etc.) what has or is already been put to service, in most of the cases e.g., The General Data Protection Regulation (GDPR).

Key words: Business model, Industrial IoT, Change
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1 Introduction

1.1 Background

In the early 1990s, the Information and Communications Technology (ICT) sector experienced an exponential increase in fierce competition (Ge et al. 2016) among vertical firms due to the relentless and spasmodic forces of technological change (Caputo et al. 2016) than enabled new services in the market. The commercialization of the internet, proliferation of end user gadgets (pcs and phones etc) and GSM (Global System for Mobile Communications) created new “value” diversity in connectivity and services to the world and therefore new markets. The internet is currently counted among the most important technologies with a great impact on business environments and society. Like any other technology, it took many turning points in order to evolve into the current flexible, available and usable service that business, governments and society benefit from. On the other side, devices and gadgets which support internet-based technologies and also mediate internet access are not only facing miniaturization but also becoming smarter and more cognisant of their environments. (Skaržauskienė & Kalinauskas 2012).

The radical advent of commercial internet sparked sequential and incremental bursts of technological innovation that aimed at maximizing customer value. There was need to both explore and exploit this novel demand surge in data in early 2000s and serve the different market opportunities (livari et al. 2015a) as had been foreseen prior. This Internet wave between 1995 and 2000 led to radically new digital business model patterns based on what is known as Web 1.0. The then new IT enabled business model patterns included E-Commerce, Leverage Customer Data, Freemium, Open Source (software related) and Digitalization (Gassmann et al. 2016). The year 2005 ushered in another wave of IT-driven business model patterns based on Web 2.0, including User Designed, Crowdfunding, Crowdsourcing, and Open Source (content) etc. This not only did increase numbers of ordinary people as internet users, but also made it possible for them to contribute content to the internet. The trend is well depicted in figure 1.

The Internet and IT booms in the early 1990s were largely spearheaded by technological inventions and innovations pushing (Dossi 1984) towards new customer segments, which eventually metamorphosed into a larger demand forces that subsequently pulled (Dossi 1984) further onto technology to adapt to the more specific needs of businesses, governments and society.

The last ten-year period has witnessed an exponential increase in technological research and development in the Information and Communications Technology (ICT) (Ferretti & Schiavone 2016) sector owing to the seemingly inexhaustible complex technological features and capabilities and global market demand to not only connect people but also include all things. The concept of connecting things to a network is not that new. Termed “internet-of-things” (IoT), it was coined by “MIT Auto-ID Center”, that later became EPC global (Skaržauskienė & Kalinauskas 2012). Their vision of IoT was based on radio frequency Identification (RFID) technology, which technology is nowadays extensively used for objects, people, things or animals tracking to facilitate management of movement of masses of inventory (Kranz 2017).

In a bid to reduce costs and increase productions, Manufacturers started to connect several machines and devices to sensors, actuator PLCs etc for better production monitoring,
troubleshooting maintenance and management of entire production units, even remotely, i.e. machine-to-machine (M2M) networks (Kranz 2017; Borgia 2014).

Cisco resuscitated the term Internet-of-Things (IoT) around 2008 when deciding how to describe the trend of devices, things, or machines being connected to each other over the internet Protocol (IP) networks and, eventually, to the Internet. (Kranz 2017). Analogous to both the IT and Internet epochs, once again, innovative value in IoT is now revealing its scopes for profit potential through its pervasive technological capabilities, almost to mirror the recent past. An arguably equal technological wave with vast business potential in business and societal and environmental aspects. This change wave also comes with its own low latency support network generational -the fifth Generation (5G), a technological wave in itself (Lema et al. 2017; Gomes & Moqaddemerad 2016). Once these opportunities are accurately confirmed, the need therefore is for a new business modelling process to allow for amortization of the so much investments currently undertaken in these technologies (Lema et al. 2017).

As the world leading ICT influencers such as International Telecommunications Union (ITU), Institute of Electrical and Electronic Engineering (IEEE), America National Standards Institute (ANSI) joined hands to cater for policy, regulatory and standardization aspects of the internet (Gershenfeld et al. 2004), once again they are, along with many others in IoT technology. The Information Technology (IT) and Internet revolutions presented a “value” of diverse connectivity and services through perverse digitalization and splendid new business models based on digital application platform. Businesswise, IoT presents innumerable opportunities for several firms, industries and nations alike at least as argued by almost all business and technology researchers. These opportunities come inform of services, platforms and applications to providers, telecom operators and integrators, internet industry etc and all market domains and sectors. However, the present IoT market is in its earliest stages of development in some and arguably maturing in others, with bitty solutions aimed at specific areas along with specific application types. Variant proprietary protocols, platforms, and interfaces characterize the solution offering (Oleksiy Mazhelis, Eetu Luoma 2012; Porter & Heppelmann 2014). This makes difficult the compatibility of the solutions’ components from different vendors. Therefore, some of the existing technologies are but de facto standards, thus not entirely open standards (Murray et al. 2016; Nonnecke et al. 2016).

Nowadays, the industrial domain, like manufacturing sector is facing increased global competition with new competitors especially from Asia (Gao & Bai 2014; Arnold 2017). This increased competition is fuelled by both shortened innovation cycles and technology and deregulation leading to more dynamic competition. Besides this significant impact on the manufacturing setting, the industrial sector has also to cope with increased markets’ volatility, which muddles quantity predictions. Increased process, services and product complexity is yet another trial for industrial firms (Spath et al. 2008; Wirtz 2013). As a result, firms’ competitiveness is vastly anchored on their capability to supply fast and flexibly customized products at the cost of a large-scale production which requires logistics and production systems that are more flexible, adaptable and efficient (Strandhagen et al. 2017).
1.2 Problem

Industrial platforms and applications for IoT are more mature than many other market domains, particularly the manufacturing, supply chains and logistics (Papert & Pflaum 2017; Caputo et al. 2016; GSMA Association 2014). Despite this success, the adoption rate still inhibited by other factors. There is absence of a generally recognised dominant design which results into high costs of building solutions. Secondly, the lack of a generic architectural reference and nonvendor- specific guidelines on how to select appropriate solutions and components also hinder IoT adoption.” (Oleksiy Mazhelis, Eetu Luoma 2012). Despite these drawbacks, there is considerable strands in the IoT business growth especially in the industrial sector over the last decade. Therefore, it is important to explore the current changes, their enablers, and barriers.

Conflictingly, whereas much funding is focused on IoT technology development research, the exploration on its adoption and how could be adapted to future business models (Laya 2017; Westerlund et al. 2014; Kiel et al. 2016) still lacks. Furthermore how ought such innovation process function (Caputo et al. 2016; Yu et al. 2016); with early progressive market success still lack. Therefore, to answer these questions, unlike in the past analyses that were made after IT and Internet revolutions happened, it is important to explore and understand how changes are happening (and why) in this moment This is the key point of inquiry in this research. In the current global economy, where pervasive digitalization has made companies like google, Facebook, Huawei, Apple etc competitive forces in their markets innumerable opportunities still lie in wait for exploration by ICT players. The fully blown digitized era brings potential
prospects especially with the Internet of Things (IoT) to the industrial sector. Such opportunities require new ways of exploration (Glova et al. 2014), among which, this research seeks to unveil.

It is known that current empirical research is less inclined to prevalent classical business model design thinking than the ecosystems thinking with regards to IoT technologies (Lindgren & Bandsholm 2016a; Bahari et al. 2015; Livari 2016). Against the backdrop of business models and business model innovation theories currently being researched and developed in search of their improvement on one hand, a new way, the ecosystems design thinking is being proposed on the other hand. This new wave of change, the Internet-of-Things (IoT) potently promises the several vertical and horizontal industrial growth paradigms. Consequently such changes can be threats or opportunities to the current industrial market players (Li et al. 2012). Whether or not for good, A wonderful opportunity for new markets and high returns presents itself (Ge et al. 2016; Caputo et al. 2016).

The earlier mentioned “push” and “pull” forces driving IoT technology availability to create valuable solutions require parallel research, seeking to understand how IoT can better serve the wider industrial and societal needs. Now, pilot solutions are already in different vertical markets while being studied and incrementally enhanced to metamorphose into dominant solutions (Ng & Wakenshaw 2017). There is also considerable talk of “communications service providers (CSPs)” to evolve into platform firms, and many of which have now garnered several customers for their IoT platform offerings. Nevertheless, these CSPs realising the most IoT success have so far focused on co-creating IoT solutions aimed at specific enterprise use cases, in specific industrial verticals.

![Figure 1.1 Showing IoT platform companies by Segment (Williams 2017)](image)

Nearly, all academic and industrial publications about IoT and leading IoT firms hype the change of business models that the technology will bring about, yet none has really studies these changes in the moment, usually under the guise of the fact that IoT is still under its infancy stage. This paper seeks to explore, this change so preached both by industry experts, and observing already in the market solutions, and therefore determining the most common kinds of business model changes and their likely implications. The graph shows that most IoT platform firms focus on Industrial/Manufacturing, a reason to explore the industrial sector.
Note that sum of the percentages goes beyond 100% because Industrial firms focus on several segments.

1.3 Research Purpose and Research Questions

Generally, the industrial domain, constitutes a rather young research field but with highly advanced development and market successes especially in logistic and now manufacturing and some agricultural areas. While previous literature focused on technological aspects, opportunities and challenges, the economic aspect is rather lagging in comparison (Kiel et al. 2016; Kiel 2017; Arnold 2017; Caputo et al. 2016; Laya 2017). However, some researchers are already generally dealing with potential influences of the IoT on BMs in in the industrial domain (Herterich et al., 2015a; Spath et al., 2013), but they focus on specific aspects in their respective research fields. A wide-ranging picture about the impact of the IoT on established BMs in industrial domain is lacking hence the need for this research.

This thesis aims at broadening and deepening our understanding of the current IoT business state, growth trends and key barriers and enablers within the Industrial domain. It suggests valuable conceptual highlights, largely previously ignored, underpinning IoT business development. The goal is to broaden perspective on the prevalent approach to understanding of IIoT business models. The purpose of this research therefore narrows down to a study of how the prevalent IoT businesses are forming and changing. What undercurrents spin prevalent business models in light of concepts in industrial management and economics. From the above purpose, two research questions are deduced:

I. How are IoT business models changing in the industrial sector.

II. Why (elaborate the factors underpinning these changes)

1.4 Research Rationale

As mentioned earlier, a complex network of devices and things with ubiquitous intelligent interconnections over the web (Fotouhi 2015; Ge et al. 2016), a universal network and service infrastructure of variable connectivity and density with self-configurational capabilities founded upon standard and interoperable formats and protocols epitomises a multi-domain convergence and is considered as the umbrella term bonding the underlying technologies and interrelated visions. Therefore, such pervasive, dynamic, and complex multi-network(s) of “multi-application” of a technology, “multi-coordination and integration” of different technologies, and “multi-actor development setting” is one of its kind.

Its numerous promises to businesses, governments and society are in tandem with its profit potential it promises. (Shaw 2015; Xu 2012). This has not yet been fully researched and theorised to guide current and future knowledge growth. This is largely because IoT is it its early development stages where no dominant designs have yet been developed. Secondly, while IoT business opportunities are being explored and exploited, less emphasis has been put towards turning IoT innovations into market successes than mere technological development...
This is due to much research funding directed towards technological development and less towards business side (Laya 2017). This thesis therefore eventually business model trends and thought processes over the past eight years to come up with a better way to allow for amortization of the so much investments currently undertaken in these technologies.

The figure 3 below is an estimation of the number of expected connected devices in their billions from 2015 up until 2025. This is an interesting case, to make one wonder, how so far, we have reached in 2018 and why. A reason for this thesis project. However as shall be shown later, IoT covers large domains and segment all of which cannot be covered in this thesis. Therefore, the arguably most advanced and successful (see figures 2 & 4), the industrial domain is the focus of this research.

![Figure 1.2 Estimated number of connected devices now and in the future in Billions. (Statista 2018)](image)

1.5 IoT, IIoT and Industry 4.0 Definitions

The term “Internet of Things” was first heard to be used by the MIT- Massachusetts Institute of Technology in 1999. Then, was meant to refer to a networked system of self-organising processes and objects which interact autonomously projected to cause convergence of the digital internet world with physical things. (Dieter Uckelmann • Mark Harrison --Architecting the Internet of Things text book) IoT is a complex network of devices and items fortified with ubiquitous intelligence connected over the web (Ge et al. 2016; Fotouhi 2015). It embodies a universal service and network infrastructure of variable connectivity and density with self-configurational capabilities founded upon standard and interoperable formats and protocols.
It comprises heterogeneous “things” with identities, virtual and physical attributes, and are flawlessly and securely integrated within the Internet. IoT research is rooted in numerous domains where diverse IoT features and challenges are addressed. These include: machine-to-machine, radiofrequency identification, machine-type communication, ubiquitous computing, wireless sensor and actuator networks, web-of-things etc (Oleksiy Mazhelis, Eetu Luoma 2012; Lucero 2016). Noteworthy, these technologies are applied in several vertical application areas, from machinery and automotive to consumer electronics and home automation to mention but a few (Gerpott & May 2016). Thus, as currently known, IoT epitomises a multi-domain convergence, and is considered as the umbrella term bonding the underlying technologies and interrelated visions.

An evolution in the network infrastructure and services is inevitable for the realization of the IoT vision. Stove-pipe or silo is largely the approach used by current systems owing to its vertical approach where “each application is built on its proprietary ICT infrastructure and dedicated devices.” (Borgia 2014). The problem with this is that Analogous applications do not share features to management of network and services, hence needless redundancy and rise of costs. A more horizontal and flexible approach can replace the vertical approach. Here a shared operational platform manages the services and the network to enable applications to work more properly. Applications do not isolation, but share network elements, infrastructure, environment and, a common service platform orchestrates on their behalf.

The horizontal representation has three key phases namely: collection, transmission and process, management and utilization phase. Each phase has different functions and different interacting protocols and technologies. In the Collection phase, the physical environment is sensed, and real-time physical data collected to recreate its general perception. sensors and RFID Technologies serve to identify physical objects and sense physical parameters, whereas technologies like Bluetooth or IEEE 802.15.4 are responsible data collection (Bilal 2017). The Transmission phase comprises mechanisms for collected data delivery to applications and other external servers. Therefore, there are Methods essential to access the network over heterogeneous technologies like wireless and satellite and gateways, routing such as Trickle and RPL and for addressing (Juho & Ted n.d.). During the last phase, data is processed, and information flows analysed and forwarded to services and applications as well as providing feedback to control applications (Borgia 2014).

1.6 IOT Market Segmentations

The figure below depicts some of the possible and already being exploited market opportunities and IoT application domains. IoT technology is and could be exploited in all industrial activities that involve commercial transactions between and among firms, organizations and several other entities. Symbolic examples include manufacturing, logistics, monitoring of processes, service sector, banking, governmental authorities, etc.
IIoT refers to the application of IoT technologies to industrial contexts. It is also called “Industry 4.0” a term created in German owing to the capability to integration the digital and physical industry. IIoT Industry or 4.0 involves cloud, big data, cyber-physical interconnects etc. It is here within Industrial IoT that physical and virtual worlds flawlessly interact and communicate with each other as intelligent things. The industrial domain, probably more than any other, has witnessed ground breaking methodologies that ushered in a new era of thinking (lean etc) from companies like Toyota, Motorola etc, especially in manufacturing. These of course helped firms leverage economies of scale and scope to earn competitive market position till today. Now IIoT a network of devices and things all cognitive offers mines of data that are starting to shift industrial capabilities as had been though best earlier. This is not only about increasing production, but providing real time 24/7 data that shifts everything, if used right. Furthermore, IIoT allowed for the creation of novel and hybrid business models that are...
transforming the industry. (Hartmann 2015). The figure below shows how the industrial IoT is a multi-layered ecosystem with component that are closely working with each other (Mike Quindazzi 2017).

Figure 1. 4 IIoT Ecosystem (Mike Quindazzi 2017)

1.8 Thesis Design

The figure 3 below depicts the full description of the thesis research design.

Figure 1. 5 Depiction of the thesis flow
2 Literature Review

In this review, key business models and business model change concepts are discussed and reviewed to help understand the topic from past literature and therefore offer a background for a general framework that will eventually be used to analyse the empirical data and finally help answer this thesis’ research questions. The methodology for this research as has been described later, a composition of both deductive and abductive approaches is used. In simple terms, while we answer the main research questions using the most prevalent literature, we do the same from an empirical perspective and after discussing the two finding to finetune answers for the research questions and thereby achieve the objective of this research.

The other purpose this literature review is to twofold:

- Review most prevalent literature privy to our research.
- Examine key business model changes and types from the literature while categorizing the usual causes of such changes.

It is divided into the following parts: business models, business model types, business model change, technological change and business model relationships and finally IIoT business models. Next, the research design is outlined before the key findings are presented and subsequently discussed. Eventually, our paper’s contribution to theory and practice is disclosed.

2.1 Conceptual Framework

The diagram below is a description of the key concepts about which the literature review is conducted.

![Conceptual Framework Diagram]

**Figure 2.1 Key concepts for literature review.**

2.2 Business models.

This section is intended to discuss prevalent literature to understand what business models were, are, and predicted to be in the future- their purpose and different semantic nuances that will serve subsequent discussion. Business models have been described, as descriptive(Caputo et al. 2016) architectural (Alt & Zimmermann 2014), a narrative and depiction (Klang et al.
A business model is defined by Osterwalder et al., (2005) as a conceptual tool that comprises *elements* and their *interactions* to allow for the expression of a firm’s business logic. It describes a company’s value offering(s) to customer segment(s) and the firm’s architecture and its value creation, marketing and delivery co-partners and relationship capital, to generate gainful and sustainable revenues streams. Most commonly, a business model is defined as a description of the rationale of how a firm “creates”, “delivers” and “capture value” (Osterwalder & Pigneur, 2010). Spieth et al., (2014), to mention but one, agree to this and re-emphasize *firm-centric* creation, and capture of value in a business model. Refer to fig below.

<table>
<thead>
<tr>
<th>Key Partners</th>
<th>Key Activities</th>
<th>Value Proposition</th>
<th>Customer Relationships</th>
<th>Customer Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who are our Key Partners?</td>
<td>What Key Activities do our Value Propositions require?</td>
<td>What value do we deliver to the customer?</td>
<td>What type of relationship does each of our Customer Segments expect us to establish and maintain with them?</td>
<td>For whom are we creating value?</td>
</tr>
<tr>
<td>Who are our Key Suppliers?</td>
<td>Our Distribution Channels?</td>
<td>Which one of our customer’s problems are we helping to solve?</td>
<td>Which ones have we established?</td>
<td>Who are our most important customers?</td>
</tr>
<tr>
<td>Which Key Resources are we acquiring from partners?</td>
<td>Customer Relationships?</td>
<td>What bundles of products and services are we offering to each Customer Segment?</td>
<td>How are they integrated with the rest of our business model?</td>
<td>Check our Customers</td>
</tr>
<tr>
<td>Which Key Activities do partners perform?</td>
<td>Revenue streams?</td>
<td>Which customer needs are we satisfying?</td>
<td>How costly are they?</td>
<td>Check our Customers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key Resources</th>
<th>Key Activities</th>
<th>Value Proposition</th>
<th>Customer Relationships</th>
<th>Customer Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>What Key Resources do our Value Propositions require?</td>
<td>Our Distribution Channels?</td>
<td>Which one of our customer’s problems are we helping to solve?</td>
<td>Which ones have we established?</td>
<td>For whom are we creating value?</td>
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<td>Our Distribution Channels?</td>
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<td>How are they integrated with the rest of our business model?</td>
<td>Who are our most important customers?</td>
</tr>
<tr>
<td>Revenue Streams?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channels</th>
<th>Revenue Streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through which Channels do our Customer Segments want to be reached?</td>
<td>For what value are our customers really willing to pay?</td>
</tr>
<tr>
<td>How are we reaching them now?</td>
<td>For what do they currently pay?</td>
</tr>
<tr>
<td>How are our Channels integrated?</td>
<td>How are they currently paying?</td>
</tr>
<tr>
<td>Which ones work best?</td>
<td>How would they prefer to pay?</td>
</tr>
<tr>
<td>Which ones are most cost-efficient?</td>
<td>How much does each Revenue Stream contribute to overall revenues?</td>
</tr>
<tr>
<td>How are we integrating them with customer routines?</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2.2 The 9 building blocks of the Business model Canvas (Osterwalder & Pigneur 2010)**


Internal artefacts are related to the inner firm sphere, and do not directly affect its external stakeholders’ relationships. Relational mechanisms influence the external stakeholders and firm relationships. External stakeholders are situated outside the firm boundaries (Klang et al.
The configuration dimensionality denotes a complex network interdependent between business model concept elements that can manifest itself in various ways such as the dyadic relationships between components (Klang et al. 2014; Zott & Amit 2010; Lambert 2015). These three dimensions could equally be reiterated into why (purpose and strategy), what (elements within) and how (how they interact within and without), i.e. classification, constitution and configuration respectively. The fig below is an archetypal depiction these three in terms of creation, delivery and capture of value.

Figure 2.3 Archotypical business model description (Chan 2015)

Indeed, common with all different perspectives to business models is that they tend to portray the notion on how a firm creates and capture value (Zott & Amit 2010; Caputo et al. 2016; Alt & Zimmermann 2014; Osterwalder et al. 2005; Lambert 2015) see figure 12.

2.2.1 Business model Innovation

To innovate a business model therefore, there ought to be; novelty to customer value proposition, logical and, or structural reframing and reconfiguration respectively, of a firm, or the discovering of an essentially different business model in an already existing firm (Spieth et al. 2014). In their presentation of the current overview of the field of business model innovation, Spieth et al., (2014) proposed a role based approach categorizing it into; explaining, running, and developing the business. These inductive contributions mirror to a large extent the ongoing challenge of constituting a clearly delineated theoretical foundation for business model innovation literature.

On a firm level, Business models and implicatively the innovations thereof tend to be complex due to the boundary-spanning and multidimensional entities linking innovation processes technological capabilities and corporate strategy (Spieth et al. 2014; Seddon et al. 2003). Deductively therefore, the business model design details consequently affect the innovation a
given business model. Industrial sustainability agenda combined elements of eco-efficiency, Eco-innovations, and corporate social responsibility practices in business model thinking, one way to positively innovate business models (Bocken et al. 2014; Schaltegger et al. 2016; Schaltegger et al. 2011). Nonetheless Bocken et al., (2014) emphasize the three elements’ insufficiency to deliver holistic changes necessary for attaining long-term environmental and social sustainability owing to several reasons like managerial attitude towards change, and over blinding focus on but financial value to all actions taken (Chesbrough 2010; Zott & Amit 2010; Bocken et al. 2014).

A Sustainable business model integrates a three base line approach and considers a larger range of stakeholder interests, along with society and environment (Schaltegger et al. 2011). Three elements of value define a business model: creation, proposition, and delivery and capture. (Bocken et al. 2014; Schaltegger et al. 2011; Schaltegger et al. 2016). This is one attempt to move from firm-centric thinking towards a common good goal. IoT literature from entrepreneurship, corporate strategy and technology innovation and management is used to substantiate the IoT business model paradox, a bridge to an ecosystem perspective (Spieth et al. 2014; Ferretti & Schiavone 2016). Nota Bene (not the eco-innovations discussed earlier).

The table below illustrates examples of businesses that have innovated their business models with time,

<table>
<thead>
<tr>
<th>Company</th>
<th>Traditional business</th>
<th>Initial business model innovation</th>
<th>Further innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple iTunes</td>
<td>Music shops</td>
<td>Digital music (Ipod, Ipad, Iphone)</td>
<td></td>
</tr>
<tr>
<td>Amazon</td>
<td>Book trading</td>
<td>Online shopping</td>
<td>Shopping portals</td>
</tr>
</tbody>
</table>

Table 2.1 Business model Innovation versus Tradition businesses

2.2.2 IoT Business model types

In this section we shall directly discuss core business models that could apply to IoT services and or products. IoT Business models may differ depending on factors like markets types (B2B, B2C), product type (physical, or intangible), geography, technological capabilities etc. For IoT, an arguably extension of the internet, therefore, some of the internet era business models have continued in operation like cloud technologies (Labaye & Remes 2015), some have been improved while others have faded out while newer models are developed and adopted. The table below shows the ICT business models that could or can or have been applied to IoT in these types.

<table>
<thead>
<tr>
<th>Business Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystemic</td>
<td>open or Closed to allow anyone to link to it or pay to be part of the ecosystem respectively</td>
</tr>
<tr>
<td>Value added features</td>
<td>IoT functionality gives value-adding feature to an existing product, process or thing</td>
</tr>
</tbody>
</table>
Platform based for cross-selling | Product or Solution provides means to cross sell other services
---|---
Platform for co-selling | A given solution creates demand for a usually higher order product e.g. Low-cost printers require ink
Simple purchase | One-off purchasing of a product
Pay per use, time, functionality etc | Customer pay only for what they used in time or functionality, or capacity, or computing power in case of cloud computing etc.

Table 2.2 Some typical IoT business model

2.2.3 Business model change

From entrepreneurial and organizational Perspectives, exploration and exploitation phases are crucial processes while innovating business models (Gao & Bai 2014; Foss & Saebi 2015). Business model change process is described by Osterwalder & Pigneur (2010) in four phases namely planning, implementation, capturing and visualization, and finally change. Along with several business model visualizations, the change processes facilitate the business plan development and the implementation (Osterwalder et al. 2005). There has been significant focus on business models and innovating them, leaving a significant literature gap. I.e. the relationship between a firms’ business models and the organizational contexts in which the business models operate (Foss & Saebi 2015). This bring a challenge for existing firms attempting to implement new business models. Unlike start-ups, such firms operate with an existing business model, which bring in a new task then to engage in a process (Foss & Saebi 2015) largely known as business model change (BMC).

Wirtz (2013) claims this business model change process to entail the following phases in the same order: initiation phase that involves analysing advantages and disadvantages of the existing business model, idea collection, evaluation of ideas, and change initiation through external and internal factors. Other’s consider and apply the principle of project management that include, Concept, implementation, and evaluation while others researcher look at it as discover learn and adapt process (Teece 2010). The concept phase is where rough concepts are developed in detail, with determining and describing interactions of business model parts. Implementation is basically about scheduling projects, setting key performance indicators and optimizing and leveraging available competencies and resources and how risk ought to be best managed during implementations. Lastly is to evaluate which comprises control of business success records, commencement of structure and components corrections and unremitting scrutiny of undesirable changes with a goal of securing sustainability (Wirtz 2013; Foss & Saebi 2015; Gorissen et al. 2014).

Generally, business model change process comprises four phases namely: initiation phase, ideation phase, integration phase, and implementation phase, and they identify various challenges at every phase (Gassmann et al. 2016; Osterwalder & Pigneur 2010). It can be clearly observed that the majority of processes in business model change are more focused on
business model innovation, yet the incumbent processes are both linear and static. This therefore raises need to consider the dynamic capabilities in such change processes, e.g., how the process can be affected and by the business model which is undergoing change when the environment for example changes? However, despite such apprehensions, business model change process has a rather basic but constructive structure of four stages namely: evaluation, goals modification, goal formulation, and lastly implementation.

Business models can be positively or negatively affected by factors within and without the company (Teece 2010; Cepeda et al. 2016). Evaluation consists of scrutinising the ecosystem under which business operates (Lindgren & Bandsholm 2016b; Gassmann et al. 2016) and leveraging the advantages and disadvantages of a prevailing business model in order to make well informed decisions (Wirtz 2013). Business modelling facilitate transformations of businesses through change enactments (Foss & Saebi 2015). And a great business model designing comprises assessing both external internal and factors (Ghanbari et al. 2017; Teece 2005). To both capture and visualize the new business model improves and facilitates the planning developments, change and implementation. When changing an existing business model (Osterwalder & Pigneur 2010). Prevailing and envisioned business models under the transformational analysis serve to comprehend how the business is anticipated to change in the short and long terms. Finally, Business model changes must be implemented, and such enactment encompasses the evaluation of both external and internal factors (Teece 2010; Osterwalder & Pigneur 2010; Alt & Zimmermann 2014).

![Figure 2.4 Typical business model change process](image)

2.2.3.1 Technological change and Business models

It is rather important to note the difference between these two kinds of confusing research trajectories which include: research on the impact of IoT on business models (Gorevaya & Khayrullina 2015) and the other being impact of business models on IoT. i.e. how business modelling affects and spins business with IoT Technologies. As stated, the subject object-
relationship is IoT-BM and BM-IoT respectively, however both of which have been used to add value to the content of our research.

Like with any technologies, IoT Adoption rate is important in order to further grow identified and potential markets (Murray et al. 2016). Arguably, IoT is a rational evolutionary phase of the internet and digital revolutions (Skaržauskienė & Kalinauskas 2012). All developers and Integrators adopted either get-ahead technology or market strategy while the customers generally adopted a get-ahead market strategy (Chan 2015; Li et al. 2012). The customers must buy the idea, then product and or solution providers accommodate later stages and after purchase design changes to fine tune post primary application. IoT adoption has however not reached a mass market in several segments; the network-effect is rather more confined to specific vertical market due to complex bottlenecks like detailed customization that requires advanced domain knowledge (Vermesan et al. 2016). Several factors lead to business model change including but not limited to technological changes as discussed earlier. There is a symbiotic relationship between technological change and business models in many researches over the years.

Looking at business models from a strategic perspective from acclaimed research (like M. E Porter) it is argued that strategic intent of firms affects technological trajectories and revolutions. Morris et al. (2005) proposed the possibility of envisioning a business model life cycle to involve periods of “specification, refinement, adaptation, revision, and reformulation”. During the early period, the fairly informal model is followed by a trial and error process, where several core decisions are taken to determine the firm’s evolution trajectory. Later, alterations are made, and continuous experimentations. An essentially sound model can endure economic slumps and intermittent turbulences. Morris et al.( 2005) suggest that at a point of strategic inflection, i.e. When external forces weaken a model, a new business model ought to be constructed. External factors like technical progress and societal changes (Dossi 1984) along with internal factors like firms strategic values(Li et al. 2012) and goals influence business model viability and therefore play a part in the change process (Fischer 2012; Caputo et al. 2016).

2.2.3.2 Path-dependence and business model Change

Both incumbents and entrepreneurial firms don’t have the same ability to tap into different of value creation sources due to the extent to which they are cognitively constrained by path-dependent behaviour (Chesbrough 2010; Li et al. 2012). Path dependency refers to both the notion that past events influence future action and persistent decision-making patterns over a given time (Gärtner & Schön 2016). In business model evolution process, path dependency is expected to have a significant influence, but to play out in different ways in case of entrepreneurial and incumbent firms. Path-dependent would lead the incumbent firms to appropriate novel technologies in their existing business models since they tend to stay closer to the status quo (Chesbrough 2010). Some researchers argue that an incumbent’s sense-making task is constrained by its prevalent dominant logic, which is a derivative of its existent business model (Bohnsack et al. 2014a). Therefore, well established firms’ filtering process can impede the identification of business models that profoundly differ from the firm’s current business model.
Therefore, incumbents are expected to focus on efficiency as the key basis for value creation and thereby evolving their model to improve cost efficiency through economies of scope and scale (Bohnsack et al. 2014a; Zott & Amit 2010). A number of “self-reinforcing mechanisms” i.e. sticking to already established decision-making guidelines, by means of internal complementary resources, and meeting the present customers’ expectations– can hinder incumbents from considerable diverge from prevailing business models (Chesbrough 2002; Bohnsack et al. 2014a). Many times, regulatory system under which firms operate can further strengthen incumbent business model, mainly with industries historically characterised a large government participation owing to their economic significance and other concerns (Bohnsack et al. 2014a; OECD 2016).

Business model evolution can take a lot longer with incumbents since they are relatively not affected by contingent events; i.e. cognitive constraints of the dominant logic resist adaptations to the business model (Chesbrough 2002) and cross-subsidization will also create a financial buffer against disruptive events (Bohnsack et al. 2014a). Entrepreneurial companies on the other hand are less hindered by path dependency, because they aren’t affected by cognitive restraint when fitting new technologies in their existing business models, which makes them develop easily entirely new business models (Chesbrough 2002; Bohnsack et al. 2014a). These companies are less hindered in the assessment of alternate models and are therefore more flexible in pursuing radically different business models. Consequently they are expected to accentuate novelty as foremost source of value creation (Zott & Amit 2010; Bohnsack et al. 2014b) which is fundamentally difference with established business model in any given industry.

Demil & Lecocq, (2010) noted that static and transformational approaches as two different uses of the term business model, where the former denotes blueprint for the consistency between core business model components, whereas the latter represents a situation where the concept is used as an instrument to address innovation and change in a firm, or within the model itself. The firm’s sustainability is contingent upon forecasting and responding to emerging and voluntary sequences of change. ‘dynamic consistency’ of a firm refers to its capability to shape and sustain its performance while changing its business model.

Structural and operational changes in costs and or revenues are the first ‘symptom’ of BM evolution (Demil & Lecocq 2010). Environmental or external changes may also disturb the firm’s usual functioning. Internal factors in form of managerial decisions, but the inner dynamics between or within core components of the business model (Demil & Lecocq 2010; Fischer 2012). Van De Ven & Poole (1995) suggested four basic theories to serve as basis for explaining change processes in organizations: life cycle, dialectics, teleology, and evolution. They characterise different sequences of change events that are influenced by different conceptual motors and work at different levels of organizational. (Van De Ven & Poole 1995). Irrespective of the causes of this change, the change itself has been well characterised in typologies as demonstrated in the table below.
### Class | Type | What changes
---|---|---
Reactivate | Add | Firm’s business model Activity set by adding
 | Remove | Firm’s business model activity set by removing
Relink | Regovern | Transactions governance between markets, hierarchies, and hybrids
 | Resequencing | Order of firm’s units activity performance
Repartition - move organizational unit across focal firm boundaries | Insource/outsource | Organizational unit’s location moves from outside to inside / outside-in
 | reassign | Organizational unit’s location moves from a unit to another within the firm
Relocating | offshore | Firm’s unit geographical location from inside firm’s home country to a foreign one
 | Onshore | Firm’s unit geographical location from foreign country activity unit into the home country

Table 2.3 Business Model Change Typologies (Juntunen 2017)

### 2.2.3.3 Continuous and emerging business model change

A firm’s trajectory results from the interweaving of emergent events and trends with the outcomes of its deliberate choices. Although the voluntary BM changes are the result of decisions linked to core components, the emerging changes are inadvertent and partially outside management’s control. These evolutions may be triggered by the not only environment, but also unexpected effects due to voluntary decisions and the BM operation dynamics which can create spill over effects and may create vicious or virtuous circle. Table below provides some illustrations of this kind of intertwining of voluntary and emerging evolutions in.

The global effect of such emergent changes can be that even if the firm does not overtly decide to change some BM elements, it may change. Consequently, Business model evolution ought to be perceived as sequences that incorporate both emergent and determined changes affecting core components or their elements. These sequences therefore put business models in a permanent state of “transitory disequilibrium” where some portions can be fixed by executive decisions, some self-reinforce in the long term. The concept of ‘permanent disequilibrium’ holds the perspective that resources are never optimally exploited, and inadequacies continually persist, thus offering new value propositions opportunities and better ways to exploit resources.

Osterwalder & Pigneur, (2010) also noted that Business Models changes because Internal (revenue, Change in Value Proposition, New Revenue Opportunities, Company Evolution/e.g. from low price to high price after starting.), and External drivers (new technologies, policy, standards, blue ocean, new markets etc) the Competition and conditions of operation change.
over time, therefore there is needing to also change in order to remain competitive in competitive environment. Regulatory and policy changes also are some of the forces that determine changes in business models (Shin & Jin Park 2017; Basaure et al. 2016).

Cycles of business model change in many instances are like those in change management, therefore in order to understand the small changes in business models, that will help us fathom the larger picture “evolution”, we ought to pay attention to the change cycles elaborated in change management. Change management encompasses an understanding of what a business goes through during its growth and development. “Lewin’s model created by social scientist Kurt Lewin.” There are three main stages namely preparation, transition and establishment of change. Business Process Management (BPM) well-established discipline that usually to analyses, discovers, designs, implements, executes, monitors and evolves collaborative business processes across and within organizations. (Janiesch et al. 2017) The figure below shows the key forces acting upon business models, a cause for its constant changes and evolution as described earlier.

Figure 2.5 Categorization of Business model Change Forces

2.3 IoT business models in Industrial Domain

In terms of the business model Canvas, figure below depicts the basic IoT business model framework. In an order of priority, Dijkman et al., (2015) identified the most important of the business model canvas building blocks with regards to IoT applications. These are shown in figure below. Value proposition as by (Gorissen et al. 2014; Uchihira et al. 2017) is the most highly ranked building block of the canvas without the articulation of which in such a multi-actor ecosystem, the business will fail.

In their research, Dijkman et al. (2015) went further to elaborate on the relative importance of the above block with respect to IoT. In the following Order: Value Proposition, Revenue streams, Customer segments, Cost Streams, Key partners, Customer relations, key activities and lastly channel recorder the least importance. Here they identified relevant building blocks for an IoT business model, option types that could be focused upon within these blocks and the relative importance of these types and blocks. Furthermore, they extended and revised the
Business Model Canvas by finding the types of building blocks that are more pertinent to IoT business. (Dijkman et al. 2015).

<table>
<thead>
<tr>
<th>Key Partners</th>
<th>Key Activities</th>
<th>Value Proposition</th>
<th>Customer Relationships</th>
<th>Customer Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware producers</td>
<td>Customer development Product development Implementation; Service Marketing; Sales Platform development Software development Partner management Logistics</td>
<td>Newness, Performance Customization, Getting the job done, Design Brand/status, Price Cost reduction, Risk reduction, Accessibility, Convenience/usability Comfort, Possibility for updates</td>
<td>Personal and or Dedicated assistance Automated service Self-service Co-creation Communities</td>
<td>Niche market Mass market Segmented Multisided platforms Diversified</td>
</tr>
<tr>
<td>Software developers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other suppliers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data interpretation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Launching customers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distributors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service partners</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key Resources</th>
<th>Value Proposition</th>
<th>Customer Relationships</th>
<th>Customer Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intellectual property</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employee capabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Relations</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Structure</th>
<th>Revenue Streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product development cost</td>
<td></td>
</tr>
<tr>
<td>Logistics cost</td>
<td>Asset sale, Usage, Subscription, Brokerage Installation, Start-up fees</td>
</tr>
<tr>
<td>IT cost</td>
<td>Renting/leasing/Lending</td>
</tr>
<tr>
<td>Hardware/production cost</td>
<td></td>
</tr>
<tr>
<td>Personnel cost</td>
<td>Licensing</td>
</tr>
<tr>
<td>Marketing &amp; sales cost</td>
<td>Advertising</td>
</tr>
</tbody>
</table>

Figure 2.6 Typical IoT business model Canvas (Dijkman et al. 2015; Vermesan et al. 2016)

In their research, (Carneiro & Menezes 2017) while tackling IoT servitization, emphasized constant mapping of the needs and uncertainties of actors, resources and activities. They emphasized business models that not only focuses on value creation in IoT servitization, but also aiming at the minimization of conflict amongst actors. Chan (2015) however, proposed a business model that consists of three dimensions: Who, Where, and Why. i.e. respectively collaborating partners, value co-creation sources in digitalization layer model and lastly how partners or actors gain from collaboration in the value network. He however emphasizes the value being created and the collaboration among actor (Kiel et al. 2016) as most important in value creation, giving the benefit less of importance due to the early stage of IoT applications development.

In other words, The IoT business model framework ought to address what (the specific IoT architectural layer), who (the stakeholders) and why (value proposition) (Vermesan et al. 2016) as depicted in the figure 13 below. Developments of IoT platforms encompasses the entire stakeholder ecosystem covering the entire IoT value chain to coordinate and deliver the services and functionalities required by the various IoT applications supported(Yu et al. 2016; Uchihira et al. 2017).
Each stakeholder uses a business model framework tool to develop its business models, by generating a value chain components overview for the different IoT stakeholders and their solutions they provide. The divergent business models are dependent on the decentralised /centralised models availed by the IoT platforms and the dynamic de-registration and registration of edge devices in the IoT topology (Onar & Ustundag 2018a). IoT PaaS is aligned with cloud architectures where a central hub delivers backend services to the devices in the edge. The main centralised capabilities of an IoT platform include device discovery and management, event processing and notifications, enterprise system integration, real-time analytics (Towarzystwo et al. 2017; Vermesan et al. 2016).

The decentralised models offered by the IoT platforms allow for autonomous communication between devices in the edge in an IoT topology without a central hub with the capabilities such as peer-to-peer messaging, decentralised file sharing, decentralised auditing (Laya 2017; Westerlund et al. 2014). “Block chain technology” serves as an assurance mechanism for enabling the block chain platform and the IoT distributed model. It offers the building blocks that enable devices in a distributed topology in the edge perform tasks and exchange data and in a secure and reliable way (Vermesan et al. 2016). The different advantages and disadvantages of adopting centralised and decentralized IoT platforms play a part in influencing business model change, specifically as barriers and enablers of IoT business model adoption and change.

IoT disrupts consumer and industrial products and services markets and serve as a significant growth driver for semiconductor, networking equipment, and service providers end markets globally. IoT business models are developed due to a number of vertical market solutions at tremendous growth rates. The IoT business models vary depending on the different layers (Adomavicius et al. 2005) as in figure 17. Different IoT business model categories that serve

![Image of IoT Context Business Model Framework](image-url)
different maturity levels for IoT adoption can be identified. Each business model plays an integrated and cohesive role in overall IoT strategy of an IoT stakeholder firm. Every active company in the IoT field can be allotted to at least one of the IoT reference model layers (Vermesan et al. 2016; Adomavicius et al. 2005).

IoT Value creation in can be classified into three layers (Pang et al. 2015) namely manufacturing, value creation and supporting: respectively, manufacturers can provide things like terminal devices and sensors, IoT used as a co-creation partner since a network-of-Things thinks for itself and Supporting layer gathers data for use in the value creation processes. Chan (2015) and Iivari et al. (2015b) detail this further into a four-layered IoT architecture Including: object sensing and information gathering, delivery, processing and smart services and Application. Here a firm can participate into more than a single layer, and therefore make its business model (Vermesan et al. 2016; Chan 2015). Westerlund et al. (2014), Shin & Jin Park (2017), Ju et al. (2016) and several others all agree that the business model, ecosystem and the core ecosystem concepts are key elements of IOT business. Usually, this requires an assembling of a framework that joins the IoT business model’s types with the primary ecosystems.

There are majorly three foremost IIoT-enabled business models types. The first one involves manufacturing assets Provision, repair, maintenance and operation. The second is innovative data and analytical services that aid manufacturing usually powered by big data, artificial intelligence, and analytics). The third involves new functionalities and services like efficient customisation and end user integration into the supply and manufacturing chain ecosystem (Ehret & Wirtz 2017). (Iivari et al. 2015b) consider a business model as a description of the system of interdependent activities performed by a pivotal firm and its partners and the mechanisms, which connect to each other these activities, business model is viewed as a boundary-spanning unit of analysis. Successful IoT enactments like is logistics are not only around technological solutions, they also involve intelligently synchronized innovation of services, products, and business models. In a context where research focus shift to include how a firm links with its exterior environment, then business model can as well be viewed as a boundary-spanning unit of analysis(Zott & Amit 2010; Chesbrough 2010).

Traditionally, an ecosystem is founded on technical infrastructure, a platform to which other ecosystem players integrate. After Products, services and systems and user applications are built on this technological groundwork. In this viewpoint, it can be taken that the lower level business models serve as value levers and enablers for the higher layers. In an ecosystem, the members evolve symbiotically through simultaneous competition and collaboration (Moore 1993; Iivari et al. 2015b). In co-evolving IoT business ecosystems (Anjum et al. 2014; Chan 2015) the business model’s role is to connect the firm with its external environment, competitors, customers, and larger society. Vertical and product-focused business models usually at the earlier stages seem more common, and as services begin to emerge at the later stages, horizontal models prevail (Iivari et al. 2015b).
2.4 Analytical Framework

![Analytical Framework Diagram]

Figure 2.8 Trends of Business Model Change Analytical Framework

The figure above is the analytical framework that depicting the key business model elements involved in the change process and their change drivers underpinning the change that the purpose of thesis seeks to identify. In this case Who refers to business actors including customers, What represents the value proposition or value being created, How represents the value chain used for value proposition delivery to customers, and finally Why describes the economic model used for capturing value. (Chan 2015). Whereas on the sides, are the change drivers in their three categories, technology, market and regulation and standardization.

3 Methodology

This section elaborates the rationale for the choice of the research design. Saunders et al., (2008) Some key definitions important for this thesis’ methodology are first discussed. Paradigm is an explanatory framework, that is guided by a set of feelings and beliefs about the world and how it ought to be examined and understood. These beliefs are generally categorized in the three, namely epistemology, ontology, axiology. Epistemology is about the relationship between an inquirer and the known. i.e., it studies the nature and the acquisition and validation processes of knowledge. Ontology, what kind of “being is the human being”, it deals with the questions about reality. Axiology is a branch of philosophy that studies judgements or verdicts on value, including values possessed in the areas of ethics and aesthetics. (Krippendorff 2004; Saunders et al. 2008)

Research paradigms help us to know the world or gain knowledge about it. Figure 3.1 below, usually called the research onion archetype is used as the principle guide of our research.
methodologies. Later, an elaboration of the rationale for the choices of the research approach, research strategy, research choice, time horizon and lastly the data collection and analysis techniques.

![Research Onion (Saunders et al. 2008)](image)

**Figure 3.1 Research Onion (Saunders et al. 2008)**

### 3.1 Research Philosophy

Saunders et al., (2008) described four key research philosophies in business research design. I.e., Positivism (the natural scientist stance), Interpretivism (researcher as social actors), realism (direct and critical) and pragmatism. Other sources also include postmodernism. Positivism usually employs empirical means, with wide use of quantitative analysis, logical development to construct formal explanatory theory. Realism, what you see is what you get i.e. that things have their existence independent of one’s the human mind. Interpretivism, advocates for the necessity of any researcher to understand the differences existing between human beings in their role they play as social actors. This accentuates a big difference between for example conducting research among humans and another with objects like IoT devices.

The nature of the research questions is explorative, it requires a broad understanding of IoT business model changes in the industrial domain. This is aided with study of the most recent theoretical understanding of business models and IoT concepts as well as their most recent practical application in the industrial domain. The goal is to understand how these changes occur, where and why in order to generate practical knowledge for businesses in the future and
how best can a industrial firm maximumly benefit from IoT. This therefore calls for a pragmatic Approach. Sensations and images of the real world (like the over hyping of how IoT can change everything) can sometimes be deceptive, and they usually do not portray the real world, Interpretivism, an approach where the researchers’ reflexes and interpretations create the concepts presented is also used. Industry experts’ views and other sources are used to generate a a new understanding of how business models are changing and why and thereby responding to the research questions. Here views, thoughts and in some case emotional cues are analysed and interpreted. (Sousa 2010; Saunders et al. 2008).

3.2 Research approach

Saunders et al., (2008) describes three approaches for theories of development. These include inductive, deductive, and a combination of the two called abductive. The inductive approach generally describes development of a new theory from data. Deductive approach on the other hand refers to testing a theory where a hypothesis is generated and is tested out. Deductive reasoning is criticized for the lack of clarity in terms of how to select theory to be tested through formulating hypotheses and inductive reasoning is also criticized for lack of empirical data amount that will certainly enable theory-building(Martinez & Albores 2003; Saunders et al. 2008). Abductive reasoning, a third alternative, is pragmatically used to overcomes these shortfalls via adoption of inductive reasoning from data collection, and deductive reason for the formation of the theoretical framework. In this research since the purpose is to explore current business model change trends in IIOT, much of which subject has less empirical data as well as theoretical literature because it is a rather new subject with less literature exploring the business aspects, an abductive approach is used. This research approach is the most suiting for this research because the inductive approach gives a clear view of what is actually taking place in the industrial IoT and the current drivers of its growth as given by the industry interviewees. Secondly, the deductive approach serves to not only partly develop conceptual framework, but also in a pragmatic manner help identify data sources, categorize and triangulate them.

3.3 Research strategy

Saunders et al., (2008) described eight different research strategy techniques that include: narrative inquiry, Grounded theory, ethnography, case study, action research, archival research, experiment and survey. The research purpose is to understand how currently business models are changing within the IIoT and the underlying drivers of the identified change trends. To answer these questions satisfactorily, the strategy involves an empirical investigation of the Industrial IoT within its real-life context and while using several sources of evidence (Yin 2013). within a case study, this is done simply because It is important to note that the boundaries between the IIoT business model changes and their particular contexts such market (vertical, horizontal, level of analysis, particular company and or a solution) being studied are not clearly evident, for these vary use case to another. Therefore, a case study is most appropriate (Saunders et al. 2008; Yin 2006).
In particular, semi structured interviews are conducted with key industry players. This is complemented with two other segments of data from two perspectives namely current IIoT running solutions and Global IIoT Consultant firms. These two forms of data are concurrently used to increase on the reliability of the findings. The narrative inquiry is used for the interviews since the interviewer engages interviewee narratives and descriptions and is not fixated on specific questions to answer the research question. Consequently, because of using a case study as this research’s strategy, the three earlier data sources namely (semi-structured interviews, current IIoT running solutions and Global IIoT Consultant firms) are triangulated. “Triangulation refers to the use of different data collection techniques within one study in order to ensure that the data are telling you what you think they are telling you.” (Saunders et al. 2008) Two main strategies namely narrative and case studies are used in this research.

3.4 Research choice and Time horizon

The research choice used is Qualitative owing to the nature of the research questions and the earlier research design explained. Since we are exploring current IIOT business model change trends, time horizon is a cross-sectional study, i.e. Analysis of the incident of the phenomena in a particular period of time, in our case i.e. currently or now. Qualitative data denotes all non-numeric data that is not quantified. It may include a short list of answers to open-ended questions, multifaceted data like transcripts of detailed interviews etc (Saunders et al. 2008). The qualitative study in our research helps to explore the scientific foundation of the IoT business model evolution since getting new insights is not about quantitative hypothesis testing but to exploring the actual world from which an understanding can be gained. In our case, qualitative research approach aims at finding various aspects that are involved in determining the overall representation of the current reality. This is because our research goal is to explore new understandings it is tacitly essential to conduct an exploratory study, because several researchers agree that this approach practically always unides novel insights in a topic of research.

3.5 Data collection Techniques and Analysis

This section seeks to explain the chosen data collection types, techniques and how it was analysed. As noted earlier, two sets of data in this case study are considered i.e. primary and secondary data.

3.5.1 Primary Data

Primary data was collected from identified key researchers, business and technology leaders in the IIoT/IoT/M2M field. They were in form of semi-structured interview questions all conducted via Skype. Despite the low turn up, insightful observations and their variations from different respondents (Yin 2014) were noted and shall be discussed in the latter sections. The criteria for selection of interviewees was to target key IoT technology and business leaders working with industrial firms today. These were identified by first, identifying major IoT firms in the market, then searching for who were the key IoT players in those firms. Many were formally contacted, and a few responded positively. This small number of interviewees had to
be optimally used to capture the current global IoT change trend as shall be described in the results. The table below shows the list of interviewees, their institutions and roles they play.

<table>
<thead>
<tr>
<th>Name</th>
<th>Company/Institution</th>
<th>Role</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>James Gross</td>
<td>KTH</td>
<td>vice director for the ACCESS Linnaeus Centre with focus on M2M/IoT</td>
<td>51 Minutes</td>
</tr>
<tr>
<td>Kalle Eneroth</td>
<td>IoT Sweden, Sigfox AB</td>
<td>Chief Learning Officer</td>
<td>37 Minutes</td>
</tr>
<tr>
<td>Thomas McKinney</td>
<td>HMS Industrial Networks</td>
<td>Director Business Development and Partnerships (Industrial automation/ IIoT)</td>
<td>45 Minutes</td>
</tr>
<tr>
<td>Mikael Falkvidd</td>
<td>Diginav AB, IoT Sweden</td>
<td>IoT consultant</td>
<td>35 Minutes</td>
</tr>
<tr>
<td>David Trotter</td>
<td>Telia AB</td>
<td>Head of IoT Sweden</td>
<td>50 Minutes</td>
</tr>
</tbody>
</table>

Table 3.1 List of Interviewees

*Interview Procedure:* Getting in touch with these experts started with a formal e-mail requesting for a discussion about the IoT business model change within the Industrial sector. The questions given to them in the e-mail were the exact research questions at hand. The target interviewees that responded back positively and agreed to discuss the questions chose their own time for the discussion. During the discussion, self-introduction and research at hand was presented then they started to discuss. The intention was to let then discuss unhindered in order to capture as much different perspectives as possible. Key changes were noted as they discussed, and the drivers also noted. In case of any unclarity, the following question were posed as had been prepared.

- Can you please describe how is IoT is evolving/ changing Nowadays? With regards to value creation, delivery and capture.
- What do you think affects the other to change, is it the technology, or the business model?
- What key fundamental issues drive this change i.e. enable and hinder it?
- Do you have any case you could elaborate demonstrate changes inhibitors and enhances?

The interviewees’ perceptions and understanding of business model changes and description of how it takes place (Saunders et al. 2008) was key. After capturing all that was needed, the interviewee was thanked and requested to allow any follow ups if need arose. As observed, these questions were rather direct and almost similar to the research question. The main intention for this was to look at the different viewpoints, their trajectories in discussion and what mattered in each individual perspective. This was very fruitful in the sense that, follow up questions then could be asked in line with along with the purpose of this thesis. Furthermore, they were also requested to suggest some sources they knew were reliable about the subject.
matter, which they did. This therefore eased and informed where to look at for credible secondary data apart from the interviewees’ companies or institutions.

Data Analysis: In this part these key questions were observed while each interviewee was discussing their point of view. I.e., what is changing, how is it linked to the business model and how is the business model changing and why. And the summary of the results is given at the end of the results description.

3.5.2 Secondary Data

Secondary data is the data that had been collected to serve a purpose, then borrowed by a second hand to serve another purpose of research. (Saunders et al. 2008). Due to the low turnup of the interviewees for primary data collection, secondary data had to be added and used to help to answer research questions. This had to be done in the most suitable way to eliminate generalizability, validity and reliability biases. This thesis’ secondary data is divided into two sets, the first set comes from world leading IIoT firms and their solutions currently in the market and the second set comes from leading IoT business consultations firms, i.e. how they view change in IoT industrial sector. The secondary data type collected is qualitative. Note that the selection focus of the two secondary data types is not dependent on the data source, but upon chosen themes. For example, a given data source i.e. website, can contribute to both data themes (solutions and consultant firms). Official websites and several fir publications were also used to get secondary data for this research. The criteria for choosing out of the thousands of them were:

- Inquiry from the technology leaders (interviewees) about the most resourceful centres of data and information they know would be of use to this research.
- Searching from the unrecommended or non-talked about sources that were found very useful and compare in terms of influence (like the world Economic forum, Accenture the number one digital technology consultant in the world, Cisco technologies, the arguably frontrunner for IoT technology since 2008, YouTube etc

However, some other secondary sources that were not mentioned by interviewees that did yield interesting results. Published documents form these big firms and websites were used to capture the IIoT business mode change trends. Some surveys (secondary) were also helpful in understanding some of the forces behind business model changes.

The qualitative nature of this research raises concerns about the generalizability of our findings. These were responded to by selecting key firms and research groups following advices and suggestions from the interviewees. Secondly the world acclaimed IoT business consultant firms have the broadest perspective of the whole industry and therefore their submissions are generally credible. By some good luck, IIoT is fairly a new venture, but with a lot of material out there to select from, most of which is misleading, and does not give the right picture on ground. Therefore, proven and reputable key actor of IoT and IIoT industry were considered. large firms, usually use several business models in the different business divisions (Cepeda et al. 2016).
Triangulation: Interviews Data was triangulated by examining key IIoT company websites, several industrial as well as and IoT Consultancies and press interviews. Both internal and external validity were insured. The latter by referring to the generalizability of results, was done by analysing 5 interview cases (Martinez & Albores 2003). However, this is evidently a quiet little number, to add more substance, to this as explained earlier, these helped point to the most resourceful firms, data, websites etc sources that could facility deeper inquiry, as well finding more data in their (interviewees) company websites. The former, internal validity, described as process of unveiling causal relationships, through building explanations and addressing contending clarifications in the discussion (Creswell 2007). Reliability, which is defined as the degree to which the used method leads to the same results when done by other researchers, was ensured by getting the interviewee’s opinions on the areas and firms that could be more suited and comparing with those that I had earlier selected before interviews. A thorough documentation of the research process was done(Saunders et al. 2008; Creswell 2007).

3.6 Research Quality and Ethics

Generally, research quality is important to emphasize especially with case studies having answering the “how” and “why” research questions (Yin 2006). Reliability, validity and generalizability (Saunders et al. 2008) are the three quality aspects that have well be considered during this thesis research process. Reliability is the extent to which data collection and analysis techniques can yield consistent results (Saunders et al. 2008). Therefore, reliability’s key issue is consistency so as to ensure repeatability. In the primary data, this was ensured by first of all giving the same questions to all interviewees. This was intended to create the same point of departure and therefore be able to clearly note the divergency in opinions. Secondly to ensure the reliability of our findings, mainly high level IoT player in acclaimed firms were targeted for interviewees. This made their perspectives more reliable than many others who were in the operational levels.

Further they were targeted because the purpose of this research is looking at capturing the industrial domain picture as a whole, not an individual firm. For that reason, they include technology professors and high-level business consultants. To ensure reliability of the secondary data findings, these interviewees were also consulted to suggest some credible websites and consultant firms. PWC, Gartner, Deloitte etc they said were great places to find reliable data about all IoT domains. These therefore along with a few others were given much emphasis, considering every publication, concept paper or websites and seminars they conducted. In so doing the question of reliability, consistency and repeatability was well managed.

Validity asks whether the findings from the study are in reality about what they seem to be about. (Saunders et al. 2008). Since there is generally no agreed ultimate way to demonstrate validity, maximizing clarity and appropriateness to increases validity (Ryan & Bernard 2003) was handled well in this study. While notes were being taken while discussing during the interviews, recording was also done to confirm latter that what had been said was what the interviewee mean. Furthermore, follow-ups were done to seek more insight on other unclear
aspects. Furthermore, secondary data from several sources was collected and presented in this thesis into themes that capture different angles of the same problem. These themes are in form of: (i) currently working solutions within the industry. This was intended to capture what has already happened in terms of deployment of IIoT solutions and what solutions are currently being sold what changes they bring. (ii) The second data set was for what do the acclaimed international IoT business consulting firms say about what is changing. Finally, these two secondary data are *triangulated* with the interview findings to increase *internal validity*.

These two secondary data themes along with the semi-structured interview findings offered a multi-dimension data sets intended to explain the same problem but from different angles. Therefore, a lot of omissions were minimised. Furthermore, this increase *internal validity*. The aspect that measure whether the right measure were taken to explore needed concepts for this research is called *construct validity* (Martinez & Albores 2003). This was ensured by examining the literature. Specifically, business model, change and IoT business model concepts. From these, a well thought reference frame was developed to explore business model change in IIoT. Furthermore, as explained earlier the three data sets were used to capture different angles of business model change and therefore come up with conclusive and *generalizable* results after the *triangulation analysis*.

4 Empirical Results and Discussion

In this section three data source categories are discussed. The first set is the semi structured interviews. The second is prominent IIoT firms and some of their solutions that are currently sold (HMS Networks, Cisco Networks) within the market. Lastly, results from key consultant companies like Deloitte, PWC, and Gartner etc., are discussed. These form the basis of the described findings in the next part from which, a thorough analysis using the analytical framework is done to capture key business model change trends and their drivers. The findings from the three data categories are described in following form: (i) Semis structured interview findings, (ii) some sample IIoT solutions, their changes and promises of change (affecting business model) in the market by prominent firms and lastly (iii) the change drivers. These are intended to as has explained in the methodology to capture all dimension of business model change since the primary data was insufficient to deliver generalizable results.

4.1 Primary Data: Semi-structured interview results

This section describes and narrates what was captured from the semi structured interviews as is. The interviewees approach to the research question was generally similar hence the need to keep the tone and choice of words.

Generally, industrial experts agree that, yes big data analytics is important and most advanced within logistics and other industrial applications. There is lots of interesting applications firms growing up right now. There is lately a huge market and several opportunities to use IoT within the industrial sector especially with in the areas of manufacturing and supply chains management. They all advised that Gartner, Deloitte, PWC etc are prime in doing credible
market research in IoT studies. Therefore, this also worked as a secondary source to concretise secondary data.

According to one interviewee, there is such a big market for industrial IoT and other applications from a business perspective because of the following, these are three: The first one is pure collection of status. IoT helps reduce service technicians’ frequency to remote operation sites where sensors deployed collect all targeted status. This real-time collection of status is with respect to the different predetermined parameters such as, health, temperature, humidity, uptime, resources reservoir etc. A typical example was given by all interviewees but with different use examples to highlight IoT value. The point was that the value proposition comes from the fact that you are becoming more efficient in operation and service technicians and other resources and therefore cost reduction. This is a huge business case for the utilities and industries changing how operations are done, resources are allocated and others.

The second proposition was additional services such as within high-level analytics and predictive maintenance, remote monitoring etc., are a huge case for IoT leveraging status updates. They therefore are key in enabling IoT within the industrial sector. The third proposition is “Continuous deployment”. This is a term used to refer to the ability to remotely reach, update and maintain for IIoT devices things and environment. These three business value propositions for IoT to the industrial sector are currently the key variables with which IoT business models are changing in the Industrial sector.

Some other respondents look at it from another perspective. They noted that the key changing business model elements in the industrial IoT business to business scenarios are given as creation of entirely new customer segments, reduction of human to increase in “softwarization” of systems and capabilities, subscription model increase like pay-per-feature or pay-per-use etc. One respondent elaborates that due to such advantages, there is starting to be less need for industrial firms to move companies oversees to China for example, in search for cheap labour and all the advantages this came with etc. Creation of new customer segments, job shortages, workplace flexibility, Shared data analysis within the ecosystem of actors, Increased employee trainings are also beginning to increase.

To try and understand why industrial firms invest in IoT, respondent had the usual reasons for the great value proposition, yet some added something more. IoT Business models are generally becoming more diverse. Some industrial firms invest in IoT with intentions of targeting their CAPEX (Capital Expenses or Expenditures). For example, buying a device for €100 and get connectivity for 5 years and cloud dashboard access (status collection) with no subscription fees. Whereas other go in targeting their OPEX (Operating Expenses or Expenditures). Here a device bought at a rate of €2/month and one gets the device for free, with a minimum subscription period of 12 months. These are all possible alternative of Sigfox’s LPWAN devices and several other firms operate in similar and diverse manner.

Furthermore, it was observed that some other actors go for a broader offering i.e. devices, connectivity, dashboards, consultancy services etc., while some focus on their respective areas like General Electric (GE) switching from broad offering to focused. Yet conversely, Telecommunications providers such as Telia AB are slowly shifting into IoT applications and platform services offerings. This is becoming typical among several giant Telecommunication firms in the developed world. Telecommunication firms here refers to typically voice and data services providers. The pressure on the ever-declining voice market and ever-increasing data
market against the massive investment in technology infrastructure is forcing some to invest in entirely new segments like IoT. The reason for such diversity, three responds almost unanimously agree is probably increased competition, increased market size, players entering from many different sectors.

Despite this high competition, connectivity prices are still relatively kept up by the incumbent mobile operators but with technologies that don’t require to use any of such licenced and therefore payed for frequency bands, like Sigfox’s register a subscription of approximately 10% of traditional connectivity prices. The reason prices have been kept up is that mobile operators see IoT more as a threat than an opportunity. The reason prices are coming down is that connectivity can be delivered much more cheaply than current market prices thanks to technologies like LPWAN (Low Power Wide Area Network), Bluetooth, 6LoWPAN (IPv6 over Low-Power Wireless Personal Area Networks) etc.

The extension of wireless communication standard that was formed around 2005 then extended into modified internet protocols, then later to 6LoWPAN. These were huge step for the Internet of Things world, but not necessarily the success factor. The key IoT enabler for IoT is cloud computing. One respondent says, “The true enabler for IIoT”. This saves huge costs of buying IT infrastructure and then programming platforms and applications with graphical user Interface to run on the infrastructure.

As noted earlier, there are standardised IoT platforms for collecting data and analysis platforms today that run on the cloud centers. Customization of such platforms and application for a given industrial firm is much easier and faster than developing one from scratch. Respondents agree that while IoT in the industrial sector seems to be more demand driven, technology itself is do and in some respects well stipulated standards, also play a role in advancing the adoption.

“There are various levels of maturity around the world in different market segments, all of which when examining their drive, may quite differ but the general technological and market drivers are usually the same”. This is due to geographical policies and regulations in the region. One expert notes.

Bluetooth, LPWAN (Low Power Wide Area Network) and other connectivity technologies also generally enable IoT in some cases however, LPWAN is game changer in M2M/IIoT. This is because, with it, there is no need to move companies oversees in china or other parts of the globe for cheap labour. There is also an observed sense of higher reliability, delivery, transparency, virtual contact, subscription models are also on an increase curve like pay-per-feature or pay-per-use etc.

There is less of contribution by policy and regulations to the IIoT and IoT adoptions, one respondent notes, however, Privacy which other interpreted as security, they all agree is the number one concern for all participants in the IoT ecosystem. Note that these privacy regulations are also not universal for they vary from one place or geographical region to another.

One interviewee notes that there is still more need for IoT companies to focus on customer business needs. This, he says is lacking and therefore, not understanding what IoT can do for your frim to achieve your business goals hinder the adoption rate within the Industrial sector. “It is very easy to get lost in the technology and lose sight of what it can achieve!” , He says. However, all agree that we are standing within a “new technological era” whereby not only industrial machines, but everything can and will eventually be connected to the internet.
Security is a major threat to adoption of IoT in the industrial sector. This dilemma is affecting the adoption of IoT among not only industrial firms but also many other market segments. On a higher level, “It is very easy to tell what all tools can do, rather than decide what you want to achieve and then choose the tools you can use” Says one interviewee.

Challenges limiting IoT scope include, the cost of data communication i.e. sensors and devices and their capacity ranges in wireless data communication. Roaming policies are hindering moving from one region to another, “there is need set up the mother of all roaming agreements” an expert suggests. However, technologies like LPWAN addresses some of these hindrances, not only do they lower both the energy consumptions down with a battery life time of 10 to 5 years in the case of sigfox, but the use of unlicensed bands allows for a cheap global mass IoT deployment within the industrial sector. The alternative without this would be to pay huge subscription to ISP to provide the network, which of course such costs hinder the adoption of industrial It especially in developing nation. This is enabling global tracking of goods from all over the globe especially in logistics with No roaming needed.

In Summary: Value proposition (What) is changing due to realtime status collection and thereby allowing in-time predictive maintenance. This tremendously reduces OPEX. Not all industrial firms adopting IoT are experts in data manipulation or applications and platform building and maintenance. All they want is the value in status etc. This has allowed for new software and data analytics firms to fill the gap. automatization of production and supply chains requires high level analytics skills hence new skill sets which adds to the actors (Who). Increase in actors to create and deliver value has led to reinventing new ways of capturing and appropriating value among players. These new opportunities change how and why and with whom firms act. Hence changing business models. Consequently, while value proposition changes and actors co-creating this value also change, how this value should be capture in such an ecosystem also changes e.g. pay-per-use. It quite evident that interviewees leaned toward market demand is high, but hindered by lack of knowledge on how firms can exploit IoT, security fears, international standardizations though to a less extent, etc. Technology (Cloud, sensors (LPWAN) etc are driving IoT growth.

4.2 Secondary Data

The following subsection describes the two sets of secondary data results collects from various sources according to the techniques and procedures outlines in the methodology and data collection parts. These are divided into currents solutions and their promises, (i.e. already implemented or in the market). The second is data set is from global business consulting Firms and it describes the current and expected changes trends.

4.2.1 Some current Solutions, their changes and promises

Mazak Corporation, a machine tool builder company and MEMEX, Inc. a manufacturing communications platform provider have both united with Cisco systems to achieve a significant leap forward with the “digital integration of the Mazak factory”. Mazak now can access and utilize real-time manufacturing data to improve overall agility and productivity along in response to market and customer changes. In the same project, SmartBox platform has been
developed and launched, to facilitate ease and security while accessing the cloud. The SmartBox project achieved and is achieving the following objectives: First is the creation of a digitally integrated platform for extra improvement in manufacturing efficiency (machine utilization, downtime) using Overall Equipment Effectiveness (OEE) as a standard measurement, Second is establish a scalable and secure factory-wide network of connected machines both legacy and new and other equipment in order to examine OEE, and finally nurture the use of sensor technology to monitor machine characteristics thereby empowering predictive maintenance (Cisco, 2017).

Cisco states two major obstacles faced by Manufacturers when realizing effective security in industrial settings. The first is that traditional security platforms lack visibility to identity industrial things like controllers, IO, drives etc. This makes it a big challenge for security policy definition for all these devices basing on just network attributes like IP and MAC (Cisco 2018). Secondly, there is fear to impact production due Operation Technology (OT) personnel having to be dependent upon a centralized IT team in order to adjust security policies to accommodate the daily operational changes. There is hardly a single product, technology or methodology to fully secure industrial operations Cisco notes. Therefore, in order to protect critical manufacturing assets, a holistic “defense-indepth” security approach that uses multiple layers of defence (physical, procedural and electronic) to address different types of threats is needed (Cisco 2018).

To overcome these challenges, Cisco has developed integration between OT tools used for process network monitoring and IT security platforms. This integration not only provides security systems with visibility to industrial assets, but also puts control back in the hands of OT personnel by giving them the ability to express operational intent and automatically have the system select the appropriate IT defined security policies without requiring network or security skills. Joint efforts of machine tool builder Mazak Corporation, manufacturing communications platform provider MEMEX, Inc., and IT leader Cisco have achieved a significant leap forward with the successful digital integration of the Mazak factory. Mazak now accesses and uses real-time manufacturing data to improve overall productivity and agility along with responsiveness to customer and market changes. This project also resulted in the development of a launch platform, called SmartBox, for an easy and secure entrance into the IIoT.

HMS Networks AB, as their slogan says, “connecting devices”, focusses on providing industrial connectivity to both new and legacy machines and devices in all industrial verticals. One solution for IIoT called eWON cosy offers not only connectivity but also remote diagnostics via their enabling cloud platform, Talk2M. The key promises this solution has given to the 10000 customers using is right now include reduction in maintenance costs and optimization customers machine uptime. HMS specializes “in liberating all of the data in an industrial system.” They say, “Our IIoT solutions can help you unlock new data, have clear visibility, and minimize costs” (HMS 2018b).

PLC’s are largely known as the pillars of industrial automation. Usually, factories have conveyor belts moving, valves, actuators, all controlled by a PLC or other controllers in some form or another. While automation in industries gets smarter, data acquisition is key in the development of real time dashboard, remote connectivity and analytics. Multi-network Connectivity; eWON Cosy offers Serial PLC and Ethernet connectivity and are also developed
and designed to integrate with several PLC manufacturers like, Rockwell Automation, Siemens, Schneider Electric etc. "Our experience has been so positive that we often offer the product to customers requiring field visits." David Langen - AFA System (HMS 2018a).

Train services help commuters, tourists, businesses cargo and many others to travel safely with minimum or no delays whatsoever. To ensure such large-scale service reliability, internal costs ought to be optimized to allow for amortization of such large scale costly business projects. The key Italian service operative, Trenitalia, Gartner reports, is leveraging IoT in a 3-year enactment plan to improve reliability while saving as much cost as possible. An operative with at least 1,500 large train sets for businesses, commuters and cargo running at least 7,000 routes every day is no different from a large centralized smart factory of moving conveyor belts. Trenitalia has moved from reactive and corrective maintenance and activities planning to a real-time visibility system reflecting the real conditions of every train and its components (Hung 2017).

Partnering with SAP, Trenitalia has built a “robust set of IoT use cases”, their financial models and related business benefits in relation to train maintenance optimization, “and the team obtained buy-in from key internal stakeholders”. The efforts end up into a well-defined 3-year implementation plan for the i.e. DMMS (Dynamic Maintenance Management System). Partnerships with AlmavivA, an Italian system integrator to cater for the implementation of IT and SAP to provide the analytics and data platform. DMMS is one monstrous solution that leverages ground-based and onboard sensors and diagnostics and then directs the data to a private cloud on the premises for real time analytics (Lazzarin 2016; Hung 2017). At the core of DMMS transformation from a blend of reactive/corrective maintenance and activities planning based on time and distance, to a system founded on health and life indicators reflecting precisely the actual physical conditions of every train’s component. While Life indicators measure the anticipated components wear by counting pertinent parameters like distance, time cycles, and energy, Health indicators on the other side measure the real component operation status, such as the door closing time or the cooling system temperature (Hung 2017).

For example, Brake pads, had been always swapped in accordance with distance based standard maintenance plans i.e. kilometre(km) intervals (Facini 2017). The addition of life indicators to measure the “energy dissipation capability of friction braking in real time”, Trenitalia can now ascertain route-specific factors like hills, bends or curves and local routes with several stops, along with km, “have a direct bearing on brake pad life”. Combined with the new health measures, lie temperature, brake pressure and whether the brake is on a coach or a locomotive, Trenitalia has successfully been able to not only optimize utilization of brake pad, but also diminish maintenance activities with no impact on safety and reliability (Hung 2017).

Summary: From the above IIoT cases described, we observe almost similar elements that construct the value that IoT offers after deployment to the industrial customers. This value is majorly in terms of cost reduction and efficiency increase. In simple terms, one would say “cost cutting and efficiency” are paramount when it comes to IoT in the industrial sector. In all cases described and many others, it unhides hidden daily operational costs that could otherwise never have been determined thanks to real time data collection, analytics and visibility. A global view of the entire production unit or train fleet can be depicted at any moment in real time as a screen shot including every important component on every train.
Here we observe, possibility of a real-time bird’s eye view over the whole customer firm operations, therefore this facilitates easier alignment and tracking of daily activities to achieve firms’ strategic goals cost efficiently and more effectively. There is increased need for partnerships in order to bring together different expertise to finally achieve IIoT set goals for a firm. The reduction in daily maintenance reduces the daily activities which are intertwined within the blocks of a firm’s business model.

In collaborations (Actors/ Who), enhanced value (what e.g. OEE) is created to improve overall agility and productivity along in response to market changes. Security is a huge threat. Operation team working with IT team is cumbersome. Enablers (Cloud platforms and application, sensors etc). Old legacy technologies being well integrated within the IoT ecosystem implies that their business models are fading, and new ones are being adopted. This therefore increase quality in value proposition, but partnerships are key to enact an end to end IoT industrial solution.

4.2.2 Business consulting Firms: Current and expected changes trends

According to Deloitte, as in any other IoT system, data is sensed by sensors and actuators, gathered and transmitted to a central source, usually the cloud base for analytics and remote access by operators and vendors (Deloitte 2017). As is being discussed by several other researchers and consultants, there is a shift from cost reduction and efficiency assurance in IIoT to growing need to explore new programmes and grow business using the IIoT technological advantage. The changes brought about here include that unlike before, in many legacy industrial systems where data is manually collected at specific times, such as this is eliminated by the described process of sensing, gathering, transmitting and making sense of the transmitted data, a process that is fully automated end to end (WEF 2015). This serves both the vendors of the technologies and their customers to access the data and results into improved customer relations in many cases, as noted by some respondents.

Deloitte provided three elements of ascertaining value in IoT manufacturing which include: financial indicator, operation indicators and business performance improvement. The change in financial indicators reveals three key company business process namely; customer, product and equipment life cycles where the latter has for some time been the focus in order to optimize industrial operation, reduce costs and increase efficiency. This data however, deloitte states that it can also show insights in customer and product life cycles as well as revenues and profits therein. Business performance improvement relate to sustainable value added continuous improvements (John van Wyk, Peter Brooke 2018).

Deloitte says that IoT creates an overall new value different from that of products and services as we know it. This capability to turn almost any action or thing into relevant information. “The information value loop” concept of the new value source derived from IoT to tackle the core questions of any company, i.e. how to create and capture value. This is different from the traditional linear “value chain” concept that merely transforms an input into an output. IoT enables to capture information during and after creation of these services and products; which information is valuable in a fundamentally different way explained in the information value loop concept- a closed loop (Deloitte 2017).
One Deloitte magazine says that the main efficiency improvement areas include, in the order of priority: “supply chains optimization”, “capital operations efficiency improvements”, “business agility and compliance”.

An Accenture says that IIoT is the most transformative industrial revolution for manufacturers and is changing how they ought to think about production processes, resource allocation, workforce and materials handling (Accenture 2018). The better visibility, efficient data utilization, and underlying systems integration IIoT delivers is helping manufacturers to “boost production efficiency” and “increase both workforce flexibility and product quality”. currently, they say, IIoT is easing the creation of completely new functionalities, not only services and processes, but also products and exposing novel streams of revenue, transforming business models and allowing for measurably of ever thing to customers outcomes. This all is continuing to allow for a controllable demand driven production, that can be changed at a press of the button hence saving huge costs by avoiding over production (Accenture 2015).

In 2015 Indeed, Accenture predicted that “We believe the IIoT will enable industries that collectively account for almost two thirds of global output to benefit from digital transformation.” In the depiction of their view of the IIoT journey in both the long and short term, Accenture categorised the evolution in four phases namely:

1. Operational Efficiency (equipment utilization, operational cost reduction, employee productivity) - near-term
2. New Services & Product (New business models, “softwarerized” services, Data Monetization)
3. Outcome-based Economy (Platform-enabled market place, Pay-per-outcome, New connected ecosystem)
4. Autonomous Pull Economy (Continuous demand sensing, end-2-end automation, waste reduction and Resource optimization)

Returns on investment(ROI) in predictive asset maintenance capabilities are immediate and easily measurable which make it justifiable for adoption.

PWC, has recently published that IIoT has all the potential to intensely boost production and cut costs across manufacturing, logistics, energy and transportation. These opportunities were clearly emerging by early 2018 for both private and corporate equity investors. The multinational professional services provider caution though, that in order seize IIoT opportunities, there is need for comprehensive decisions about the capabilities to be acquired, business models to be pursued, when strategic alliancing and partnership is a correct path. This will distinguish between leaders and laggards (PWC 2018a).

PWC observed the ever-increasing investment prioritization in IIoT solutions and capabilities for leading technology and industrial players. Capabilities are enhanced through collection of new operational data streams by using embedded sensor technologies. Then employing machine learning and advanced analytics to get optimum value from that data. PWC also offers their version of how companies are progressing along their IIoT journey. Data generated is, by use of artificial intelligence used to alert impending event and generate predictive models that allow for in-time prescription of what can be done in accordance with organizational objectives. Hereafter, the operational model is revised and optimized accordingly (PWC 2018b).
Mergers and acquisitions (M&A) are increasingly becoming essential strategies to technology and industrial firm (Gupta 2012). The goal is to tap into the several opportunities that IIoT is creating. Small technology firms and most especially software start-ups are developing numerous leading analytical platforms and applications solutions, thereby playing as attractive targets for acquisition. The IIoT advent is also creating opportunities to innovate service-based business models (Rimmer 2017; Harmandeep Ahuja 2018).

PWC reiterates the instant cost cutting efficiencies as a result of manufacturers ramping up operational IIoT initiatives i.e. supply chains, connected field services and smart factories etc. And, as IIoT-related components costs (i.e. data collection, communications, storage, and analysis) continue declining (as functionalities rise and improve) IIoT fence sitters are also getting attracted and adopting. 5G mobile network deployments alone are estimated to enable $3.4 trillion in economic output by 2035 in the global manufacturing sector. The tremendous changes in technology occurring are helping manufacturers hunt for other better ways to monetize IIoT “through revenue-generating products and services— or to differentiate their core product and services offerings in an increasingly converging or commoditizing marketplace” (PWC/MAPI 2017).

Whereas in a Survey that was recently sponsored by General Electric- GE, according to the atlas, 402 Industrial CEOs in Asia Pacific Economic Cooperation (APEC) were asked to cite IIoT benefits and the following was gathered. Participants include from (Australia, Canada, Chile, China, Indonesia, Japan, Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, Philippines, Russia, Singapore, Chinese Taipei, Thailand, United States, and Vietnam).

Figure 4.1 IIoT benefits (PWC/ATLAS 2018)
Gartner research on the other hand in 2017 gave the following trends as most eminent, these include:

- operational improvements, such as predictive maintenance, to digital business transformation, such as selling product usage as a service.
- alliances continue forming around the autonomous vehicle leading car companies.
- IoT use cases focused on delivering cost savings from fuel, energy and labour often have significant financial impact and shorter payback time frames. (use cases in asset-intensive businesses or “heavy” industries.)

Summary: Emphasizes IIoT automated value creation and delivery by sensing, gathering, transmitting data to the cloud for real time status updates analytics etc. Data collected is usually accessed by the actors however its ownership is still in doubt. Initial IoT adoption usually focuses on cost reduction and efficiency, latter exploration new programmes and business models follows. Collected data shows insights in not only equipment lifecycle, but also product and customer life cycles. Thereby a better understanding of the customer as well as several better ways to enhance their needs. This improves customer relations through value enhancing customization for each customer. Shift from linear value chain to turning any action into valuable information efficiency improvement usually starts with supply chains optimization, then capital operations improvements (How), New Services & Product (what) and lastly business agility and compliance. Virtually every action is measurable, therefore every action can be improved. and Small new IoT software start-ups are developing numerous leading analytical platforms and applications s thereby playing as attractive targets for Mergers and acquisition. Competitive pressure and attractive returns are the main reasons for investing in IIoT.

### 4.3 Drivers of Business model Change

IoT start-ups are drawing attention. In early 2018, venture capitalists had invested up to $2.5 billion in the US firms developing IoT services and products, which is double 2013’s investments according to PwC/CBI Insight MoneyTree report data. Manufacturers find it inevitable to work on several fronts and join forces with a cluster of (usually new) players to commercialize IoT through revenue generating value offerings and also to improve collaboration and internal productivity. The figure below depicts PWC’s survey of factors forcing firms to invest in IIoT (PWC 2018b). 57 CEOs were requested to prioritize these factors in terms of what drove them to make decision to invest in IIoT.
Another survey conducted by PWC where 57 respondent CEO’s. They were asked to indicate which of the following factors influenced their firm’s decision to invest in IIoT. Furthermore, they had to select all that applied, of which among the subsequent factors they thought accelerates their firms IIoT products and services development see figure 4.3 below.

**Figure 4.2 Drivers of investment in IIoT (PWC 2018b).**

**Figure 4.3 Factors that accelerate IIoT solutions development (PWC 2018b).**
It is worth noting that some change drivers have already been discussed within. PWC maintains that IoT technology is progressing, simultaneously and rapidly, in disparate fields such as healthcare and industrial manufacturing, because of the following concurrent factors: Cheaper access to technology, globalisation of technology, increased comfort with technology, the competitive advantage of technology, multiplier effect of technology. Key drivers for IoT industrial solutions include: the need for supply chains optimization and efficiency, the desire to enhance customer experience and increase revenue and better product safety and risk management. All of which drive the technology demand.

Main barriers include the lack of interoperability standards that hinder compatibility of several machines and devices of different standards to communicate. This still but to a lesser is a barrier to the adoption of IoT in industrial manufacturing because of the high costs involved with it.

The lack of technical personnels to operate the technology is also a barrier to the rate IIoT adoption for it slows the process of implementation and increase the cost for consultancy. This however can be, but in these early stages of IoT technological development characterized by few expert professional in the growing field. Ownership and security of data is still a discussed about issue not only in China but also Europe and America since such valuable data can be accessed by industrial customer and solution provider. 46% of the surveyed firms noted data ownership as a barrier to IIoT adoption within China.

Although Trenitalia is more than halfway through its three-year implementation plan, many other businesses and IT leaders are still wondering if the IoT can ever overcome the hype and fulfill its promises of organizational and societal disruption. Key findings of the PwC/MAPI IoT survey about how and why manufacturers are getting involved in IoT initiatives. PWC noted that the key reasons why manufacturers offer IoT-driven services and products include: competitive pressures; prospects for new return on investment and revenue; and customer demand. Furthermore, they also note that while standardization is necessary, it in the meantime is affecting the choice of partners.

Technological enablers according to Gartner include: architectural components — things, gateways, mobile devices, the cloud and the enterprise. While they agree that security budget is a big barrier. The rate of current IIoT adoption especially in Europe, Gartner say will slow a due to the imminent enforcement of the GDPR beginning 25th May 2016 and other relatively new international standards like ISO 22316, IIoT firms are reincorporating these issues within their portfolio, and to some they note, it is taking time.

Accenture recommends key factors of consideration in order to accelerate the rate at which manufacturers progress towards smart production, these include: Level of investment, Ability to align OT and IT, Affinity for technology change, Speed to reskill workforce, Agility in deploying industrial security solutions.

From these discussions we observe that:

1. increased data exposure increases information security challenges which imply increased budget for security
2. Identify the right IoT staff with the skills needed to implement the technology
3. Coordination between IT and OT, where one ends and starts, boundary spanning increase
4. Fear for being early adopters
5. Difficulty in identifying use case and IoT implementation road map (strategic) etc.

Standardization/ Regulation. According to Deloitte, IoT and IIoT firms face several regulatory challenges ranging from privacy and security to taxation and while Gartner’s recent publication agrees with this, it adds on data sovereignty. “The power of the regulators is undeniable—their impact can literally be catalytic or catastrophic for businesses.” Deloitte 2018. The key issues found in this area include the GDPR and ISO 22316 etc.

The GDPR, acronym for general data protection regulation presents new requirements and challenges for both the legal and compliance functional entities. Numerous organisations shall require a new role of “Data Protection Officer” (DPO). The DPO’s main role will be to ensure safeguard compliance. An estimated 28,000 new DPOs will be needed in Europe alone. According to this European regulation, organizations and firms that fail to comply with GDPR will face the heaviest fines. Therefore, there is a currently emergent emphasis on organisational liability that requires proactive, robust privacy and security governance. organisations therefore are reviewing privacy policies (Boardman et al. 2017).

(ISO) 22316 caters for Security & Organizational Resilience. It serves to protect Protect Customers i.e. their invoices and other payments, shipping, logistic and delivery information, sales transaction processing, digitized media related to customer communications and transactions etc. This relatively new standard also, is intended to serve as describe for the benefit of the customer (James Crask 2016). Therefore, collaboration among various organizations is important and needed.

Currently, the industrial sector is vigorously thinking about ISO 22316, the new International Organisational Resilience Standard. This standard is intended to improve organisational resilience i.e. improve ability to anticipate and mitigate risk, increase integration and coordination of management to improve performance and coherence and lastly a deeper understanding of involved parties and dependencies to support strategic objectives.” Resilience is critical for IoT systems.” From Gartner (Heidt 2017).

Horizontal standardization – International standards are usually the preferred approach for cross domain activities. geopolitical boundaries, functionalities and requirements elaborated at the international level. These standards include: Horizontal standards from ISO, ITU, IEC, IEEE; IETF Internet standard; oneM2M Horizontal common service standards; Modelling Object Management Group standards; W3C Web Standards. Vertical standards for firms and organization are domain-specific or geopolitical usually draw on higher-level horizontal standards (IEC 2016).

Currently, the General Data Protection Regulation (GDPR) that is designed to unify and strengthen and data protection for everyone in the EU, will be enforced starting May 25, 2018. It enforces a “privacy by design requirement” to ensure that data privacy and protection is no longer an afterthought. Since IoT devices gather huge data amounts, GDPR is a key focus for businesses now. Therefore, Steps ought to be taken by businesses to ensure that suppliers, are not only GDPR compliant, but also warrant that the data collected from IoT devices, and the ways in which it is stored and protected is in accordance with the GDPR. This of course is a hiccup in the almost all IoT segments including IIoT (Jose Francisco Pereiro Seco 2017).
“With regards to moving physical things in IoT, there is limitation to its scope in terms of roaming policies” one respondent reveals. He argues there is need for the “mother of all roaming agreements to freely move things around the world”.

This lack hinders the rate of global proliferation of IoT due to different standardization of IoT devices, furthermore, the internetworking data transmission RF capacities need to be increasing to accommodate such voluminous transmission this creates the need for a new support network, 5G still under development and field testing phases. He notes however despite these, there is rise of different technologies to address this issue like Low Power Wide Area Network (LPWAN) as discussed earlier.

The following Data comes from a survey conduct with 156 professionals in manufacturing working in a range of industries survey mentioned about earlier, also yielded the following as the main challenges that manufacturers face while leveraging IoT.

![Figure 4.4 Challenges for IIoT adoption (PWC/ATLAS 2018)]
5 Analysis and Discussion

The three sets of data results described earlier include: (i) some key market solutions perspective, (ii) what consultant firms say about the current and expected change trends and (iii) semi-structured interviews. There are clearly reiterated, and consistent benefits attributed to IoT technologies within the industrial sector and how they benefit business operations. From these, the implicative changes can be deduced, some already mentioned, while others are obvious in IIoT adoption. The focus is on both the vendors and the customers as well. The overall purpose is to identify these business model changes. Every element in the analysis is expressed in relative clarity to bring out the picture of the existing business model change trends and their drivers according to the analytical framework. Figure 5.1 above depicts the triangulation analysis for the three data sets. In triangulation, finding from the three data sources are compared and contrasted to crosscheck these changes in three different dimensions as well as capture others that one data set cannot reveal. This serves to increase credibility in the final results and contributions of this thesis.

5.1 Business model change trends

In this subsection, IIoT business model changes are analysed and discussed. The themes formed in this section describe, what is found to be changing about IIoT businesses. how that is causing business models to change and finally what elements of the business model is changing. These themes include value proposition, collaborations, new skill sets etc., whereas the business model elements according the analytical framework include who, why, how and what. For this purpose, the business model in terms of who, how, what and why is discussed. The figure below depicts the summary of the business model change trends across the who, what why and how elements with respect to the analytical frame work. The subsequent themes explain how the change is affecting each of four elements of a business model change framework. Therefore, themes such as value proposition, telco to ICT etc., have been used to explain the
changes within who, what why and how. The intention here is to describe what is changing, how it is changing and or how this cause the current changes in the IIoT business models, see figure 5.2.

![Figure 5.2 Business model change Trends](image)

**What: Value Proposition**

From the semi structured interview findings, operational cost reduction and increased efficiency is the IoT value position for most industrial firms. On this, a firm could add a lot more, but this is the major target. This agrees with data set two from current implemented and working solutions. Cost cutting, and efficiency increase can even be seen in the naming of these solutions i.e., DMMS (Dynamic Maintenance Management System) and Trenitalia and Overall Equipment Effectiveness (OEE) Mazak Corporation (refer to findings for details). Consultant firms like deloitte and Gartner subscribe to the same though they usually go deeper to elaborate these benefits. Therefore, it can be concluded that IoT value proposition (i.e., newness, customization, cost and risk reduction etc.,) (Dijkman et al. 2015) is different which makes it new to many industrial firms. The shift to this new form of value offering is the observed change, bearing in mind that value proposition is at the core of any business model (Kiel et al. 2016). Since the description of “what” in the analytical framework entails value proposition, it can conclusively be said that there is a business model change in that element (what). Furthermore, the information value loop concept in data set three is a huge shift from the traditional value chain model.

How it is changing. The entire automated process from sensing, gathering, transmitting, storing and making sense out of the data is not necessarily the direct value offering for customers. What all this is intended to serve, which is mainly cost reduction and efficiency and many others customizable features are of value to industrial firms. Such a process however, is a disruption of the traditionally manned industrial production processes and service delivery. The
business model change of note in the industrial cases from the findings is the “new value” that the continually stored data offers to both industrial IoT vendors and their customers. This value in data is depicted in aspects like real-time visibility, equipment performance etc and therefore a stepping stone for predictive maintenance of the entire production plants and processes and the possibility of servicing of the industrial production systems and supply chains.

Of course, such changes in value creation impact how the business model is operationalised to capture value for both actors i.e., vendors and industrial customers. Considering a case for Trenitalia in our results, installation of sensors on every maintainable part of the train allows for predictability of future failures. This helps use technician more sparingly on only when there is need. In other solution deployments, maintenance can be remotely done. Therefore, this changes in operational strategy are reflected in the business model change, since business model by definition reflects the logic how a firm operationalizes to capture value. (Glova et al. 2014) The alignment of operational servicing activities intended to operationalize a given business model between the vendor and the industrial customer(i.e., value chain) such as that the case of Trenitalia and all the others is thereby changed. A notable difference between the three data sets however is the hyping of what IoT can do for the industrial sector and what it is doing or has done so far. The changes in the tone of expression especially among consultant firms and the other data findings shows a visible gap. This gap is that while consulting firms do a lot of market research which put them in a better position to predict the future, some of which has not yet been actualised. This clearly may suggest an over signalling effect, not necessarily exaggerated but iron out the discrepancy between what interviewed experts on the ground say and what such business consultant firms say. In other words, one may say the two sets of data suggest the same trajectory of events (MCCARTHY n.d.). Primary as well as secondary sources agree that there is an increased individualization and mass customization of IIoT value offering. This is increasingly quickening time to market for services and products. Increased automation and data gathering using sensors and other connected devices, cloud interfaces and “softwarerized” systems offer quality, flexibility, and continuous innovativeness.

This further agree with Gartner’s 2017 observations that expounds rather on the success behind the subsegments. “IoT use cases focused on delivering cost savings from fuel, energy and labour often have significant financial impact and shorter payback time frames. Also, in this category are use cases within asset-intensive businesses or “heavy” industries. Here, industrial mechanical devices with high cost and complexity, critical asset value and remote geographic location realize IoT benefits such as remote asset monitoring and predictive maintenance that maximize asset utilization and minimize critical failure unplanned downtime. (Hung 2017) In summary, the change in value proposition affects all the rest of the business model elements (who, how and why).

Who: Collaborations, partnerships and networks

Though the word collaboration from the interview results was latent, the signs of collaborative activities were permeated in the interviewees descriptions. Collaboration as described in literature review denotes partnerships or actors who work together to create deliver and capture a given value (Yu et al. 2016). The inevitability of collaboration is best demonstrated in the second data set description, current solutions. Mazak corporation, a machine tool builder company teaming up with MEMEX, Inc. a manufacturing communications platform provider
and Cisco systems to deliver the “Overall Equipment Effectiveness” (OEE) solution. Or Trenitalia, SAP and AlmavivA to deliver the DMMS (Dynamic Maintenance Management System). Due to the complex nature of industrial challenges, IIoT solutions require a set different specialised firms to partner and specify a unique solution for a given customer (Hung 2017). These sometime may include a consultant like Gartner on board.

It is clear that, in the discussed results, both data from consultant firms and current solutions perspectives, there is hardly an industrial vendor or customer firm that creates delivers and captures IoT value on its own within the sector. This agrees with what the literature says especially in an ecosystem of actors (Kiel et al. 2016; Uchihira et al. 2017). There is observed an increase in value co-creation and co-capture. The prefix co- denotes partnerships and collaboration and therefore actors (who) is a key changing element. The convergence of key partners and key resources into the same pool is to offer values spans the boundaries of tradition business models.

Value co-creation is at the centre of the changing business model elements (Wirtz 2013). However, despite the existence of adequate technological capability and its customizable nuances, a challenge lies in identifies a new industrial use cases apart from those that are common and mentioned earlier. This increased collaboration in value cocreation has led to an increase in value co-creation and co-capture. The prefix co- denotes partnerships and collaboration and therefore actors (who) is a key changing element. The convergence of key partners and key resources into the same pool is to offer values spans the boundaries of tradition business models.

Increased value networks cause a shift from transactional to relational dealings the cut across key partners and relationships with customers. Which are also key block in the business connected belonging to the “who” yet their changes may the “what” “how” and perhaps “why” elements. The increased change from products to premium products and services, and ultimately to a platform is common in industrial companies, like Siemens and Schneider Electric (PWC/eu). Typical platform offering firms have embarked on offering products as well.

**Why: Cost- Revenue Models**

The ultimate role of a business model is to generate a logic for optimal profitability with available resources in a given environments (Seddon et al. 2003). These firms are generating new revenues streams by establishing in touch BM types, e.g. “multi-sided”, physical freemium, pay-per-feature or pay-per-use, digital add-on, digital lock-in etc business models (Zott & Amit 2010; Peyton et al. 2014). Accenture (from third data set) argues that industrial internet of things (IIoT) is the prime driver of growth and productivity in the next decade. This latest digital wave will not only accelerate but also reinvent big sectors which account for nearly two-thirds of world productivity. It is estimated to add to the global economy USD14.2 trillion by 2030, much of which gain will particularly be for mature economies’ gross domestic product (GDP).

Cost structure, much of cost structure within the IIOT technologies and IoT as well lies within the customization and right problem-right solution identification. Interview respondent, three and one clear agree to the fact that technology can do everything, but much of what it can do
in terms of costs depends on understanding the problem to be solved. Thereby designing a collaborative scalable and flexible solution in the most cost-efficient way with respective to key determining factors about the geographical location, effective demand (to purchase the best option).

How: Value chain

New Skill sets: The need for new skill sets and the fading of some skills is another noted change in IIoT business. The different architectural layers described in the IoT business model framework require relatively different skillsets (Vermesan et al. 2016), most of which are specialties for IIoT adopters. Even when there is increased collaboration in the back-end of these solutions, at the user end there is increasing need for specialists are well acquainted with cloud solutions, analytics. From our literature, this majorly belong to the actors. Skillsets are not over emphasized in the interviews, but they are more expressed within the two data sets. The simplest unit of an industrial actor in an individual. Trenitalia in this case hired a specialised systems integrator firm AlmavivA to install and maintain the solution developed with SAP (Lazzarin 2016; Hung 2017) in the second data set. The importance of skill sets reappears as “skill gap” in change drivers. The graph following from a survey conduct with 156 professionals in manufacturing faced while leveraging IoT (PWC/ATLAS 2018). Furthore the GDPR as described in the findings also will require at least one data protection officer within an IoT firm.

Technologies like artificial intelligence, machine learning, blockchain etc., that can actualise IoT digitalization within the industrial sector are creating a new need for skill to enact that(Kiel et al. 2016). As has been proclaimed by Gartner research, Deloitte and several others such skills are most needed with the development and deployment of IoT industrial solutions. To the contrary however it is worth noting that while some new skill set needs are emerging, some other existing skillsets are losing market. New firms segment especially in software development, machine learning and AI are currently creeping up to fill the gap.

In such a scenario, not only are activity sets of the firm being added and removed, they through the digitization of business processes being again sequenced governed and hybridized or even outsourced for optimum function, (refer to business model change typologies). In this way there, business model is implicative changing since the processes that enact the older ones have been revamped and or replaced. In addition, therefore the daily transmission and storage of new huge data needs direction, i.e. big data, requires target-oriented data analysis, which then again necessitates specific experts capable of data mining and processing activities (Kiel et al. 2016).

Another respondent says, “yes data is key in all IoT deployments, the question is how you want it to serve you?”. Therefore, Customers knowledge of how they want It data pool to serve them in is important. This, then calls for thorough reassessment of identified use case. While it is explicitly clear from both the literature and data collected that that the cost-benefit margins clearly attract support for IIoT adoption, there is more awakening needed on the adopter’s side to identify how, the technology will value their specific business setting and segment, which my need to examine and negotiate a specific business model transaction between to industrial actors. This is already happening as described in the finding but will only increase.
**OT IT Convergence:** Connectivity is not necessarily discussed as trending within the IIoT. This is because as discussed in the literature and introduction, connectivity has for quite some time been around in technologies such as M2M, Bluetooth, wired and wireless connectivity etc (Borgia 2014). To some extent digitized, these technologies have digitized production and supply chains processes. The goal as described earlier in value proposition has been to improve operations, reduce costs and increase products and service quality. It can be observed that IoT not only offers new, effective and cheaper technologies to allow for mass connectivity even intercontinental connectivity such as LPWAN. The level of digitization through data that it adds to industrial connectivity and its operations technologies is above the aptitude and skill sets of operational technicians as described previously in the second and third data sets.

This as one interviewee called it the need for “hardcore Information Technology (IT)”’. It involves the new skillsets especially in data manipulation as earlier discussed. The accent of change this brings is the increased convergence of IT and OT within the industrial sector (Kiel et al. 2016). The convergence of the two comes with the “intelligence” to auto-communicate both to the customer and vendor with updates and visibility of the entire IoT ecosystem. In order to operationalize the strategy of an IIoT adopting firm, as OT an IT converge, the traditionally connecting departments are increasing merging into one. This is partly explained into the earlier skill set dilemma. This is an equivalent of adding, realigning and perhaps outsourcing etc all of which are typologies of business model change as discussed in the literature(Cavalcante et al. 2011; Juntunen 2017). From an activity system perspective of value creation in a business model (Zott & Amit 2010), This converges depicts a business model change. This is so because business model has for long been linked to strategy and referred to as a way to operationalise a business strategy by some scholars. Furthermore, this is depicted also in the key activities of the typical business model canvas (Dijkman et al. 2015). Eventually the way “How” a business model is operationalised is changing due to the convergence of the information technologies and operations technologies departments. This farther since it deals with the actors within a firm, the “who” does what is changing. The part of the intent is cost reduction and increase efficiency which value as describe in the framework is inherent of the why (cost model).

**Platforms & Applications:** While much talk in the past has been about product and technology and perhaps services (Laya 2017). The three result sets all expound on platforms and applications as key enablers of IoT. These serve as remote “channels” where vendors and customers interact with the collected data via specified applications. This implies an elevation to another integration level intended to derive more value. There are several platforms including for IoT, analytics, ERP (enterprise resource planning) etc. This shift is exemplified in “SmartBox”, “Talk2M”, “DMMS” and many other industrial IoT solution being developed and adopted. The majority of these IoT industrial platforms are therefore cloud based hence adhering to the common cloud business models, of which some were described in the literature review. Cloud technologies come with a lot of advantages in terms of very low cost of investments and high availability. Since almost all IoT solutions are cloud enabled, cloud business models of pay per use or per function etc., are also being adopted to deliver IoT solutions. This change mainly affects the “why” or cost revenue mechanisms. Furthermore, the operationalization of daily business activities (how) is changing. While some industrial firms opt for generic cloud-based platforms that can only be customized to enact their IoT plans, other are involved in development of proprietary platforms (like the DMMS) for their IoT
industrial operationalization. All these alternative choices are some reflection alternative ways of enacting industrial firm’s business models (Cepeda et al. 2016). There is an increase in change of large global firms offering industrial products to now move towards platform offerings like GM, GE while platform-based firms like Google are also increasingly incorporating their offerings into physical products. This change is leading to an increase of industrial firms having several business models. An example from the interview in Sigfox company. One may choose to buy a device at a rate of €2/month and gets the device for free, with a minimum subscription period of 12 months. or buy a device at €100 and get 5 years of connectivity and cloud dashboard access without subscription fees.

*Telecommunications to ICT:* As found and discussed in the semi-structured interview findings, another change is slowly emerging among telecommunications services providers. The shift from a strictly offering voice and data to diversify and include platformed IoT value offerings to B2B and B2C markets. This has been increasing because of the increase in “price pressure on minutes and megabytes” up against massive investment in telecommunications infrastructure. Secondly, there was expectancy by telecommunications providers for big profits from providing connectivity services to the IoT industrial firms, this is unfortunately not turning out that way since newer and cheaper connectivity solutions for IoT are instead being developed to replace the arguably expensive legacy telecommunications connectivity solutions. There telecom firms are join the IoT race and massively investing in platforms and applications to expand their portfolio as well as reduce over dependency on the legacy telecommunications solutions, that will eventually fade out to be replaced by new ones.

The ramifications of this shift to telecommunications IoT business models is huge. Perhaps for the first time we are starting to witness, telecommunication OEMs start to compete with their old good customers, telecommunications services providers for the same customers especially within applications and platforms-based solutions. A good example is Telia AB from the interview results. In effect, typical industrial product manufacturers like General Electric, Samsung, have over the year been shifting to premium products, then services and now, they are incorporating platform-based solutions within their portfolio. On the other hand, the platform-based providers such as Amazon and Google are seeking to do the reverse in some market segments. This phenomenon is increasing industrial service-orientation, empowered by the digital and physical components integration to subsequently offer hybrid solutions especially by the former. Part of this increase competition has been the reason for the reduction in IoT investment cost. This reduction in IoT costs the cost revenue models (why) to change.

*From firm level to ecosystem level:* In IIoT scenarios, “ecosystemic” value co-creation with multidimensional value and service streams across stakeholders (partners, customers, users). An all-inclusive view towards all key stakeholders and their value offerings. design and conception of complex value streams in stakeholder networks. novel ways of exemplifying the added value in the network of stakeholders which help to identify interactions and dependencies, this is lacking. Traditional methods to demonstrate value chains are inept in capturing the IIoT added value due to its assumption of linearity in value chains i.e. from suppliers to the central firm then to customers. explicit consideration of stakeholders’ value propositions in the earliest business model design phases. The change drivers that both enable and hinder changing business models within Industrial sector, are analysed and categorised into three main paradigms, as earlier discussed in the literature review namely, technological, market and regulatory and standardization. Our findings only reveal the apparent enablers.
5.2 Business model change Drivers

In this section, the drivers of business model change in the results are analysed and discussed with reference to the analytical Framework. It is important to note that these findings are not the only ones there are, but the main ones that surfaced during this research especial with the technological aspects. Technologies like blockchain are left untouched even when some data sources like Gartner consulting claim it will be of great use to all IoT applications.

5.2.1 Technological Drivers

The following section describes the business model change drivers in IIoT with respect to the prescribed analytical framework. Much of the technologies mentioned in this part as technological drivers of IoT business model change in the industrial sector have already been discussed in the literature. They simply are the technological pillars for the IoT ecosystem. The research purpose was not to delve deep into IIoT technological aspects, however a couple of these identified were already expounded upon during the literature review. Therefore, this discussion enumerates some of the key technology drivers for IIoT.

Cloud computing: The high cost of private investment in IT infrastructure by industrial firms is eliminated cloud computing business models. Software infrastructure for a cloud service includes applications that enable customer firms to create and manage their own accounts. Therefore, even at the worst-case scenario, sunk cost are eliminated and therefore the walkaway cost in case thing don’t work out is eliminated. The cloud is key in the implementation of IIoT capabilities by enabling extraordinary operational and business flexibility. With the cloud, IIoT businesses can design, provision and configure the exact solution they need, where and when they choose which agrees with the revised literature (Onar & Ustundag 2018b).

However, already partly digitized firms face a decision to make about what and what not to migrate to the cloud (Vermesan et al. 2016). This is not affecting the new comers according to the findings. With IIoT, firms ought to make such decisions with business objectives in mind. The reasons for this include the need for better and secure access across an organization its partners and customers (GSMA Association 2014). Exempli gratia, an Industrial customer may have some convincing reasons as to why they need to keep their HMI/SCADA systems on-premise rather than migrating them to the cloud. But, it may make sense to host predictive maintenance or OEE monitoring capabilities in the cloud (MCGREEVY 2017). With such an enabler, industrial Operators can customize their solution offerings along with several combined business opportunities.

5G, LPWAN, 6LoPAN and other wireless technologies etc.: Depending on the use, some technologies can be appropriate in the transmission of collected data by the sensor through the network connectivity layer. They ensure transmission of data to the cloud platforms at very low cost hence allowing mass deployment of sensors in the industrial sector. These technologies include LPWAN, 6LoPAN etc. (Fotouhi 2015). Massive industrial IoT and M2M communications requires a strong network to successfully support enormous IoT deployment (Borgia 2014). The normal cellular networks from the telecommunications service provider are quite expensive as explained in the results and analysis of business model change trends and can easily get over clogged. To allow for long time remote connectivity that IIoT and M2M
promise, battery longevity is essential to claim that IoT reduces daily operation costs, such as battery replacement. Here Sigfox as explained in the results solve this with devices of 10 to 15 years of battery life. Latency, a delay that occurs in data network communication is also eliminated by using devices enabled by these technologies.

Massive deployment of IIoT services requires low cost devices. IoT connectivity can create low average revenue per user or per unit (ARPU) which dwindles even the revenues the more in comparison with broadband or mobile subscriptions. Therefore, the devices must cost very less, where Sigfox’s LPWAN devices range between two to five USD each. The cost of deployment is also low with these technologies. Extended coverage is need in several IIoT applications such as smart meters embedded in positions that are rarely easily reachable. This therefore requires increased coverage in areas like under the buildings. The IoT connectivity link budget target is 15-20dB which can easily penetrate a huge wall or floor to enabling profounder interior coverage. Finally, it can be concluded that the low cost of these technologies enabled devices plays is playing a big role in the high rates of adoption of IIoT.

Sensor/ actuator technologies and Multi-connectivity: As describe in the literature (refer to IIoT Ecosystem figure 1.5) and with the Trenitalia case, sensors enable IoT by detecting, measuring or indicating specified physical quantity such as motion, light, temperature, humidity, pressure etc and convert them into electrical pulse signals. This is data collection. All possibilities of data analytics and real time remote visualization of the entire production and supply chains units within the industrial sector require the data collection process which is conducted by sensors. Therefore technological, sensors are key enablers of IoT industrial solutions thereby driving IoT business. Multi connectivity is another aspect that is better elaborated in the second data set i.e. eWON Cosy for HMS AB that offers both Serial PLC and Ethernet connectivity to Rockwell Automation, Siemens, Schneider Electric etc., equipment.

5.2.2 Market Drivers

There are mainly three types of forces can influence a technology ecosystem namely social and governmental forces, economic/ market forces, and technological forces (Gupta & Kauffman 2005). Typically, a market is when individuals or firms agree upon the exchange of a given commodity irrespective of the medium of exchange. Market demand or demand pull (Dossi 1984) are the core elements that drive such an exchange. Perceived value the and specific needs lure firms to adopt IoT technologies. Therefore, within the industrial sector there exits several value drivers of which include: faster time to market. Competitive forces, lower total cost of ownership (TCO), improved asset unitization, enterprise risk management etc. These along with many others form the rationale for industrial firms to adopt IoT currently. The third data result explore these in detail than current solutions and semi structured interview results.

From the earlier described third set of results, a survey conducted by PWC in which 57 CEO’s participated figure 4.2, competitive pressure and attractive returns were the main factors that influenced firms to decide to invest in IIoT. This agrees with the cutthroat competition earlier described in the introduction (Porter & Heppelmann 2014). Paradoxically market demand follows after as a factor that influenced firms to invest in IIoT. This implies that the profit margins on IIoT investment are very attractive despite the constant market demand. A firm is
therefore better off delivering solutions to its same number of customers while using IIoT capabilities than not using IIoT capabilities to serve an even greater customer demand numbers.

While competitive pressures and ROI were found to be the main factors influencing CEOs to invest in IIoT, the same were not the main accelerator of IIoT development, see figure 4.3. In fact, technological advancement was prime in accelerating IIoT development in all the three data themes. As deduced from the three data themes including figure 4.1, cost reduction and increase efficiency are the key factors influencing the IIoT adoption. In hindsight, cost reduction and efficiency improvement were found to be the prime value proposition of IoT to industrial player.

“It is very easy to get lost in the technology and lose sight of what it is that you are trying to achieve” says one interviewee. “it is very easy to get stuck into what the tools that you have can do, rather than to decide what you want to do and then decide on the tools that you must use” says one Interviewee. It is the unique value identification most appropriate for a particular business, that brings all stakeholders and customer onboard. This then requires handling industrial customers case by case, because each case has its own strategic goal, technological capability, operational variables to optimize and its organizational culture. What is the customer doing today? what drives customers costs? what can be done to optimize operations? are three questions that respondents agree upon to be important in value creation. Then what are the next new revenue stream that can be generated using new the technology comes later.

“Initially, leaders viewed IoT as a silver bullet, a technology that can solve the myriad IT and business problems that their organizations faced. Very quickly, though, they recognized that without the proper framing of the problems, the IoT was essentially a solution looking for a problem.” (Hung 2017) Gartner Research Vice President. As discussed in the findings, low maturity of the IoT is partly causing insecurity and risk anticipation among customers, a reason enough to avoid being early adopters. This agrees with the literature (GSMA Association 2014; Chesbrough 2002) and several others literature sources.

Competitive pressure, attractive ROI, Market demand, commoditization pressure and others in order are the reasons for IoT investment according to one earlier described survey, PWC where 57 respondent CEO’s. For factors that accelerate this adoption they the same survey put technological advancement to forefront of IoT industrial adoption, whereas customer demographics, which of course is on the market side takes the second position (Murray et al. 2016). In other words, from the two graphs, the key enabler was more technological than market forces, whereas the same survey results acknowledge that market forces (competition, demand, high ROI etc) among fellow competitors in the industry were the prime lure them into investing in the first place in IoT. Keeping in mind that these parameters were given to the interviewee CEO to prioritise the incentives and drivers.

5.2.3 Regulatory and Standardization Drivers

**GDPR:** The newly decreed GDPR European requirements mean that that the way in which technologies including IoT are designed and managed is changing. “Documented privacy risk assessments requisition” will be mandatory for a firm to deploy new IoT systems and technologies (Docquir 2018). Any breaches of Security must be reported to regulators within
72 hours. Therefore, this means that IoT firms dealing in data are now implementing new incident management and response procedures. The concept of privacy by design has now fully become enshrined in law (since the 25th of May 2018), Gartner 2018 reports that “Privacy Impact Assessment expected to become commonplace across organisations over the next few years.” therefore, to be legally compliant, organisations and firms are expected to look more into data masking, encryption and pseudo-anonymisation etc. This enactment has massively slowed down development and implementation of IoT solutions in the EU in order to incorporate in solutions the statutes of the decree.

Despite the many concerns about the negative impact of GDPR especially with regards to customer data, there is much hope for more opportunities in an even better levelled competitive environment for all actors. It also requires IoT firms not to make it hard for their clienteles in transference of their data f to another firm. GDPR implementation will no doubt contribute to the security practices improvement owing to a legal obligation put on firms to “in default” protect data, hence facilitate the growth of trust among industrial IoT actors their customers while simultaneously creating new opportunities for security firms.

ISO 22316: While ISO 22316 and GDPR are intended for the betterment of security and increase trust and accountability among organization and firm, they are in this short run slowing down the pace of IoT development so as to be incorporated and ensure compliance. Therefore, their influence is rather negative with respect to the rate of adoption.

Roaming: Generally, however standardization in Industrial IoT is just developing. There are several organizations that are making standards, authorized and non-authorised such a wide IIoT application. Several solutions currently developed rely on several co-existing protocols, platforms and interfaces, either proprietary or standard. Some of the Industrial IoT standards will be authorized standards, whereas some will act as de facto standards that are only approved by alliances and forums or dictated by firms in decisive roles. All the three sets of data agree that that standardization plays a significant role in Industrial IoT for contributes to compatibility, security, interoperability, reliability, and effective and efficient operations between heterogeneous technical solutions globally.

Interoperability: Technological interoperability is a considerable challenge for the IoT than the mere traditional internet scenario. Solutions like eCOSY solve this as explained with multi-connectivity capability (HMS 2018a). Interoperability can be a challenge because technologies have dissimilar technological capabilities and can connect people and things. This all-in-one interconnection between humans with diverse devices produces a large volume of joint and mixed information. More developments ought to do especially the information model of the devices to interpret the shared data appropriately. However, in order to achieve true interoperability, IoT standards must be created and enforced on a large scale without which interoperability will still be a hindrance (Cepeda et al. 2016).

5.3 Reflections and Implications

From the analysis of how changes are taking place in each element (what, who, why, how) of the analytical, it is clear that much change is occurring in the value proposition i.e., what. While value proposition is key to any business model, the absence of any other elements
delimits the definition and functionality of the business model. The elements as describe are intertwined in and dependent upon each other in one way or another. For this reason, we observe that a change in value proposition has a causal effect of change to all the other elements (who, how and why). The difference that can be observed is that in creation and delivery a number of actors is changing (co-creating) in most cases. This in effect implies that a change in value proposition is mostly reflect in and increase or collaborations of several actors to provide a needed solution. The reverse is also true, that while partners combine to deliver a solution, each partner business model changes in terms of increasing or decreasing number of partners in order to affect a new value.

Therefore, it can be adequately concluded that the change happening in the four elements is actually a dynamic and ever changing interconnected business context not only impact innovations, but also creation and capture of value and eventually competitive advantage. Yet this research’s findings have shown that competitive pressure is the number one factor for which firms invest in IIoT, then seconded by attractive ROI.

The key changing elements are value proposition and actors. From the analysis, it cannot be conclusively said that it is market, technological or standardization and policy forces as the key drivers of business model change. However, standardization and policy do not have as much an impact on the current IIoT business model changes as market and technology forces. Nevertheless, it is acknowledged that during this same period of the research, the GDPR has been enacted which has slowed down the pace of development and adoption of IIoT solution to incorporate the its regulatory requirements. In this effect, and in this current time, when this research has been conducted to explore how IIoT business models are changing and why, it has impacted the rate of IIoT growth in the EU. It is also observed that while technological forces affect and transform value proposition and value chain, they don’t do as much to the other business model element in the framework.

The value chain depicted by how is also changing in terms of departmental convergence ie IT and OT as well as the need for new skill sets especially around data manipulation and security issues. The addition, removing, resequencing reassigning etc., of components of this business model element denotes business model change (Juntunen 2017).

In agreement with Osterwalder & Pigneur (2010), the main two reasons why industrial firms invest in IoT are competitive pressures and attractive returns on investments, both can be categorised among market forces. In summary they seek first survival then profitability. On the other hand, the main factor accelerating IIoT development is technological advancement. Lastly the prime value for which IIoT is being adopted is cost reduction and efficiency. It can clearly be observed that there is a trending shift from traditional business models depicting a linear value chain to one more characterized by creating value in stakeholder networks. There is clear overlap of the traditional business model blocks and in some cases a total absence of others like channels etc.
Business models for cloud services are being adopted and therefore the cost revenue models of most IIoT application and platform vendors have not changed much. Our finding particularly agree with Kiel et al. (2016) that much of the literature mainly puts it emphasis on IIoT-triggered changes in key resources and activities, whereas predominantly the customer outlook is mostly disregarded. However, the findings in this research give a deeper insight on the IIoT customer side. This given in terms of what motivates CEOs to invest in IIoT solutions and what are the prime benefits that can be recouped from the investments. Customer challenges and fears for adoption are also discussed with security being the biggest challenge on both vendor and customer sides. Regarding the key changes in business models, it has become apparent in this research that IIoT permits a cumulative offering of customization of services and products associated thank to service-orientation adopted from cloud business models. This service orientation has its own strategic choice challenges as expounded in the recommendations later. Regarding service orientation, customers are almost entirely integrated in development processes. This has allowed a new set of roles “IoT architect” that are somewhat dissimilar to the IT or cloud architect.

There is need f to visualize IoT value stream in new way. The word business model in our findings especially interviews was used to mean the logic of selling and buying and nothing more, e.g. pay-per-use, yet theoretically this only explain one of the four business model composite elements. The shift from a single focal firm level value creation and delivery thinking to ecosystem level thinking requires a new and simpler way of visualizing how value is created delivered and capture (a nonlinear value chain). This is because the thin boundaries and definitions that have guided past research and distinguish between the business canvas blocks on one hand, and on the other between creation delivery and capture are disappearing.

#IoT businesses in the industrial sector are shifting from an instinctive and probabilistic management perspective to one more deterministic, a reason for the increasing need of big data specialists. This is due the over reliance on what data say in order to make strategic business decisions for firms that eventually determine present and future business model operationalizing. The exemplified cases in findings and analysis may wrongly suggest that one IoT vendor firm has one business model. Most firms however are found to be focusing on several segments and simultaneously operating several business models across its partners and customers. This creates a more complex scenario that can barely be depicted let alone being analysed by the traditional business model concepts at hand.

On the operational, as IoT technologies continue to proliferate the industrial sector, the interconnections among people, products, process, services data, and things is also increasing drastically. Eventually information technology and operations technology are converging together. Evidently a clash of professional cultures ensues, both systematized, but with slightly different objectives and roles. We therefore are currently observing a subtle cultural transformation brought about by the IoT technological change with an industrial firm setting a good example is Trenitalia working closely with SAP and a systems integrator. Therefore, while business models are changing, we observe a contextual operational change affecting either inside and outside of industrial ecosystem.

For example, Operations team may be disturbed when information technology team schedules a production shutdown on weekend with the reason of updating systems and software, all at the expense of production requirements. Therefore, the latter may view the former as resistant
to up-to-date technology. While the information technology team is profoundly concerned about cyber security, operations and production team has customarily depended upon physical systems isolation for security. There is therefore a huge gap for a standardized framework or mechanism, like ITIL (information technology infrastructure library) that facilitated and streamlined process and procedural discrepancies between the different IT, operation and service desk etc., all in the interest of aligning day to day departmental operations to optimally work for but the firm’s strategic goal. Through the process of business model change, the results agree with Juntunen (2017) who argues that the change helps manage threats better and transform opportunities.

The difference with the literature and also the several data sets occurs in terms of prioritization. While some firms adopt IIoT for cost cutting as the number one priority, others go in for exploration of new revenue streams as their number one priority for adoption. New start-ups especially software firms target the high returns as their main lure for engaging in IoT business, whereas, legacy firms prioritise cost reduction and efficiency. Secondly, this research acknowledges that there are some factors that have not been emphasized, like some elements in standardization and regulation (ISO, roaming, etc.). The rationale of emphasis stems from the findings and the generic impressions from the three sets of collected data. For example, with roaming, only one firm mentioned that, and this is because they offer their IIoT solution in the remotest parts of the world, where a telecommunication network connectivity and roaming agreements work in some regions and not others. This however does not take away the need for a global roaming agreement as discussed in interview findings.

Furthermore, IIoT also brings in extensive organizational threats and opportunities. IIoT technologies’ implementation enables the reorganisation of complete value chains (how), i.e., firms collaborations, value offerings, as well as a firm’s relationship to its employees and customers. These changes in value creation causes manufacturers to closely reflect upon their existing strategy, identifying new market opportunities, and therefore innovate and consequently acclimatize their business models in order to stay competitive (Chesbrough 2002). According to Chesbrough (2010), a business model depicts how firm organizes to capture value, from this therefore, a business model defines value creation, delivery and capture. IIoT bring the real-time capabilities, intelligence, horizontal, and vertical connection of people, objects machines, and ICT systems to dynamically manage complex systems in the industrial sector. This results into smart factories where production, infrastructure and facilities are completely digitized, connected, intelligent, and arising problems are independently solved.

6 Conclusion

The conception of this research was triggered by the over hyping of how IoT will or can change business models and allow for creation of entirely new ones. Yet, less research has been done to examine how far these claims are currently factual. Against this background, the need to explore and understand how IoT business models are changing became this researches purpose. While IoT is being adopted in several sectors, the industrial sector was found to be one of the most advanced in IoT application, hence a good sector to focus this exploration. It is clear that, there are two key areas that this research has observed that stand to gain the most. The first being profit optimization related to production value chain and the second is the maximization
of returns on capital and assets i.e. maintenance and performance improvement and reliability assurance. The former is about the entire firm’s value chain (how) while the latter is about the aggregate efficiency of daily operations. i.e. strategic and operational changes are taking place in these two areas respectively, thereby either way causing business model transformation.

The data that was collected to answer these research questions included semi-structure interviews, large consultant firms in IoT markets and finally solution-based analysis of IoT impact in the industrial sector. With the aid of the analytical framework, the findings for the first question include value proposition, collaborations and partnerships, new skill sets, convergence of OT and IT, Platforms etc. These are the key identified areas in which business models are changing on both sides of buyers and sellers. It is worth noting however that, some of there were quite covert and had to be derived as described within the analysis.

Secondly, the technological enablers, as within the literature and empirical findings included cloud as the key enabler of not only IIoT but also IoT generally along with several other technologies like sensors, actuators etc. Standardization and regulation especially from the primary data has not been considered as such a big hindrance or driver of how business is conducted within the industrial internet of things. However secondary data expound more on it and its implications to business operation e.g. GDPR.

It can be observed that business model approach has shifted from services and products to designing the suited business model in the following process, identifying a use case, identifying a problem to solve or to optimise in the specific use case, determining what variable parameters in the use case that drive cost, then designing how value can best be created and captured in that industrial use case, lastly plan the model developing and providing the product or service in the use case. This is 180 degrees shift from the tradition general purpose technologies.

“Initially, leaders viewed the IoT as a silver bullet, a technology that can solve the myriad IT and business problems that their organizations faced. Very quickly, though, they recognized that without the proper framing of the problems, the IoT was essentially a solution looking for a problem.”

Mark Hung, Gartner Research Vice President

6.1 Implications and Reflections

For a very long-time, manufacturers in several industries had put their focus on capturing value, through a product-oriented business model, a manufactured product being sold as an asset to a customer while in some cases providing aftersales services like operational maintenance etc. When products become smart and connected, this can improve product performance and dramatically optimize how the product is operated and serviced. Such an improvement can be captured by the customer in form of reduced service visits in all cases mentioned in the findings and or less need for spare parts. This may however result into a service paradox, where incremental improvements in service efficiency may do incremental damage to the revenue and profitability of a service business.

The question therefore is that should one shift or change their business model to a service-oriented business model that is perhaps outcome based or usage based? The latter business model charges the customers in accordance to their degree of utilization for the product. This in return encourages manufacturers to maximize the utilization and perhaps even across
multiple customers. The former, outcome-based business model can also result into the customer paying for the utility or productivity or the functional result of the product rather than for the actual time spent using the product. For example, it may require new skills, new culture and even new technological infrastructure to process the orders the transactions associated with the service business model.

Furthermore, by definition, services are inherently time bound, which means that at some point they expire, and they therefore renewal. Commonly at this point, customers have very low switching cost simply because they don’t have cost sunk into any asset. In some cases, like with Sigfox’s LPWAN devices, the cost of walking away is indeed small. The recommendation is to think again through the likely impact of the service paradox in a given IoT industrial business. It is important to Ponder how new business entrants might leverage this new business model and how a firm also could leverage it to create distinct differentiation in the market, since as from findings, survival is prime then profitability. The gist in any service-oriented (especially cloud based IoT) business model is to ensure that the customer recurrently and progressively receives good value from the services offered. Either way, there are costs and risks ought to be thought about.

Another implication of the findings is that due to the ever increasing IoT technological prowess that is slowly proliferating the industrial sector and promises to do even much more, it is increasing becoming clearer that concepts like “fail fast and learn” will only stay to exploit human psychologies for consumers market till they get it right. But within the industrial sector, the vast amounts of real-time data availed by IoT capabilities offers a new concept of relying on the data to determine strategic direction and hence the appropriate business models therein. This indeed gets it the first time when well applied. To do so, as has been shown in the data, expertise in the IoT architecture, machine learning and big data analytics are pivotal for IoT success.

6.2 Limitations and future research

The first limitation to this research has been the low turn of interviewees for primary data collection. This however was tamed by the massive used of formidable secondary data sources as described earlier in the methodology and findings. Furthermore, the data collected was pragmatically apportioned into two major streams, the first being data collected and implicated by studying prominent solutions or prominent IIOT players in market today and the second set was from prominent IIoT market and business researches some of which were advice from the interviewees. After having identified the main areas in an IIoT business that that keep on changing to reflect the consequences on the business model transformation, these finding can be used as a basis to explore both the change process and its implications to the entire ecosystem. Furthermore, there this can also serve the exploration the theorise the change as either evolutionary or any other types of organizational change.

While this research was not about management methodologies like lean 6 sigma, etc its quite evident that what IoT promises i.e. improving production and process is similar to what these methodologies promise. This allow a gap on how best the two, methodologies and technological capabilities can enhance production and processes.
Regarding further research, the data so far enables us to identify areas that require deeper thorough and extensive examination in future. For instance, and among others, we suggest investigating the customer perspective in more detail as well as to examine the BM as an entire system contributing to a more comprehensive understanding of changes in the context of the IIoT. The customers role is partly solved by a company (customer) hiring an IoT architect or IoT consultancy.
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Appendix 1: Interview guide

Thank you for allowing to have an interview with your company. Please feel free to inform if you or your company would not like you to be mentioned in the final project. This Interview as earlier mentioned is semi structure but with rather open-ended questions, wherein additional information beyond the purpose are welcomed. The Results from the interview will in a master thesis. The question once again, are basically how is IoT affecting business models in the Industrial sector, or how are business models changing due to IIoT. Here the focus is on the overall overview of things, including OEMs, Integrators etc i.e. buyers and sellers alike. The research seeks to find the key factors therefore enabling and inhibiting this change of business models in the IoT industrial sector. The following key questions were asked, ever, depending on the trajectory of interviewee’s though, follow-up questions were asked to further reinforce data availability in this phenomenon.

- Can you please describe how is IoT is evolving/ changing Nowadays? With regards to value creation, delivery and capture.
- What do you think affects the other to change, is it the technology, or the business model?
- What key fundamental issues drive this change i.e. enable and hinder it?
- Do you have any case you could elaborate demonstrate changes inhibitors and enhances?
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