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INDUSTRY 4.0 AS SMART ENABLER FOR INNOVATIVE BUSINESS MODELS

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STATEMENT OF DECLARATION

I hereby verify that I am the sole author of this thesis and that this thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title of recognition.

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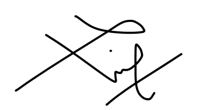

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The main conception behind this thesis was co-developed and discussed with my supervisor Mr. Andreas Enrich Wald who is Professor of Strategy at School of Business and Law, University in Agder and EBS Business school. This research has embedded in economic veins in order to develop incremental knowledge base in unexplored field of industry 4.0 and its implications on businesses architectures, I would like to pay my gratitude to my supervisor for his excellency in guidance and support during the process of the research and my family and friends for active moral support.

Appreciations to all supportive experts and professionals who took part in this research, their valuable insights were part of the reason for this research to be feasible and complete. We hope that this research will help the academic and the practical practitioner in their future proceedings in the given topic.

Abstract

Industry 4.0 is the upcoming 4th revolution within industrial setups across the world, mainly in manufacturing hubs. Industrial internet of Things (IIOT) will alter the dimensions of the way businesses used to be conducted and the way value was assessed and retrieved. IIOT tends to have a critical impact on the business models (BM) within various industrial sectors, either manufacturing or services. This study tries to observe IIOT related effects on the business models in regards to manufacturing industry from a Tech-based consultancy point of view. This study employs exploratory multiple case study approach to the topic, which is based upon semi-structured expert's interviews from high-tech consultancy firms and managerial consultancy firms across the Nordic region with holding an international profiles and background experiences. Since it is observed that there is ambiguity and lack of enough research regarding the IIOT and BMs in combine relation, thus this study contribute to the existing managerial literature and preliminary research works with following valuable insights: Collaboration with IT based firms will be key success factor for the successful implementation of smart factory in a sustainable manner. Smart technologies associated with IIOT will adapt in more optimized manner for proactive players according to their specifications. Cost efficiency can be achieved if the structural policy regarding IIOT designs is feasible enough to maintain large scale operations. Moreover, this study provides some valuable advisory information for the firms looking to kick start modernization efforts towards IIOT related advancements.

Keywords:

Industry 4.0, Industrial internet of things, business models, business model elements, multiple case study, consultancy, expert interviews, qualitative study, smart enablers.

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INTRODUCTION

The recent concerns regarding increasing the productivity growth from industrial sector that is considered to hit stalemate due to procedural and technological facilitation limits as per some experts suggested, this stressed the questions that what will be next chapter in industrial manufacturing to increase its current stagnant value added average growth percentage of 2.7% (2012-2015) globally (World bank, 2015). Recently industrial power houses like Germany, America, China and, etc. initiated the concept for next industrial revolution namely termed as 'Industry 4.0' or 'Industrie 4.0' for German practitioner.

According to the credible industrial associations at United Kingdom, they suggest Industry 4.0 or 'Industrial internet of things' IIOT is a cyber network of industrial processes that interlinks people and technology to optimize the processes that they were already were capable of and while enable some of the new possibilities that were not cost effective or possible before on commercial level. The concept itself have little reference towards smart products or off the shelf packages, it has more emphasis on the connectivity of people, machines, materials, systems and products alike. Therefore, they can communicate in a standardized format effectively on a network, also can access and analyze the large amounts of data, capable of autonomous decision-making power and provides the enhanced flexibility all across the value chain. The apparent focus is towards convergence of Information technology IT systems with integrating manufacturing systems which includes material planning, automation, resource management, enterprise systems and supply chain. One of the major principle of industry 4.0 or IIOT is to shift the business models based on mass productions within manufacturing to mass customization, which also prompt the idea that rather putting large facilities in low labor cost countries and then executing the sales around the globe, the concept itself enables flexibility of 'batch size = 1', with the manufacturing based locally where the markets are domestically accessible. Shorter lead times, customized products with traits like feature flexibility, optimizes the productivity and reduce the potential wastage for the higher wage economies to be competitive on global scale. Although this will require significant amount of investment and also over all alteration in mental approach, towards the way of conducting the businesses (Pye, 2016). In a survey study about 'blueprint for digital success', it was surveyed that around two thousand multi-manufacturing industrial firms from 26 countries are pledging investments of 907 billion USD for digital advancements in the area of industry 4.0 or IIOT, from which most of these firms are anticipating approx. 493 billion USD gains in digital revenue and 421 billion USD in cost and efficiency gains (PwC, 2016).

There is always been discussion in the academic and practical institutions about alignment in between business strategy and information systems, according to credible research works indicating hypothesis that alignment between business processes and Information systems strategies improve the performance. The linkage in between Information systems/ Information technology and business models is resulted particularly strong in the findings, since information technology and information systems act as smart enablers for various innovative business models. However, given feasible acknowledgement regarding this topic there is not enough sufficient research reports on how such alignments are executed and sustained over time (Gilchrist, 2016a). Such arguments led this study focus to feel confident that studying the business model concept based on information systems such Industry 4.0 or 'Industrial internet of things' IIOT enablers can contribute to create a novel knowledge base required for studying the shared understanding of feasible requirements for functional IIOT related integration and the alterations caused within business model's BMs and as well as appropriate relevant IIOT based business applications.

Industry 4.0 or 'Industrial Internet of things' (IIOT) are often emphasized on business platforms by consultants in high context, the main focus is on business models and operational efficiency as they support the arguments about new business models and financial gains which are obvious but one of the problem with these presentations is that they do invigorate executives but don't properly identify the lower-layer complex structure that inter-links at multiple stages in between smart technological facility and business value chain under umbrella of IIOT based smart factory (Gilchrist, 2016a). Secondly as industrial update is adopted sequentially and many firms in multiple industrial sectors for instance industrial manufacturing, engineering and construction, chemicals, etc. (PwC, 2016), will be adopting or implying few functional elements from concept of industry 4.0 according to their specific business requirements and engagements. It's considered significant to seek what implications it will have on the current business models involved in industrial setups and what can be interpreted for innovation in such models and new business models.

Based on these facts and arguments we formulated the research question as;

How does the Industry 4.0's smart systems change the business models within the industrial sectors?

However, the main research question is dependent of some minor questions that are following; what are the smart systems or enablers of industry 4.0 or IIOT? What are the business model elements? And how IIOT and business models are related? We sequentially answer all these pre-requist questions with the help of the managerial literature and later with the extent of empirical findings. At last based on these prerequisite answers, the main question is answered and validated.

Therefore, the structure of this thesis is first to explain the concept of 'Industrial internet of things' IIOT and technologies involved within the concept, based on available theoretical literature. While, later chapters focus on business models and business model core components, where a business model can be examined with the help of a multiple case study approach. This multiple case study signifies alterations in the business model that is in relevance with IIOT concept. This is made possible with the help of semi-structured interviews from the experts that belongs from different Information technology IT and managerial consultancy backgrounds with some accredited experiences within the manufacturing industry, mainly as primary data sample. Finally, with the help of the findings and observations this study will outline some of the basic requirements needed to facilitates these new business models and innovational principles of industrial 4.0/ IIOT, while taking a critical view on the topic and conclude the research with recommendations for potential advancements in the specific research areas related to the given broad topic.

P.T.O

CHAPTER 1

INDUSTRY 4.0

The forth industrial revolution which is also termed as ‘industry 4.0’ or ‘Industrial internet of things’ IIOT will be the actual format or platform based on real time cyber connectivity and predictive transparency. Although, the pervious revolutions for instance 3.0 are pre-requist steps for coming 4.0 generation, which deploy the smart systems with sensor based facilitations of ‘Internet of Things’ and the ‘internet of services’ with the integrated manufacturing environment. In the future, Industrial businesses will be adopting new business models that will be based on global networks to connect their factories, machinery and warehousing facilities as cyber physical systems. These systems will provide the basis for interconnectivity and information control that can be analyzed and prompts required actions, these actions somewhat will be self-taken by connected systems based on mutually configured communication, that these cyber physical systems will be capable of while interpreting the queries and make smart decisions. This will be an architect of the smart factor, where industrial process within manufacturing as whole, the product-life cycle management, supply chain, and supervisory body among these functions will be optimized and enabled with some intelligent traits to be self-sufficient (Gilchrist, 2016a)

General Structure:

Industrial internet of things IIOT is a systematic upgradation of the processes, making them cyber based progressions that can be interlinked with the other units within the value chains. Transformation of such sort requires prerequisites developments in terms of managerial polices and facility based infrastructure alike within a firm, theses developments are however relied upon the foundational smart systems for instance big data analytics, smart sensory systems, artificial intelligent designs, additive manufacturing setups, advance human-machine interfaces, etc. In such developments sensors, machines, workpieces, and information technology systems will be interlinked with business entities across the firm’s boundaries. These connected systems are referred to be ‘cyber physical systems’ as mentioned earlier, these systems can communicate with each other utilizing the standard internet-based protocols and can intelligently simulate potential failure notification, can adapt to the changes based on active information access, also initiate self-configuration with other systems and processes. In simplistic terms ‘industrial internet of things’

IIOT will enable to collect and analyze data across machines and processes alike, making them more agile, flexible, and more efficient processes for the high-quality driven manufacturing at reduced costs. Transformation on such terms will better off the manufacturing productivity, will have positive shift in economics, industrial growth will be complimented, and overall bring in new roles for workforce, thus altering the competitive scales of the firms and of the entire region (Rüßmann et al., 2015). On in-depth view the actual optimization is based on integration of different isolated production referred processes into a one automated production flow unit, which alter the foundations of traditional production relationships among stakeholders for instance producers, suppliers, and customers – as well as the way human operators used to interact with machines.

Associated Tech:

The better understanding about 'industrial internet of things' IIOT can be formulated by understanding the smart systems that act as some elements for this concept, these are some of the smart technologies that determine the smart factory concept and smart processes alike which are made to enable the operational level status with respective to IIOT requirements. These technologies are the enablers that will help firms to achieve IIOT related advancements in its true nature. Most of these techs will have the broad impact on the business models, altering the structural requirements and operationality. Big Data analytics, Internet of things, Artificial Intelligence, Virtual and augmented reality, Cyber physical systems are considered as some of the main enablers for the next smart upgradation (PwC, 2016).

The term big data is referred to the large data sets that are technically complex for traditional data applications to analyze and process. Big data analytics enables firms to have the feature trait that is called 'prediction', firms can predict proceedings with the help of in depth analysis of large data sets which will be actively monitored. According to PwC's (2016) surveys the quantity of information stored grows 4 times faster than the world economy, while computing speeds grows 9 times comparatively. Why does this hold significance as enabler that is because since early start of man creating digital data until year 2003 there was 5 exabytes of information that was created and now the same amount of information is created in every two days as mentioned in the detailed survey. Importance of data mining and analysis was acknowledged by 80% of the global CEOs for their organizations. Big data enables to extract new value from the data, providing important technical and business insights which helps in making enhanced and informed decision-making (PwC, 2016). Cloud computing and machine learning are also dominant technologies under Big data analytics, cloud computing is scale able platform which helps to utilize the computing resources in more rational manner, aiding the automation and reducing the cost generated due to idle systems still online or active, 'cloud manufacturing' is the concept which reflect the idea of smart factory i.e. collaboration of advance manufacturing models with cloud computing technology to achieve new computerized service-oriented manufacturing (Givehchi, Tresk, & Jasperneite, 2013). Internet of things (IOT), the idea for the internet of things first emerged to fit the definition of automated teller machines ATMs (Shon, 1996) back in 1980s, since then number of the devices have been connected on a network. Internet of things (IOT) is terminology used for the physical devices or components that can connected via network and have ability to communicate among each other with each of these aided with RIFDs or smart sensors (Gilchrist, 2016b). However, this is similar concept to cyber physical systems CPS but IOT talks in specific to network integration on industrial component level. In an estimate about 25 billion devices/objects will be interconnected and have communication among them and this will be in use by year 2020 as per PwC's (2016) survey. Internet of things enables firms to add transparency in the processes and make them analytically measurable, these sensors can be implanted in humans, places, processes and products in order to gather data and track performance of various parameters (Xia et al., 2012). Augmented intelligence factor of IOT helps firms to optimize their decision-making capacity, efficient data collection and reporting from their business environments. IOT is aiding the business to achieve the intelligence, giving them ability to analyze their physical processes which were not measurable before. This all aids into a better strategic and operational capability and some cases competitive advantage (Kopetz, 2011). The 'smart' trait of the concept is aided by functioning capacity of Artificial intelligence, AI was introduced as research field in the late 1950s. Artificial intelligence is a subfield in computer science, which has sole purpose to give human like intelligence to the machines or robots that they become self-relied platforms and can carry out smart decisions autonomously (McCarthy, 2007). There are two types of AI, Narrow AI which is related to applications we witness these days to performs tasks in specific domain and then there is "Strong AI" that discuss Artificial General Intelligence (AGI) which still under development. The concept of AGI is broad, deep and contain features that surpasses human intelligence in many dimensions for instance analytical speed, memory, multitasking, pattern recognition, and ability to adapt with new self-learned information (Muehlhauser, 2013). According to (Hawking et al. 2014) the success in creating AI would be the biggest event in human history but they are uncertain that it might also be the last, unless we learn how to avoid risk, this signifies the hesitant view experts generally hold for AI. Estimates from PwC's (2016) survey suggests, that the robots and AI may take up to 50% human jobs in next 30 years for instance, recently Japan's biggest bank, Mitsubishi UFJ Finance, installed robots for their customer service operations and IPsoft which is a call center that is using an AI robot "Amelia", who is capable to self-learn apart from pre-programmed knowledge and now she can process more than 60% all incoming inquires (PwC, 2016). Smart factory will be aided with advance human resource programs in 'Virtual and Augmented Reality'. It's a computer simulated environment which is also known as Virtual Reality VR, it has the ability to create real-life like environmental space with the help of compatible digital devices which can help with employees training programs and in operational process assistance. While augmented-reality is one step ahead and let the user interfere with simulated environment that alter the dimensions of simulated environment and generate responses (Boud et al., 1999). According to Jason Ganz, CEO of Agora VR "The internet allowed us to learn anything – VR and AR will let us experience everything". Conferring to PwC's survey (2016) they suggested some of the managerial tasks will be held virtually as meetings, strategic conferences, apart from this VR/AR will help with human resource department in training and continuous assistant system in digitally connected environment that industry 4.0 promise. In order to make the smart factory operatively enabled or functional we will require 'Cyber Physical Systems', CPS are smart systems which enables to form a network bridge between virtual and physical components used within manufacturing, logistical, and products. This is the concept that combines with Internet of Services (IOS) to make industry 4.0 possible which opens up new potentials for innovative applications and processes. Cyber physical systems CPS will facilitate the paradigm shift from existing business and market models, as new smart applications, service providers and value chains becomes a working possibility. All these technologies in combination along some other technologies for instance additive manufacturing i.e. 3D printing, Robotics, etc. lay format grounds for smart factory, which is the amalgamation of virtual and physical systems through cyber physical systems. Such fusion of the technical processes and business processes will make a gate way to the concept that is known as "Smart Factory" (MacDougall, 2014).

In given literature it can clearly be seen that disruptive technologies have impact on business processes and functions alike, altering their designs and achievable capacity, Industry 4.0 or Industrial Internet of Things IIOT can be defined as “the end-to-end digitization of all physical assets and integration into digital ecosystems with value chain partners.” (PwC, 2016)

CHAPTER 2

BUSINESS MODELS

Business model (BM) are gaining common core characteristics in the academic literature after being unit of analysis within research work for some time now, business models try to focus on value generation relationships which defines the logics for such value creation for all involved stakeholders. Value generating activities that are outsourced or performed by external partners for instance suppliers, customers, and co-developers are considered critical for understanding the value generation logical reasoning (Zott, Amit, & Massa, 2011). In order to clearly determine and elaborate the BM concept in relation to research question for the further analysis in the focused area of interest and field, we need to acknowledge the clear and accepted definition for further analysis within this given thesis. However, Zott, Amit, & Massa, (2011) argues that clear and specific business model structure still does not exists that is entirely similar to what other authors has proposed for instance BM proposed by (Casadesus, & Ricart, 2010; Johnson, 2010a), lead us to understand that one clear standard definition can't be achieved as this definition will not able to cover aspects of different field requirements and specificity that will cause inductive ambiguity in many areas of BM (Zott, Amit, & Massa, 2011). As businesses functions differently from each other this implies that standard structure can be a challenge to specify for specific observations.

Business Model (BM), is a platform which provide conceptual structure of the connected objects and their relationships with each other, thus explaining the business logic of a specific firm. This set simplistic description and illustration of how and what value is provided to the customers, explaining how this value is created and what are the costs attached for such value generation (Osterwalder, Pigneur, & Tucci, 2005). Given explanation is broad enough to reflect the business models that can relate to the concept of 'Industry 4.0' or 'Industrial internet of things' (IIOT) which highly based on information systems (Pateli, & Giaglis, 2003). Business Models BMs highlight's the mechanisms that links the interdependent activities that are operated by firms and by its partnered firms as in one collective body. Hence, we can term a business model as a template that depicts the way the firms conduct its business operations in its entirety. The motive behind the construction of a model is to determine the best practices to tap into the market opportunities which can help firms to achieve the appropriate customer satisfaction levels, such construct can often span across the firm and its operational industry limits (Chesbrough, 2010).

STRUCTURE:

In the study of Osterwalder & Pigneur, & Tucci (2005), they have mapped out the most common BM components in the existing academic literature by incorporating the business models and concepts that refer to different logic origins and ones that are most cited and analyzed, as mentioned in *Figure O1(Appendix)*. This provide us with a reliable model that incorporates nine components that are highly regarded among other business models. The given business model also covers appropriate range of business model components that provide basis for logical value reasoning on comprehensive level. As industrial internet of things IIOT concept is highly based on information systems and since this BM has been developed in such context which lay appropriate foundations for applied analytical framework in this research.

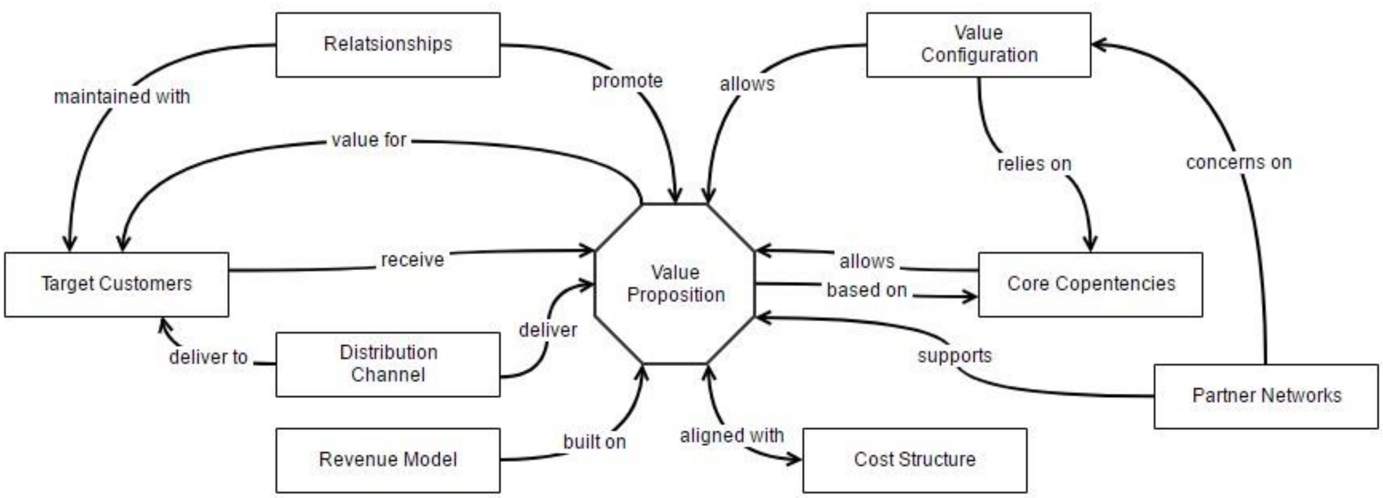

Figure O2, Business Model nine components and structure, self-representation.

Within the work of Osterwalder & Pigneur, (2010), they describe the business model as a logical explanation of how an organization generate value and then deliver it and also how it is captured. *Figure O2,* illustrates the nine elements that give an overview of a business model structural components and how each of them are connected with one another and for what purpose. This provides logical reasoning for value creation under IIOT type settings. We have further described the model with respect to it nine components as mentioned earlier in the *figure O1(appendix)* and *figure O2*.

The center core of the model represents *Value proposition*, which is proposal for the value in forms of products and the services that generates or increment value for the specific targeted customers or buyers, these targeted groups received this value proposition in the mentioned forms. *Targeted customers* can have different profiles and requirements that an organization intends to capture and deliver, this determine the generated value's purpose and reason to exist in the first place. The *Distribution channel* layout the format of how the organization will reach or connect with these customers and what sort of communication pattern will be adopted. Therefore, the channels are acting as bridges that facilitate the follow of the value proposition to the target customers. *Relationships*, describe the relations that organization maintain with its different customers segments and reason is based on promoting and sustaining the value proposition for long term relevant connections. The *Core competencies* are the main aptitudes or attributes that are must needed to perform the activities that keep the value generating cycle running within the model, hence it is critical and it is based upon the business model's value proposition requirements. On the other hand, *Value configuration* explains the arrangement of the activities the organization have to execute in order to create this value proposition, therefore, these two business model elements actually permit the value propositions for the rest of the connecting nods within business model. The critical chain of certain inputs for value creation in form networks, suppliers and, partners are labeled as *Partner networks*, these are the entities that provide or facilitate the means for business to function in certain areas of operationality that firm itself can't perform due to capacity or ability constraints. These networks play a critical role on the activities that are often facilitated or replaced by these collaborative partners. Hence, these element supports the offerings based on value proposition. Lastly, the *Revenue model* and *Cost structure* give an overview of financial profile and cost based structural aspects required to run this cycle, the elements discussed above are constructed on the value proposition and the one mentioned now are based on costs that relates to value creation, marketing activities and, delivering of this value. Cost structure is aligned with rest of the Business model so that it can be executed within the financial support. Revenue model is based on the cost structure in order to generate revenue flows to support the business model. Therefore, the mentioned nine components all are interconnected in one way or another making a complete working cycle that define rational for value creation. (Osterwalder, Pigneur, & Tucci, 2005)

Now the adopted structure for the business model is determined, it is appropriate to discuss the change principle because later in the study we will analyze the change emphasis due IIOT related enablers. In academic literature change is associated with Business Model Innovation BMI, however this assumption can be questioned as generally business model change can be differentiated into business model development and business model innovation (Johnson, 2010b). Some of the authors for instance, Schneider, & Spirth, (2013) & Teece, (2010) think that there is not enough clear definition of the business model innovation and the clarity that the business model development and the business model innovation are differentiated forms of change. In the literature, there are some contributions that try to explain the difference between them, first is that the primarily adjustments that are made on the existing business models is done to make it better configure with the competitive advantages or to cope up with new business strategy or situation (Arnold et al., 2016). On the other accounts in some research papers there is mentioned of similar reference of differentiation between radical and incremental change within business models, what is mentioned is that developmental change is minor adjustments within business model and doesn't abruptly change fundamentals of value creation architecture, value proposition, or cost related elements (Johnson, Christensen, & Kagermann, 2008). Thus, it can be agreed upon that business model developments are minor adjustments and have prime focus of existing business model. While business model innovation according to academic literature hold a different ground for change, i.e. extensive, radical, structural which normally ends up in a new business model. Business model innovation are referred to ongoing changes in the market requirements thus it has more focus on external environments (Calia, Guerrini, & Moura, 2007). This indicate the nature of difference from business model development and moreover it is studied that fundamental changes are difficult to adapt and it is one of the referred struggle with business model innovation. Rational behind this is that company's managers are often more familiarized with their working or existing business models since the business is developed on that and their work tasks revolve around this model, so innovation is hard principle for working managers to opt for because they have to change their logical patterns to new dimensions and realities which require time to adapt to (Chesbrough, 2010).

CHAPTER 3

INDUSTRY 4.0 & BUSINESS MODELS

When we talk about industry 4.0 in relation to business model we refer to technologies or systems like cyber physical systems CPS, internet of things IOT, cloud computing etc. as these terms are mostly associated with the concept and being mentioned 267, 182, 69 times respectively in academic and practical publications combine (Hermann, Pentek, & Otto, 2016). Based on orderly review of managerial literature it was acknowledge that there is not enough material to examine industrial internet of things IIOT's impact on business models of any specific category for instance manufacturing or high-tech solution providers. There is still vague understanding of how the elements that are referred to business models get affected with industry 4.0 driven enablers (Kiel et al., 2016). However, there are some clues and assumptions based on many reviews, business conferences and research work where they give fair rationales for innovation based upon industrial internet of things IIOT concepts and how it will affect the business models within industries based on their working backgrounds and experiences. Integrated digital, web based production solutions are now much in works within manufacturing's value chains and this is referred with innovation that is base for change in new business models (Arnold et al., 2016. & Brettel et al., 2014).

In overview of managerial topics like human resources, value offerings and, collaboration and networking in literature and how IIOT enablers affect them given in academic and practical articles, there is much emphasis on individualizing of services and value offerings that somewhat also add value to traditional product offers in terms of production or pre-or post-value-added services in a smart manner with the help of internet of things concept. Facilitation of active information flow, transparency that is backed by active monitoring and intelligent analysis for instance machine self-adapting, learning and, conditioning can provide basis for integrated product and services (Kagermann et al., 2013) & (Kiel et al., 2016). These integrated and networked based processes and operations open up dozens of possibilities for collaborations and partner networking. Industrial internet of things enables enhanced interaction between customer and product service engineering and design development, moreover it also leads to new suppliers that reimburse for inaccessible resources that are required for establishment of innovative products and services (Brettel et al., 2014). When we talk about human resource, the concept industrial internet of things also reflects on its effect on the way tasks and roles that were required from human resources for instance IIOT creates different requirements in terms of employee skills and on the same hand also facilitate better skill building platform in terms of data analysis and software structuring. Industry 4.0 indicates that lower and middle tier staff may be subjected to be less required with the time as smart machines will replace that role and while the new skill requirements in terms of digital supervision will still exists. This will prompt the change roles from machine operators to supervisory roles. (PwC, 2016) & (Arnold at al., 2016).

'Industrial internet of things' based enablers specifically cyber-physical systems, Internet of Things, Artificial intelligence, etc. have certain influence on the business model's nine components. As it has been mentioned earlier in the chapter two, now we will discuss about this influence according to literature in order to have more broad view on our topic of research. Technologies like cyber-physical systems, internet of things, etc. enables firms to have more flexible options with value propositions which facilitates more innovative product offerings that can be more personalized according to targeted demand and can be at same time cope up with even batch-size-one production (that is when you can create multiple variation in the base product on the same production line) (Kagermann et al., 2013) & (Pye, 2016). This can be highly sophisticatedly smart since processes can be monitored in the highly data driven environment which leads to the responsive processes within manufacturing due to the machine learning, conditioning, active monitoring etc. that creates possibilities for predictive maintenance to prevent stoppages and waste within production. However, given enhanced customer-orientation provided with these innovative service offerings in the production, IIOT still provides optimization regarding costs, reliability, time, efficiency, and, quality with increasing individualized and service-oriented product manufacturing (Sanders et al., 2016).

Being able to cater larger varied customer base due to enhanced flexibility creates possibilities for the new targeted customers not only limited to known industry but also across known industrial boarders. Digitalized and transparent web-based platforms give new meaning to the distribution channels which are emphasized to be more interactive towards the customers and in partner's participation. It is important requirement for understanding the customer requirements in a proper manner to formulize the individualized products and services which translate into long termed, direct, intensified and, improved customer relationships. More integrated customers in the product design and service engineering, creates meaningful co-designers and important collaborative partners. (Brettel et al., 2014) & (Jazdi, 2014).

In order to have a smart structure which is based upon decentralized control and production processes, also require chain network of connected objects which is essential for industrial internet of things IIOT functional format, which furthermore requires certain value configuration activities within your manufacturing premises (Kagermann, 2015). Excessive data related engagement for instance data mining, data management and then putting this meaningful information in the utilization for automated decision-making, holds significant appropriate role importance (Kiel et al., 2016). Manufactures at most would require novel core competencies, especially in mechanical and hardware oriented firms which will have to get familiarized with software handling know-how and its development into integrated network with smart machines, this will alter the way these firms use to formulate their human resource, for instance excessive use of the network based components and objects will need data analyst to handle such patterns within the data detection from these devices. Firm's human resource would not only be required to attain new skills but also new roles for its workforce, roles will shift from operators to controllers and analyst, who would supervise connected devises when they head into malfunctioning or other problems once in a while. One of the most critical element for IIOT system will be partner networks, which will alter the strategic fit in such context. Those resources that can't be acquired due any core or material limitation will be covered by these partnering firms such IT firms which will hold significant technological expertise in terms of IIOT, cyber-physical things and cloud computing etc. These players will have crucial role as collaborative partners in regards to IIOT based developments, cloud computing related development, engineering, and, ready to use IIOT based products and services (Arnold et al., 2016).

Further reviewing the literature for the alterations in business model components prompted due to IIOT related changes, these of the followings statements were observed against each business model component;

Value proposition:

IIOT influences the range of products and services that are offered to the customers, mainly focusing on the individualized offerings i.e. focusing upon mass customization principles and the batch size 1 production, furthermore reducing the 'time taken to market' aspects. IIOT also facilitates development of the smart product and services, making them innovative and flexible to altering market requirements (Brettel et al., 2014). Another aspect of IIOT is based upon ‘condition monitoring’, which act as platform for predictive maintenance i.e. products and services offerings becomes data driven. This helps to gather the active information from these offerings with the help of sensors, processors, connectivity, and cloud interfaces which further improves the service orientation and generate possibilities for the new business ideas and revenue creating methods (Porter, & Heppelmann, 2014).

Target Customers:

New markets can be accessed due to IIOT based integration into the value creation as these IIOT based improvements enables manufacturing firms to create new customer segments which could not be accessed before due to limitations in abilities and capacity (Porter, & Heppelmann, 2014).

Customer Relationships:

According to Keil et al., (2016), IIOT emphasized collaborative and intensified relations which strive for close teamwork and more transparent integration of the customers for instance social media, open source, and open innovation are some of the methods for such developments. This requires collaboration not only limited to information sharing extent but also involvement of these key partners into corporate structures. Manufacturing firms require high level of collaboration and integration levels with its customers for co-designing and cooperation.

Channels:

IIOT enables the opportunities in the venue of e-commerce and interactive online markets for creating the platform which transfer value propositions to the customers in an optimized manner. Extended use of social media under IIOT principles provides manufacturing potentials in terms of better data sourcing that can optimize production processes (Keil et al. 2016).

Core Competencies:

IIOT requires number of resources in order to be fully functional concept, one of the important key resources is considered as ‘value creation networks’. These networks enable the firms to be responsive actively in some real-time environments which helps to improve the flexibility of value propositions. However, this require connectivity with serval production and logistic functions, manufactures, service providers, suppliers, and customers via cloud oriented platforms which can insure a standardized, automatized, and smart connectivity. (Frostner et al., 2014) & (Keil at al., 2016). Information connectivity technologies (ICT) will have to be optimized within the firms for IIOT based advancements related to the internet of things and services. Firms will have to initiate this to achieve connectivity across the facility, also for improving the availability, flexibility, man-machine integration, and for gaining expertise in big data analytics (Ramsauer, 2013). IIOT will augment the key resources with facilitations of cloud technologies and additive manufacturing AM, both of these technologies will introduce novel attributes to firm's functional capacity for instance integration of cloud systems into the production environments will create new working platform for the firms i.e. cloud manufacturing CM. CM will provide basis for decentralized on-demand services which will be adapted to the production processes. Similarly, Additive manufacturing AM which alter the production methods based on its additive material manufacturing process which require less resources utilization and it reduces the waste significantly. AM also helps firms to achieve the capacity to offer customized value. (Davis et al., 2012) & (Kalva, 2015). Human resources will have to face alterations due to IIOT based advancements i.e. workforce will be required with additional analytical skills as decision makers, sensors, and actuators will form the core of the BMs. Due to integrated network-like production plants, involved objects and smart components there is chances for machine, network, etc. related malfunctioning, this will prompt human intervention with the supported systems. IIOT based advancements will underline new requirements as must needed resources such as employees with high data analytical skills and potential downsizing of lower and middle qualifications as their roles will be taken by AI supported machines (Keil et al., 2016).

<u>Value configuration:</u>

According to Bulger et al., (2014), analysis in terms of big data analytics will be one of the important activity, the collection of data from the processes and machines itself will be vital for setting up algorithms for analysis later which will result into early detections of errors and prompts protocols for corrections, reduction in the downtimes. This will enable firms to increase their production efficiency and capitalize on new business opportunities. Customer integration will also play important role for co-developing of the value offerings which will be more aligned to their respective needs, which promotes the idea of (Matt et al., 2015) that trend of distributed manufacturing i.e. IT based production network will aid in customized products, shorter delivery times.

Partnered networks:

IIOT alters the established supply relationships, since the processes are highly digitalized which will require expertise such as data related specialized analyst and IT experts from the partnering network if the firm don't hold ability to do so itself, otherwise it have to build such capabilities within its IT departments. Moreover, in literature it is emphasized the relevance of having reliable partner networks which contain IT suppliers and high-end service providers. This facilitate the idea of open innovation, making firms having broader approach towards market environment, thus changing the traditional inside-out perspective with an outside-in perspective. This allows concerned partners to participate in the production processes, with help of cloud systems. (Porter et al., 2015) & (Kiel et al., 2016).

Cost structure:

IIOT helps to reduce the cost due to its predictive prevention methods based upon smart simulations which helps to reduce the wastage of resources and prototyping costs. Enhancements of the value chains due to IT results into operative cost savings for instance concept like 'smart cities' where consumption of electricity can be monitored and adjusted according to civil needs at different time periods which helps to minimize cost. Up to 60 or 70 percent of cost can be saved in regards to inventory, quality, logistics, complexity, and maintenance. (Posada et al., 2015) & (Keil et al., 2016).

Revenue model:

Value creation cycle of a business model can only be sustained if revenue flow is higher that total cost incurred, Due to hyper integration among digital and physical components and emergence of hybrid solutions, this will lead into new ideas for revenue generation and innovative BMs. (Fleisch et al., 2014) & (Keil et al., 2016). One of the industry 4.0 promises is the reduce overall cost with production and processes. Concerning financial aspects, IIOT will give birth to new revenue creation structures within firms for instance performance-based billing, Dynamic pricing, and, pay-by-usage. High investments in IT infrastructure is also anticipated (PwC, 2016).

CHAPTER 4

RESEARCH DESIGN

The core idea of this research is to provide better understanding for the concept of IIOT and its impact on the business model elements or components as mentioned earlier, explaining how these business model components will be effected or altered for manufactures from different industries. In focus, the study adds another layer of combine perspective of relevant tech oriented experts with experiential backgrounds with IIOT related projects and the managerial consultants whose domain lies in overall firm strategy and consultancy, this is to add context to already ongoing research about such changes in different disciplines on varied scales. Information from these experts will add another dimension to already preliminary findings on this topic existing in academic journals. Technological experts have backgrounds with internet of things, big data analytics (cloud computing, machine learning, etc.) sizeable portion of sample are also entrepreneurs which holds profile as platform providers for IIOT related services or assistance to the industrial clients which are heading towards 4th industrial revolution. It was also thought important to take notice of managerial implications as it's important to link managerial discerning regarding modification in trends, there is not much information available that how manufacturing companies and their management is coping up with concept industry 4.0.

The research deals with a new phenomenon which is still relatively new on many grounds, which give logical explanation for this paper to be exploratory in nature. Exploratory research design is based on the fact that there is not sufficient centralizing and conclusive work exist on the topic and neither can't be backed by industry-specific reports. Thus, there is a lot of ambiguity with industrial internet of things IIOT related changes on manufacturing bound business models. In order to make a meaningful understanding for this topic it was decided to choose multiple case study approach, which is deemed as appropriate for researching a complex phenomenon which is not much known in real life like context (Yin, 2013), which proves the ground base for the topic industry 4.0. and it's key enablers. It's often advice to adopt case study research for information systems as it's deemed appropriate, due to its novelty with respect to old designs (Dube, & Pare, 2003).

The knowledge base for this research is generated with semi-structured interviews from the technological experts and managerial consultants from various industrial sectors mostly with close affiliations with manufacturing business, along with this the data is further validated with archival data which develops a platform for the analysis and discussion. These interviews are analyzed in logical pattern that serves appropriate source for the developing the theoretical knowledge (Edmondson & McManus, 2007). Due to the ambiguous understanding regarding the topic it was decided to keep the option for openness of expression for the interviewed personal and this is sole reason for keeping the semi-structured approach for these interviews, as semi-structured interviews are viewed as appropriate data collecting medium for exploratory study and these type of interviews helps to obtain structured data and as well as unstructured data that helps to further develop understanding for practical reasons in the research (Cannell & Kahn, 1968).

Case study research is termed different from the sampling method, as per author Yin, (2013) suggests for multiple case study research sampling which is based upon actual logic that helps to minimize the possible adverse effects of sample bias or any related heuristics and this was kept in focus while data collection time period. It was decided to took on board various technological experts that are working with relevant IIOT related technologies and with similar or IIOT related projects in the past or present, however, most of these tech experts are also consultants that provide IT solutions to the industrial buyers, so they hold managerial understanding of business models as well. While on other hand we had detail in depth interview based discussions with core strategic managerial consultants who provide advisory based strategic coverage to the businesses for enhanced business models or improvements. As for this study, the targeted group mainly operated in Scandinavian region with some exceptions in the managerial consultancy area. Fair amount of primary data was obtained in form of expertized content from our interviews and these all interviews were programmed and coded under three themes with the help of content analysis software, which defines word frequencies and coverage area on target principles or objects. Time duration for conducting these interviews was from mid-February until end of April, all the interviews were audio recorded and later formulated into textual transcripts.

The credentials required for sample selection had following requirements;

Profiles	Managerial Consultants	Technological Consultants	Tech-based advisory firms	Total
Years of Experience	<5	<5	<5	Above 5 years
Region	-	-	-	Scandinavian/EU
Projects involvements	<=1	<=1	<=1	Manufacturing / Technology
Technological Expertise's	<=1	<=1	<=1	IIOT based or related

TABLE O3 – Primary data sample profile. Self-representation.

Referring to *table O3*, these were the few requirements that were maintained in order to increase validity of information that was to be obtained for the analysis. All the respondents had minimum 5 years of experience in tech or managerial consultancy and most of the interviews were done via using skype and Google hangouts, while some of the interviews were conducted as in person. All interviews were audio recorded under the agreement that it will not be shared with any third party and their identities will be kept anonymous, also with clear agreement that research is for sole academic purposes. Most of the respondents were located in Scandinavian region, respondents had been involved with at least one or greater manufacturing clients in the past for a project or services etc. and had at least one or more expertized knowledge with IIOT related technologies.

The basis of this research is initially influenced by the study done before which was accessed as secondary archival data for this research. Referred study was undertaken on similar grounds as this research, they worked upon mainly on manufacturing industrial business, they also analyzed the effect of 'industrial internet of things' IIOT on the business models of the different industrial sectors in their excellent award-winning study (Arnold et al., 2016). However, they lacked the technological stand point because such disruptive technologies need an understanding bridge from tech-based service providers in order to better understand the prime effects and what actually technology provides and where it stands on the hype curve, which is deemed critical for actual execution of smart industrial format or IIOT related advancements within these manufacturing

MNE’s. An appropriate balance was taken to complement on their work findings further ahead, although their findings were treated in similar fashion as academic literature was treated for guidance. Their work was done upon similar 9 parameters of the business model that they analyzed from manufacturing firms point of view so their observed sample was different as mentioned earlier, however, for this study only average from their findings were taken under consideration just for comparison purposes so that results can compared the in a similar pattern and contribute in an already existing solid research platform. Although, this study answers some new topics as well that were not part in their findings.

The topic at hand as previously emphasized, is not as clear within the industry yet and its practical implications on the businesses, as there is no entirely smart working example within the manufacturing industry which define industry 4.0 or IIOT as in its totality. Under the guiding principle of literature, the interview agenda was created with appropriate balance between structured and unstructured questions, which gave open areas to talk on the topics which reflect respondent expertise in general (Kasabov, 2015). The interview guide was divide into three themes, primary theme reflects on the respondent personal expertise and background and his/her understanding with general topic of industry 4.0 and business models. Secondary theme deal with detailed topic specific questions which relates with the core 9 business model parameters under the focus from the smart industrial enabler that the respondents were expert within. Lastly third theme geared questions which prompt future knowledgeable estimations for the study and uncertain elements attached with the topic. The process of conduction was fairly simple, all the interviews were audio recorded and later transferred into qualitative textual formats for programming and coding as a requist for the content analysis, we used well known content analyzing software NIVIO 11 for formulation and findings of the frequencies. This approach made the content organized in categorical manner with respect to literature and as was logically defined by (Holsti, 1968), as for data reliability during entire conduction process it was made sure that coding process was as per researching standards and followed the requirements needed for inter-code reliability (Holsti, 1969).

As mentioned in *figure O4 below*, the data coding was performed by using content analysis software, which let audio, textual data to be sorted out in organized manner which helps to compile data and can be used for interpreting logically and with connected reference (Edhlund, & McDougall, 2016). The data was divided into four separate code divisions that categorize different informational base. First code division was responsible to identify respondents general profile regarding professional background, expertise, field area of interest, his/her knowledge about Industry 4.0 or Industrial internet of things IIOT and how well they are knowledgeable about business models etc. this help to label each respondent under specific category or relevance and importance. Second code division take business topic related discussions in to more detail manner, where the question was asked with reference to Industry 4.0 or IIOT. This helped us to verify their way of approach toward the topics that were analyzed afterwards. Third code division was formed to categorize business model related changes for nine business model components, frequencies of words, statements, were compiled and later analyzed separately giving us different coverage areas, which helped to identify variations in data regarding each component, that further aided into studying alterations significances. Fourth code division compile the future oriented topic themes, which helps to determine respondent's areas of focus regarding IIOT and business models or in combination and their assumptions based on their knowledge.

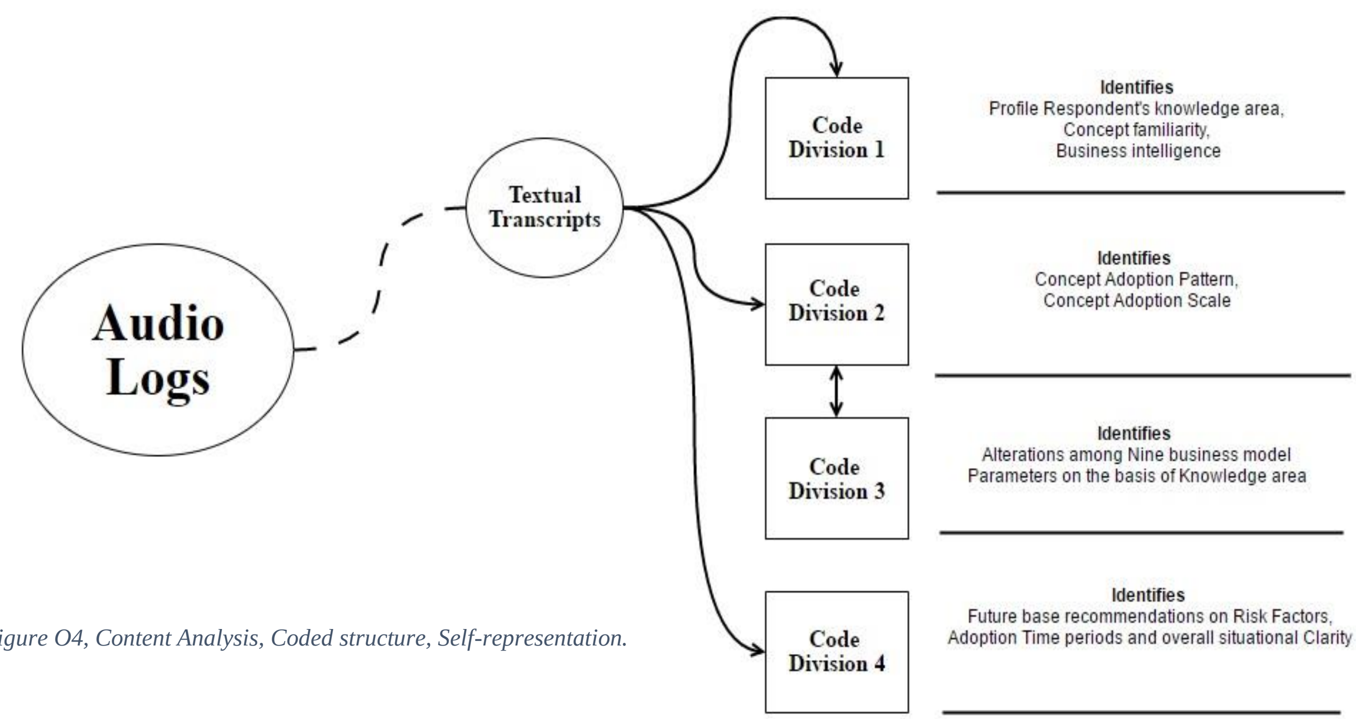

Figure O4, Content Analysis, Coded structure, Self-representation.

CHAPTER 5

EMPIRICIAL FINDINGS

Business and technology consultants plays crucial roles for strategic and tech related advice for the businesses regarding their business models and ICT setups for the concerned firms, the sample group responded under the context of industry 4.0/IIOT and with the relative technological based or strategic based expertise that they possessed and had experienced with. Almost 60% of the respondents admit they are well acquainted with the concept of industry 4.0/IIOT the smart factory, however, there were some ambiguous reservations due to absence of the working IIOT concept in the practical world for now. From the primary data collected, the three most common IIOT associated terminologies mentioned with the concept of the industry 4.0/IIOT was ‘Internet of things’, ‘Big data analytics’ and ‘Cyber physical systems’, however there were also mention of robotics, augment reality, neural networks and artificial intelligence which was subordinate in reference with respective to the earlier mentioned tech terminologies. This identifies the current focus of tech consultancy based firms with the IIOT concept, which further also signifies that what is most in demand in terms technology requirement from the manufacturing firms at current level of operations. ‘Internet of things’ believes to be first step into smart factory as per one current understanding of the industrial market. On the conclusive end, automation was greatly emphasized for various processes not only from smart factory stand point but also from strategy and supportive functions like human resource, logistics and even finance. As per managerial respondents, the focus of the smart factory was majorly based towards technical side of the businesses.

When asked about Digitalization’s effects on business model almost 80% of the Tech-based along managerial consultants expressed agreed notions for the positive alterations. Although, they have different approach to the idea heavily based on the areas of expertise. According to the primary profiling, all the Tech-based experts had three common IIOT related technological knowledge base that was in ‘Cloud computing’, ‘machine learning’ (Big data analytics) and, ‘internet of things’ as developers, consultants and due to professionally involved projects experiences. They emphasized how digitalization has change the way business were conducted and were they are heading, manufacturing industry is in a process to adapt optimized resource utilization processes which can be enabled by technologies like internet of things, cloud computing and machine learning etc. However, they noted it is important to acknowledge that not every manufacturing firms requires such advancement reasons associated along such claims were small scale productions, product types and firms size.

All the firms are slowly taking steps towards smart automatization as known from the literature, so it was deemed wise to ask their opinions regarding adoption scales and patterns for the manufacturing firms, the responses were equally divided based different prepositions. As illustrated in *figure O5*, Proactive approach towards employing smart solutions dominated with mere 0.17% coverage area over reactive approach from the content analysis. Two interpretations were drawn, first that firms taking proactive approach are mainly large firms with high resources that can cover infrastructural and initiation cost but this accounts for short representation sample of entire industrial hub, these firms have high innovation curve and mostly act as first adopters for new innovations to keep their competitive profile in the industry. Second interpretation signifies that technology is not mature enough to provide all the anticipated benefits for instance reduced cost of production, large scale utilization. It was mentioned many manufacturing firms even today are using the devices that reflect IIOT related advancements for smart factory for instance 3D printer, still haven't proved to be cost effective platform as per well experienced senior managerial consultant from the sample. Technologies like artificial intelligence, augmented reality that are considered requirements for smart factory still don't exist in form to be employed at large scale and initially is not advance enough to promise self-sustained factory and mass customized value enablers. All this been said, still general outtake on responses represents favor for proactive posture towards adoption of smart solutions, rationale behind this is as once the technology will be put to the use, that will clarify the potential sectors for further improvements and updates required by the factories and earlier you adopt the earlier you will get familiarized with smart systems, which will enhances their business models towards optimization on some elements and new opportunities possibilities.

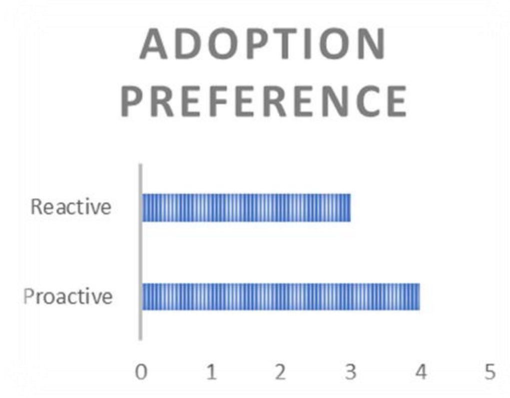

Figure O5, Source: Primary data self-representation

Furthermore, in *figure O6* it was identified that smart technologies involved which make up the smart factory are considered as operational optimizer rather as base for competitive advantage. Score from the content analysis determined that respondents weigh ‘functional optimizer’ perception towards smart factory three times more than it acting as base competitive advantage. Coverage area of 1.29% accounts for operational optimizers and 0.69% for competitive advantage, this signifies that employing smart systems or solutions are more perceived as operational optimizers rather as asset that might give sustainable competitive advantage to the manufacturing firms as per analyzed sample. Determined the reasoning behind this according to audio logs suggests systems like machine learning, cloud computing and internet of things, just provide platforms where you are more enabled in terms of information accessibility and autonomous control of your manufacturing processes, this doesn’t really provide you a strong reasoning platform to label it as way to obtain competitive advantage. Although some of the aspects of the smart technology may act as facilitator for competitive advantage that aspect is mostly referred as ‘mass customization’ according to the experts, which will enable innovative business models that can support personalized profiling towards their customer base and this will also enable them to address larger customer market.

Figure O6, Source: Primary data self-representation

Experts also commented on either if adoption should be initiated at horizontal chain functions or rather vertical chain functions. As illustrated in *figure O7*, Responses were normally pointed out horizontal chain functions since industry 4.0 is aligned more towards active collaboration between Information Technology and business processes as per their understanding of the IIOT concept, which provides argument that manufacturing companies will be more co-dependent on technology suppliers in the early phase of adoption until they get familiarized with the systems and develop expertise in terms human and infrastructural resource to handle the supervision themselves in the long run. As per senior cloud computing expert suggested that the concept for self-sustained smart factory will

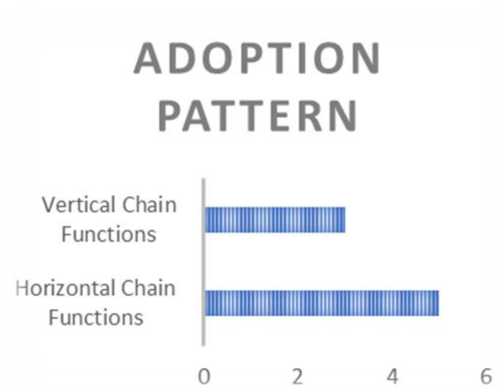

Figure O7, Source: Primary data self-representation

require a lot of expert skills through execution phase to bring it to the status where it can be relied upon by the manufacturing firms and connected partners. According to senior managerial consultant Industry 4.0 itself is a broad concept that don't is not really confined towards factory plant only, it notifies changes on large scale throughout your horizontal and vertical chain functions, depending upon where you lie in the chain, specifically for manufacturing firm's emphasis is more towards smart supply chain network. Based from primary data 'internet of things' until now successfully implement on the warehouses by some manufacturing firms which helps them with better data analytics and tracking procedures. However, vertical functionality was also referred as preferred position to employ the smart updates by few experts but that depends on what type of smart system you want to setup, for instance installing just 3D printer does identify smart tech and starting point for the smart production but it far away from the actual concept where multiple processes working and communicating simultaneously via connected industrial internet. It is emphasized that it will take a while for entire smart factory concept to come into its practical terms as much of the associated technologies are not production ready for utilization on large scale and all this will require sizable amount of investment from firms end as well.

Referring to the *figure O8*, it is illustrated the difference in coverage area of the collected primary content which signifies the importance given to each parameter in terms of alteration due to IIOT based smart technologies like internet of things, CPS, and big data analytics. From the coded primary data, we can easily two most dominant BM components that are mostly likely effected by smart technologies are partner networks and value prepositions respectively. Partner networks is most effected as per tech and managerial consultants with coverage area of 18.51% from the change emphasis due to two reasons first the smart factory adoption will prompt more dependent collaborations and partnerships due to lack of expertise skills to handle the smart systems in the initiation phase and more over the technology is still not advance enough to be fully automated when it comes to self-learn and self-decision. Although it was also acknowledged that partner networks might be

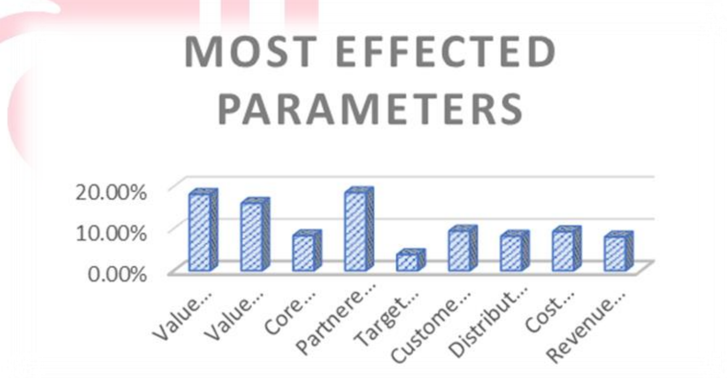

Figure O8, Source: Primary data self-representation

effected less once companies/systems have developed the expertise to self-handle smart processes and operational tasks and don't further require outsourced expert knowledge. Second most effected parameter is value preposition which is effected due to enablers that technologies provide, mass customization, self-sustained automated processes, real time information tracking and analytics. This effect as per experts is mostly like to be remain dominant even in even when manufacturing companies are familiarized with smart systems, as per sample understanding industry 4.0 truly enhances the approach towards value preposition and flexible business models. The third most likely effect parameter would be value configuration, which signifies that there will be critical changes in the configuration aspect of the business model, much will be augmented by the smart systems and much new elements depending upon employed smart solution will be introduced which will initiate novel activities and task structures accordingly as per experts. The change emphasis on the value configuration is either because of implementational changes which might be infrastructural, or procedural in nature and the second emphasis of enablers which will augment the current configuration or will totally add new feature to get acquainted with. Fourth most effected according to change emphasis coverage area is customer relationships with the value 9.39% which reflect change emphasis on base of how experts identified the procedural changes and new interactive ways the customer relationship can be maintained and managed. The smart technologies facilitate better data analysis which create valuable information that customers require and the user interaction enhanced features of technology helps to create more understanding channels with customers, the results are apparent that customers will be more informed and more synchronized with the processes which prompts active feedback and more customized profiling for each customer involved. Cost structure and similarly models are fifth important factors given in our change emphasis study, according to our expert respondents this was accountable for large long-term investments that will be required to setup the smart factories and overhauling the current setups to standards which can facilitate smart tech infrastructure, this will not be limited to material basis but also lot will be needed for workforce training and for initial maintenance, trail error matters. Given early high initial costs the cost minimization as theorized in later stages by the concept itself can't not be confirmed yet according to our sample since real life like example don't really exist and few elements within large manufacturing firms for instance automotive or aviation industry don't really reflect expected cost savings for the systems which define by IIOT, this is why cost structure has its limitations to some extent for now and revenue model reflect the cost structure, change emphasis analysis shows although flexible traits associated with revenue models due to access to larger customer base but this can't be validated due to cost structural limitations. Core competencies is sixth important factor when considered the results as per expert's point of view, tech will either augment the current core competencies in more efficient way and will create new areas where firms can further develop new or enhance their existing core competencies possibilities. Eight most affected parament is distribution channels, Tech like industrial internet of things really improve the ability of 'enterprise resource planning' ERP systems within the supply chain and logistics however this is branch where the frame work for the smart factory is already begun at small scale level as per respondents but it still doesn't portray that advance robotic and drone like environment as per concept principality. Lastly the ninth most effected according to change emphasis is target customers, as per obtained findings the low percentage for target customers were due to reasons that it's not directly influence or affect element within business model due to IIOT according to the sample, especially when we take B2C customers in account rather B2B, which is somewhat still affected. Rationale behind this low percentage tell it's not significant because customer expectation will be reflective of what firms can offer, the concept IIOT itself work as optimizer and submerges the different scopes of business and technology together turning business environment into smart system.

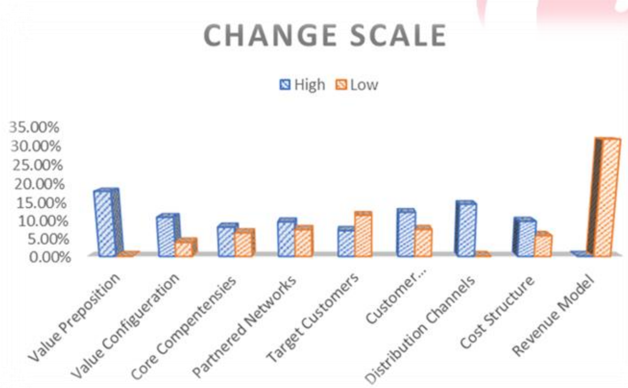

Figure O9, Source: Primary Data self-representation

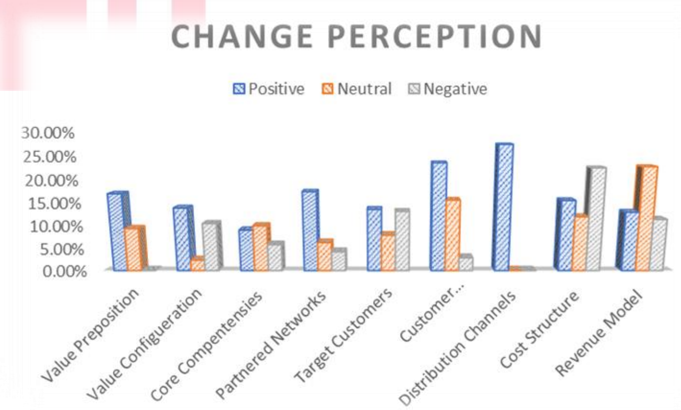

Figure O10, Source: Primary Data self-representation

The *figure O9* and *O10*, determine change emphasis in terms of scale 'High to low' i.e. how respondents identify the change in terms of high or low scale, if rather they suggest abrupt or large changes from current setups or small scale changes for each business model element and in *figure O10* there is analysis of statements reflection made by the sample group either it reflected positive, neutral, or negative statements and in what terms these each statements were said for specific element and what we can interpret from these statements about nine business model parameters for manufacturing businesses for advisory purposes.

Following are some notable statement interpretations from the interviews for each specific business model elements, which specifies High or low scale changes based on data and also identify combined statements coverage area in percentage these statements reflect three stances either positive, neutral and, negative or combination regarding each business model parameters. Please note that percentage coverage area mentioned in bullet points is from change perception not from the change scale.

Value Preposition

- High scale changes with coverage area of 26.3% due to new enabling possibilities to create, capture and deliver the value.
- Enhancement of production capabilities and broader customer targeting is important factor
- Data intensive environment will add traits like mass customization and more personalized value delivery
- Reactive or incremental approach is suggested due to technology maturity issues at the current time periods.

Value Configuration

- High scale changes with coverage area of 26.7% due to new platforms that might need additional adjustments to current systems and as well as labor expertise requirements
- New systems will augment or replace the old systems hence result in much better service and process handling
- Human resources will have to look into IT related advance expertise within their workforce profiles
- Might take longer time period to adjust to complex technologies processes in technical terms, Firms less involved with advance systems will likely to struggle in the process.
- Managerial role will be critical in large organizations for change implementation that wrongly reflect job replacement or cuts due to automated systems.

Core Competencies

- Subordinate role with coverage area of 24.7% when compared to change scale with rest of the elements.
- Much of the task will be either augmented or replaced by automated process
- Artificial intelligence will play important role in altering the core competencies
- The process of developing core competencies along with smart AI systems will be sequential and time taking
- Outsourcing is one of the alternative suggested to keep managerial scale of functions workable

Partnered networks

- High scale changes with coverage area of 28% due new implementational requirements and need for uniformed configurations within the partner networks, as well as volume significance.
- Technology will facilitate transparent connection within horizontal value chain functions and will play significant role in their interconnection on a same uniformed network
- High number of partner collaborations is anticipated for reasons like technology implementation, smooth communication alignments within the supply chain.
- Easy and more enriched communication enabled by smart techs will optimize the information transfer and negotiation patterns.
- Some business segments of customer's interaction will not likely to be affected by the new smart tech associated with IIOT

Target Customers

- Subordinate changes with a coverage area of 25.7% due to IIOT smart technologies for industrial process, this is least effected parameter.
- Better product quality, service and, utilization is expected due to highly data intensive process monitoring.

- Post service likely to improve regarding product or service malfunctioning issues.
- Information privacy is one of the critical factor that might off-set full potential of the smart technologies.
- B2C customers are unlikely to be effected, B2B customers will affect only in terms of process accessibility and transparency.

Customer Relationships

- subordinate changes with a coverage area of 42% due to new patterns of communication and engagements.
- Self-service will be thoroughly adopted as per suggestions due to smart automated systems
- More convenient models will be adopted for better engagement for instance, virtual reality support for real time issues etc.
- Active transparent, self-aware responsive communication will be end results of smart technology
- Some uniform adaption and configuration issues might be persistent due to variety of solutions of same sort available in the market.

Distribution channels

- Major changes with a coverage area of 27.4% due to supportive infrastructural requirements for smart technologies
- Transparent processes, active monitoring of value transfer, self-adapt systems will augment the distribution channels.
- More cloud based scalable approach options will be enabled by smart techs, which will supplement current ERP systems.

Cost Structure

- Unsure of the scale of change with a coverage area of 50% but significant change in terms of initial investments and cost reduction
- Smart AI based technology will be luxury to afford, hence it will be very expensive to acquire on mass scale as per educated assumptions.
- Current smart systems don’t signify cost reduction due to small scale utilization.
- Cost reduction in terms material wastage, labor error is emphasized the most.
- Maintenance cost will be significant but less likely to create technical hurdles due to self-aware and self-adapt nature of systems.
- Cost will rise in terms of hiring high skilled experts or supervisors in large proportion.
- Cost minimization possibilities will be created as tech incorporates more advance features.

Revenue Model

- Unsure of scale with a coverage area of 47% but much appreciative stance due smart tech ability to gauge ‘value’ and capacity building traits for faster ‘time to the market’.
- More focus towards engineering and production for revenue generation.
- Smart utilization of resources will complement the flexible revenue model.
- Earlier adoption will be better for revenue model familiarity and workability.

Figure O11, gives us brief insights about manufacturing industry outtake about how the business model will be affected due Industrial internet of things we took out most prominent aspect from the data and arguments from the study that was already conducted which was based on the interviews conducted with manufacturers from different manufacturing backgrounds (Arnold et al., 2016).

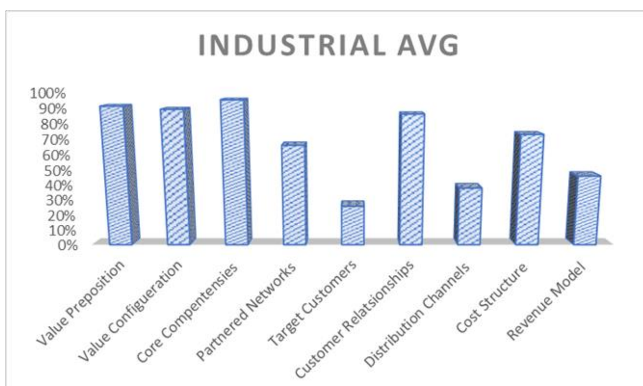

Figure O11, Source: (Arnold et al., 2016) – Self representation

Value proposition, almost all industrial sample believes that value proposition will likely to be affected with IIOT and changes will be terms optimization of processes for production and customers. Medical engineering, ICT companies, and electrical engineering will have high scale alterations. Data mining and analytics will be a catalyst for this substantial change. IIOT is expected to be modifying the particular manufacturing activities for all the industries as part of *value configuration* process. *Core competencies* is also acknowledging to be highly affected by IIOT triggered changes, most significantly in medical engineering, electrical engineering, etc. *Partner networks* are not notified as significant factor for IIOT triggered changes in comparison with components mentioned above. However, IT service provider roles were considered important. *Target customers* had minor importance in context of IIOT triggered changes within entire multi-industry sample. *Relationships* had high importance in terms intensification and requirement. *Distribution channels* where also not consider as significantly affected by IIOT along with target customers. *Cost structure* held importance in much of industrial sample for instance 80% of automotive suppliers, medical engineering and electrical engineering companies anticipate alterations due to IIOT. Lastly *Revenue model* also didn't hold much of importance among manufacturing industries within the context IIOT triggered changes (Arnold et al., 2016).

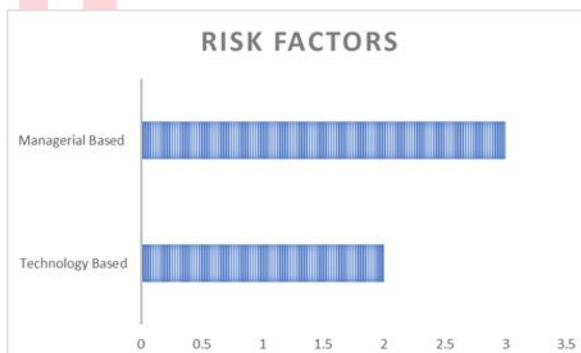

Figure O12, Primary data – self representation.

In addition, referring to *figure O12* some further information regarding associated risks with 'Industry 4.0' or 'Industrial internet of things' as analyzed from the coded content was interpreted, as per sample analysis managerial risks were highlighted more than technology based risk. Although the most critical risk i.e. cyber security was most noted able among rest which classify as technology based risk, configuration issues, high maintenance cost, perception regarding AI/automation and bureaucratic approach within large firms are some of the risk associated in combination. However, all of the sample agrees on long time frame of 10 plus years for industry 4.0 to become a reality or workable in practical terms. Strong sense of unclarity with overall functioning outcome of the IIOT concept was also acknowledged based on their clients reviews and self-experiences with similar projects along with market awareness.

CHAPTER 6

DISSCUSSION & CONCLUESION

As mentioned from reported findings the entire catalog of data set consisting of primary and secondary data, there are many interesting insights regarding how the smart tech of industry 4.0 will change the business model's elements/components for the future development. However, some of the most significant findings were highlighted and further discussed in a comparison with secondary data models from previous study on the similar topic and managerial literature.

First it was observed that tech-based experts and managerial consultants mostly referred IIOT based advancements just as 'operational optimizers' in terms for business processes rather than competitive advantage in current time periods, which adds a developing point to the IIOT based arguments given by Rüßmann et al., (2015) & Kopetz, (2011) which reflected forming of competitive advantage due IIOT based alterations. However, competitive advantage due IIOT was acknowledged on subordinate terms by the consultants which can be a possibility in long run but on many cases in literature IIOT was referred to processes optimization rather a means to attain competitive advantage for instance Gilchrist (2016b), Givehchi et al. (2013), Xia et al. (2012) & Kagermann et al. (2013) they all notified upgradations in sense of process improvements. More over proactive approach towards IIOT based advancements were advised due to reasons that early adopters will help develop the IIOT related tech according to their specific requirements which aligns with what (Bulger et al., 2014; Ramsauer, 2013; Keil et al., 2016) suggested in regards to IIOT related alteration in value configuration and core competencies. Furthermore, it was observed that adoption for IIOT based advancements should be considered at horizontal chain functions rather vertical chain functions, although some of the authors do signifies importance of collaboration across the value chain for instance (Arnold et al. 2016; Brettel et al., 2014; Kagermann, 2015) they all hint towards horizontal value chain collaborations. This validates the point that IIOT based advancements should be initiated within horizontal value chain but of course vertical chain functions are also essential to facilitate these advancements, as learned that IIOT works as one collective system under the value chains rather isolated processes.

According to comparative analysis it was observed that there were some anomalies regarding business model element's change perceptions among two observed groups, first our sample suggested *partnered networks* as the most effected element and the secondary data suggested it to have just a sub-ordinate role. To understand this variation in the clear manner some of the pre-requist notions were bought forward in the context before argument, technological and managerial consultants believe that partner networks will alter the most from the way they are operating in current setups for the manufacturing firms. When the interview was conducted, it was make sure that respondents were talking in context of manufacturing firm's business models that will be effected by Industrial internet of things IIOT or any other smart associated technology of industry 4.0 which clears that case reason for high change emphasis percentage for partner networks was not because of their professional affiliation as consultants for these firms. However, there were two logical reasons behind the relative high change emphasis that was based on transformational aspects of IIOT and post concerns regarding smart industrial format. Role for IT based firms in a sense of collaboration and partnership is emphasized in the research works which explained how industry 4. will function or will be executed (PwC, 2016; Brettel et al., 2014; Porter et al, 2015). It was observed that current manufacturing firms will have to heavily rely on partnered networks specially with IT based firms for implementation of the ICT based transformations for their plants or processes and since such advance tech related skills are still scare within the market or the manufacturing firms themselves. Initiating the smart factory will require collaborations from the IT based firms. As per discussed BM model, partner networks are concerns on value configuration and value configuration relies on Core competencies (Osterwalder, Pigneur, & Tucci, 2005), which gives us good reasoning that why partner networks are emphasized by the experts. Since, it will take time for manufacturing firms to develop such novel expertise or core competencies which will require active collaboration in an implantation phase. IIOT has a broad effect on each parameter as observed most of the time when 'industry 4.0' is referred which is still considered as a buzz word within manufacturing industry. Hence, reflection on the concept is taken from a point where smart industry already exists or in imaginative context but not in real terms. Secondly why partnered networks will be significant because once you have smart setup, you would require your supplier and all connected nodes with this smart setup to be capable enough of receiving and processing the autonomously transmitted information by smart systems and will require appropriate response in the similar digital manner, just how network operates in general terms. However, this task will be challenging in terms of configurational issues and supplier's digital capacity. This argument is backed by IIOT based requirements on mentioned in chapter 1 and 3 (Givehchi et al., 2013; MacDougall, 2014; Brettel et al. 2014; Kiel et al. 2016).

There were some important insights made about rest of the business model components as well but they were almost aligned to the pervious findings which reflect validation on similar grounds among consultants and manufacturing professional. Some of the highlights from primary data are mentioned under the *table O13* below which are validated with existing literature and models.

Partnered networks	Collaboration for IIOT based ICT upgradations & Facilitations	Ramsauer, 2013 Porter et al., 2015 Keil et al., 2016
Value proposition	Mass customization, active monitoring	Matt et al., 2015 Brettel et al., 2014 Porter, & Heppelmann, 2014
Value configuration	IIOT based Augmented systems	Bulger et al., 2014 Kagermann et al., 2015 Kiel et al., 2016
Customer relationships	Synchronized in product & service designs	Keil et al., 2016 Brettel et al., 2014 Kagermann et al., 2015
Cost structure	Optimized in terms of industrial processes	Posada et al., 2015 PwC, 2016 Davis et al., 2012
Core competencies	Supervision & enhanced skills	Keil et al., 2016 Arnold et al., 2016 PwC, 2016
Distributed channel	Automated & Transparent	Keil et al., 2016 Frostner et al., 2014
Revenue model	Flexible & innovative	Keil et al., 2016 Fleisch et al., 2014
Target customers	Broader segments	Porter, & Heppelmann, 2014

Table O13 – Business components alterations due to IIOT enablers.

However, there is some generalization for each manufacturing sectors as each manufacturing sector works differently but from the smart technological perspective which acts in a similar pattern we further elaborated IIOT based technology changes as per our sample's best understanding and experiences.

Industrial internet of things IIOT associated technologies will impact on the business model elements at various specific levels and will create new possibilities for novel value offerings and platforms for revenue flows associated with digital based production etc. which confirms **(**Porter, & Heppelmann, 2014) arguments regarding new business model ideas and predictive monitoring. Interestingly it was also observed under the context of the selected respondent sample that how multiple elements indicated the patterns towards mass customization and personalized offerings as potential enabler for the manufacturing firm's due to smart technologies of IIOT. Business model's elements like value proposition, distribution channels, target customers and, customer relationships all will be augmented with mass-customization based traits or capacities. It's also identified due to enabling features of 'big data' analytics which create possibilities for data mining and analysis, which enable appropriate information to be actively be monitored in terms of feedback/adaption and more over production based AM technologies like 3D printers also built capacity for more customizable designs on a uniform production line as authors (Davis et al., 2012) & (Kalva, 2015) proposed in literature. However, such advantages are still under process to get more feasible and attainable as technology matures with time to facilitate large scale production or services augmentation, in this regards Artificial intelligence AI was also brought up by experts as disruptive technology that will play a critical role for alterations within the business models not only in terms of production but also services, these two aspects will highly be effected with AI as it gets more potent to solve complex procedures and responses which proves that some technologies still need development time as argued by (PwC, 2016) & (Muehlhauser, 2013), It will highly affect element 'core competences' of business model, one of the respondent went as far as saying that "*the financial services and related workforce will also be replaced by AI which is area mostly people are not talking about*" – Strategy expert *(classified)*. Which signifies that much of these disruptive IIOT based techs will result into the shift in the job roles within the manufacturing firms, many jobs roles will be augmented with AI like smart systems and although the human operators will be still significant but will require more expertise knowledge in IT and for supervisory roles within the plants and across the vertical chain. This has been acknowledged by (Gilchrist, 2016a/b) & (Arnold, & Daniel, 2016) that the importance for IT based skills will be high in demand in future for supporting the smart factories and processes alike within the industry.

Smart scale-able solutions like 'cloud computing' will affect the cost structure, revenue model, scalable solution will help the ICT based industrial firms to be more efficient in resource utilization and data volume process capacity, this will result into smarter service and model designs. Such benefits were also being discussed within the previous study from authors (Ramsauer, 2013) & (Davis et al., 2012). Uncertain factors involving tech related and managerial specific risk were also notified, although the most highlight risk was associated with 'cyber security' which has been also acknowledged by authors (Arnold, & Daniel, 2016) under their study where they concluded the same cyber risk as critical concern for most of the industrialist in relation to IIOT based alterations, thus validating the critical nature of the risk in IIOT related environment. Lastly, it was observed that industry 4.0 or IIOT related technologies are acknowledge as disruptive as mentioned and discussed earlier, which give us good understanding that IIOT related alteration on BM are abrupt and radical. This is referred as innovative based change as per study by (Calia et al., 2007) & (Chesbrough, 2010) thus proving that IIOT do innovate business models by altering its components.

MANAGERIAL INFERENCES

Giving the conclusive outlook to the presented empirical findings and apposite management literature for the multiple case study which was undertaken with the help of advisory suggestions from experts, following critical implicative statements for the firms that will be looking into adapting their Business models to the new industrial format of industry 4.0 or IIOT

1. Partner networks, for instance with IT service providers, will have significant and critical role in the implementation phase for IIOT based business model, these collaborations will have to be reliable and secure due to high importance. Further collaboration will help firms to mature IIOT based smart ICT platforms according to their specific needs and capacity.
2. Firms are advised to have incremental and proactive approach towards the smart systems upgradations, i.e. to implement the systems according to their configurational setups to avoid complexity and de-configuration issues within their value chains. All the advancement should be sequential and well synchronized with its vertical and horizontal

chain functions. Making sure all connecting nodes and stakeholders can cope up with these advancements.

3. Human resource will have to cope up with new requirements and changing job roles and have to be aligned with the IIOT related advancements within other departments or units. More supervision related task will be required much more in multiple departments. It is also advice to the firms, to generate such expertise within their IT departments and initiate efforts to build knowledge around IIOT related subjects.
4. It is acknowledged that IIOT will have high initial cost during the implementational phase but it will also provide feasible opportunity for cost reduction in the later stage when it is well aligned and connected with all the other systems within the operations. Positive attitude is required towards pledging investments for such IIOT based advancements and with expected cost minimization outcomes.
5. Firms which will be concerned with IIOT are advised to be well-aware of data protection and security actions to make sure the safety of production systems form illicit designs of hackers which can result into data destruction, manipulation, and even halted production. Furthermore, Firm should also pre-define its data handling, sharing, and processing policies with it all appropriate stakeholders to keep integrity of its data access and protection.
6. Firms which will opt for IIOT will not only require to alter infrastructure to benefit from such smart processes but will also require to alter the organizational culture that promote digitalization and share benefits of such advancement.

Hoping that these findings and recommendations based on business model changes due to IIOT based enablers and advisory insights will support the concerned supervisory practitioners in their future proceedings.

P.T.O

RESEARCH INSINUATIONS

The research topic serves it purpose as creating additional understanding base for the ongoing research on Industry 4.0 related changes within the industries across the world, this study helps to discuss the changes that will likely to occur in the business models in the future and how these business models will change with new enablers of industry 4.0 to extent of the knowledge we have currently. The topic was overviewed from tech-based and managerial consultant's perspective and this study was then compared with the knowledge that was available as perception of manufacturing industry and by doing such comparison the new context was added to the existing knowledge with the help of collected empirical findings. Hoping that it further clarifies the case and build upon already solid concept, it was identified that the partnered networks will be dominant factor prone to alterations based on new enablers and list of advisory acknowledgments based on the expert's point of views for the manufacturing firms that will be interested to invest in IIOT related technologies. It was identified that the adoption will be sequential and will be according to overall industrial involvement as a combine uniform pattern, this will create new collaborations with external value-adding partners, cost efficiency will be depended upon actual utilization and maturity of the IIOT related smart technologies within these manufacturing firms.

However, due to the reason that research is qualitative in nature, the result was prone to have some limitations. The topic at hand is still very new to the industry that is reason some of the content can have general outlook but it still signifies the focused direction nonetheless, which helps to further validate given information. According to sampling logic imitations (Yin, 2013) the arguments revolve around identification and explanation of the observed patterns that cause business model's elements to alter due to IIOT related enabling technologies. This research has taken recommendations from work done by (Arnold et al. 2016) in a similar context but with entirely different primary data sample, which gave us solid grounds to further develop proposed idea. For the future findings, it will be appropriate to simulate given advisory recommendations within the manufacturing firms of specific sectors and analyze the feasibility in real time environment. Furthermore, topics such as risk factors associated with IIOT ecosystems related alterations, Industrial Internet of services IIOS which reflects the service oriented topics regarding smart factory and processes (Wells et al., 2014) & (Jammes et al., 2005) could also be studied in order to further cover the ambiguous areas within this field. Some of the subordinate IIOT associated topics as per some tech-experts, ‘cyber data utilization’ will be also a critical topic to look into as these are areas which are less worked upon and the actual systems which will incorporate such attributes don’t exists in an abundant manner within the industries yet but that doesn’t weigh down the importance of the subject relevance and feasibility because similar recommendations exist in the literature (Liu et al., 2012).

Hoping that this study contributes a better understanding of Industry 4.0 and its effects on the current business models within manufacturing from consultancy point of view, adding valuable context to the existing knowledge.

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APPENDIX

Value Proposition	The overview of Firm's range of products and services.
Target Customer	The segments of customers that firm normally generate value for.
Relationships	Describes the type of links a firm maintain with its various customer segments.
Distribution Channel	Explains different means that firm uses to connect with its customers
Partner Network	illustrates the collaborative network agreements with other firms required for offering and commercialize value
Core Competency	Determine the competencies must required in order to execute firm's BM
Value Configuration	Determine how activities and resources are arranged
Cost Structure	Portrays the monetary consequences of the activities opted in BM
Revenue Model	Explain the way a firms makes revenue through various transactions

Figure O1 the nine components of Business Model. (Osterwalder et al, (2005). – Self representation.

<u>PRIMARY CODED DATA FIGURES</u>:

Parameters BSN	High	Low
Value Proposition	17.78%	0%
Value Configuration	10.75%	3.85%
Core Competencies	8.07%	6.49%
Partnered Networks	9.51%	7.39%
Target Customers	7.11%	11.29%
Customer Relationships	12.13%	7.43%
Distribution Channels	14.33%	0%
Cost Structure	9.68%	5.73%
Revenue Model	0%	31.48%

Change Scale Values (Content Area Coverage) – Nvivo 11

9 BSN P	Positive	Neutral	Negative
Value Proposition	16.95%	9.35%	0%
Value Configuration	13.86%	2.34%	10.45%
Core Competencies	9.00%	9.95%	5.79%
Partnered Networks	17.39%	6.27%	4.22%
Target Customers	13.56%	7.91%	13.11%
Customer Relationships	23.55%	15.58%	2.86%
Distribution Channels	27.42%	0%	0%
Cost Structure	15.50%	11.93%	22.48%
Revenue Model	12.92%	22.72%	11.38%

Statement related content coverage area – Nvivo 11

BSN 9 P	Value
Value Proposition	18.13%
Value Configuration	15.98%
Core Competencies	8.30%
Partnered Networks	18.51%
Target Customers	3.80%
Customer Relationships	9.39%
Distribution Channels	8.16%
Cost Structure	9.25%
Revenue Model	7.99%

Change Emphasis, Content area coverage Values – Nvivo 11

REFELECTION NOTE

The topic I worked upon holds very high significance within the industry around global as smart scientific applications are being made more incorporated within industrial processes more than it was ever before. Well known survey companies have highlighted large investments within this field area of ‘industry 4.0’, which validates the importance and trend focus[i]. This 4th revolution within the industry will have its impact internationally, it will alter the dimensions of industry’s ability to create, respond and formulate the new possibilities for its clients all around the world. It will affect the global community in many optimized conducts to name few the industrial wastage will be reduced, mass customization will be achieved, labors skills and process adoption will be improved, customer experiences will be enhanced on personal levels, analytical ability of the firms will give birth to new innovative business models based on high end flexibility and agility. Industrial internet of things IIOT concept is divided under various factions for instance, smart process, smart factory, smart facilities and smart city. Industrial internet of things IIOT based enablers are one of the main facilitators for such smart augmentation with the help of sensory data, which will turn industrial objects into communicating self-aware components within the large network of industrial processes. This will enhance capabilities of the firms within many different sectors due to its smart infrastructure and products alike. Active monitoring with data transparency will facilitate firms to be smarter with customer’s offerings and processes prioritizing within its business scope. When you combine the possibilities of industrial 4th revolution you are not only altering the way you see how businesses around the world will be affected but also cities itself and this not end here you are altering the perception of current capabilities of inter-planetary missions which is next step for humanity. In simple words Industry 4.0 is positive advocate for globalization, business optimization and humans’ cosmos related capacity from what was learned from this topic.

Since this topic is still very new within the academic and industrial sphere, there are a lot of limitations involved when researching regarding topics within the whole concept, my study act just as validation to already inductive research from a different angle of scope which adds more context to what we already know and in order to reduce the ambiguous elements within the researched topic. I struggle at times with content literature and primary data methods since very less people have concrete idea or experience with IIOT’s proper framework, many experienced people put down the requests for interviews due to lack of enough knowledge to comment on it in a detailed manner. However, fortunately I did manage to get some experts from internationally renowned institutions and firms for the comments. Most of observed sample was familiar but was in early adopting phase of the implementation and at many points they couldn't picture the complete impact due lack of active real-life examples, point to make is that much of the concepts about industry 4.0 is still much academic based rather practical based, people still view it more like a buzz word than something they actually seek to obtain within their business operational boundaries. There is much to studied about how the implementation will be mapped out first and then we can reflect on the actual expectations and perceptions knowledgeability based on active examples. With my experience with the topic it became clear to me at later stages that this is a very long-term investment and will be initiated in step wise procedure or minor projects rather abrupt, although the technologies it incorporates brings some abrupt changes within the process of the business but firms can't afford such large scale infrastructural and mental change with the absence of market requirement, there is much risks and uncertainty involved. Knowing the bounding factors attached with the concept but initiation has to start somewhere even if minor in scale and such approach is also being suggested by managerial experts that were interviewed. The problem doesn't end here when you look at the topic with a critical view you have to reflect on implications and post-effects or issues, 'cyber security' was one of the main issue many experts notified to be a huge hurdle to the concept for instance we have recent example cyber-attack on 5/12/2015 from anonymous source that halted the operations from different industrial sectors and demanded ransom in order to revive their systems from a hostage situation[ii], this very critical when you imagen an industry or firm working under IIOT principles because their entire functionality from finance to manufacturing are all inter-connected on network which can be breach able unless a solid system exists to counter weight such illicit attempts.

With my experience with the thesis, I came across many interesting novel topics which often dragged me to different paths due to its interesting profile, however, learned in order to research we have to be well prepared with our content accessibility approach although admittingly it is hard to do so when you are very initial in the study but it does help to keep the linear focus towards specified goal. I believe, what was created as knowledge will be beneficiary towards all the stakeholders and will contribute as step forward within the specified industrial sector. I would like thank my supervisor, tutorial guides offered by university and the business school to let me be part of this entire learning experience, this was worthful accumulation to my skills set.

[i] PwC. (2016). Industry 4.0. Retrieved Feb 04, 2017, from Global Industry 4.0 Survey http://www.pwc.com/gx/en/industries/industry-4.0.html2016

[ii] Press, T. A. (2017, May 12). Cyberattack Shuts Down Hospitals, Telecoms Around The Globe. Retrieved May 15, 2017, from http://www.huffingtonpost.ca/2017/05/12/global-extortion-cyberattack-hits-dozens-of-nations_n_16582372.html