Analysis on implementation of Lean tools and techniques in IT engineering service industry in Ireland

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Declaration

I, Ruchira Kulshreshtha, declare that this research is my original work and that it has never been presented to any institution or university for the award of Degree or Diploma. In addition, I have referenced correctly all literature and sources used in this work and this work is fully compliant with the Dublin Business School's academic honesty policy.

Signed: Ruchira Kulshreshtha

Date: 7-Jan-2019

Abstract

The research titled ‘ Analysis on implementation of Lean tools and techniques in IT engineering service industry in Ireland ’ tried to understand how the lean principles in manufacturing industries are being applied in service oriented firm. The first chapter lays down the importance of the lean evolution, and its criticality in improving the efficiency of the service delivery process for the customers. The IT engineering service sector has emerged strongly as the PLC (product life cycle) of IT has progressed over the years. For Ireland the rationale to conduct the research is appropriate as it tops in Europe in terms of IT, ITES and IT engineering service MNCs firms operating in that region. The research aims, objectives and questions are laid out with research chapter briefs at the end of chapter one. The second chapter unfolds with the literature review, the concept of lean, principles behind it, the description and structure of the IT engineering services sector, lean appropriateness in this sector, lean in services. The research gap is evident as there is no significant study to corroborate as to how lean impacts the services in IT engineering services in Ireland. The research methodology shows the choice of primary research agenda given the nature of the research topic with sample size limited to six managers of different Irish IT engineering firms as a convenient sample. The open ended questionnaire helped to capture the status of lean, the application methods, implementation barriers, type of lean tools applied. The recorded interview made into transcripts was analysed in chapter four. It showed that managers involved in lean has been focussing on the process efficiency with lesser manpower, lesser time and cost parameters to manage. However, VSM emerged as a favourite tool, with Ishikawa, ‘5Whys’ to confront the challenge and problems in operations. The next chapter discussed about how the lean in services sector has helped to link design and delivery to be shortened to manage cost and time issues. The conclusion in the last chapter shows that lean has been adopted but requires consistent efforts as dynamics of services have threats and risks involved. Higher level lean tools like FMEA to identify the failure or disruption of IT engineering service is critical to the firm survival. The gaps is about responsiveness that Irish firms in this sector lacks, and an elaborate recommendation has been outlined based on best practices from consulting firms.

Acknowledgement

I am thankful to my research supervisor, Prof. Paul Taaffe, whose encouragement, guidance and support from the initial phase of topic selection and literature review guidance has led me to the final stage. I am thankful to everyone else in whatever form of help that they have provided to me reach the final level enabled me to develop an understanding of lean in services.

subject with emphasis on IT engineering services in Ireland. I would also like to thank my parents for their constant inspiration and my close friends for their advisory and contribution for the research.

Last but not the least, I would like to thanks all the respondents who have given their precious time for making this study valuable for the industry.

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Abbreviations:

FMEA – Failure mode effects analysis

CI - continuous improvement

TPS – Toyota production system

JIT – Just in time

VSM - value stream mapping

SIPOC- suppliers input process output customers

KPI – Key performance indicators.

CMMI -capability maturity model integration

QMS- quality management systems

VOC - voice of customer

CTQ - critical to quality

BCP -business continuity process

RFT - right first time

MNC – Multinational corporation

GDP – Gross domestic product

RFP - request for proposal

VoIP - voice over internet protocol

BPO - business process outsourcing

SME - small and medium enterprises

GSCM -global supply chain management

Chapter One

Introduction

1.Background:

The businesses have moved from product centric to service centric platform, aligning their operations to meet the customer expectation sets (Sundar et al. 2014). The application of lean from their earliest origins in Toyota production and manufacturing industry in Japan (Liker, 2004), has evolved over the years in terms of the range and depth of deployment. The industry wide application of lean is based on the lean principles based approaches that are adapted to the business sector and work environment, to achieve the desired outcomes in the respective sector. Staats et al. (2011) explained that lean principles focuses on maximising the production process velocity, as it uses the tools and techniques to analyse the process capability, process flow and eliminate the delays in each activity. Lean approach is a quantified metrics and made complexity to be resolved with the value added and non value added distinctions of work activities. The importance of lean in the IT engineering service sector emerged as it is an industry that uses knowledge of programmers, complex iterations in project delivery environment which needs to justify the return on invested capital (Jeyaraman and Kee Teo, 2010). In businesses, that is labour intensive, the cost of people to rationalise wages in servicing clients therefore needed tools and techniques. Lean as a technology that fits the quality parameters or address issues of cost or speed showed the versatility in terms of application shifting beyond the manufacturing domain, extending to stakeholders, and fine tuning the operations process (Sousa and Voss, 2001).

The IT engineering service which serves the client base, though have huge opportunity in project management and billing, as it is challenged by cost of services that forms (30-80)% waste. Especially in IT services environment, that has innumerable cross functional ,departmental, work practices complexities for production and operations goals to be met, the need for a solution centric improvement to meet the customer expectation set is the core issue. As the industry life cycle in IT matured, the development of IT hardware industry gave way to more prominent, the IT service desk over VoIP (voice over internet protocol). This helped in ushering outsourcing of jobs to different continents and BPO (business process outsourcing) for technical, non technical, ecommerce production got a boost. The fundamental premise is to take advantage of global labour wage differentials with similar

educational qualifications which is served by a different continent (country) that is able to meet the business purpose. The IT infrastructure service provider, managed service providers offered services for retail to corporate clients 24X7X365 that exploited the new dimensions of technological advancements. Though the IT service sector had embraced automation, businesses however are fraught with a range of issues therefore the ability in providing varied kind of IT service assistance that meets customer requirement criteria is important. Keyte and Locher (2016) stated that some of the bigger challenges is IT product management, and communication within and outside to counter the customer feedback for bringing in change in the outcomes. The firms in this sector are trying to improve the productivity and profitability, faster time to market the IT product or IT service. Therefore the importance of IT production practices that has quality embedded in software programming and coding, used lean methodology, ISO audits, deployed six sigma (Pepper and Spedding, 2010), agile practices (Ramesh *et al.* 2006) that helped this sector emerge strongly. The IT engineering services firms selling hardware and software along with dedicated services found competitive advantage in managing labour and knowledge intensive industry to streamline for greater productivity, profits for business viability. The use of lean is most prominent as it changes the production parameters and output, to meet the project deadlines in any industry sector (Shah and Ward, 2007). The inclusivity of lean techniques and six sigma and their outcomes borrowed from the different sectors is yet to be tested for the operational yield in maximising the business capabilities. Businesses including IT sector are constantly trying to reduce cost, time and effort equation by analysing their production outcomes which is closely linked to the level the customer experiences (Schutta, 2005).

Middleton and Sutton (2005) argued that the firms are also looking to reduce errors and increase the quality level of IT processing capability that pertains to higher level of customer satisfaction, business efficiency which is related to the operations input output paradigm. Lean based adoption practices that rest on indentifying the value criteria in the customer wants, actions adopted has been done in IT sector with mapping the value stream function that identifies those actions and activities meant for higher customer satisfaction. For an IT domain, that has service centric production process, creating a continuous flow by demand (pull) centric operations in the production system is important. It stresses the capability of the business environment positively . This research aims in understanding in greater depth the practices followed in implementation of lean tools and techniques specifically in the IT

engineering service sector. The aim of the research with particular reference in Ireland, needs to be justified which is discussed in the next section.

1.1Research Rationale:

The research is important as technology sector in Ireland deploys over 105,000, in over 900 firms that has 75% MNCs operating in the country (Irish IT industry, 2018). The remaining independent Irish IT firms have been rapidly diversifying into a global technology hub that is together contributing to the nation's rank as the second largest exporter of IT services and computers after Silicon Valley in USA (Riain, 1997). Around 40% of Irish GDP (Euro 72 billion) is from technology sector (Irish IT software industry, 2018).

The research therefore is appropriate as the IT industry in Ireland needs to be competitive in terms of IT engineering service delivery that is the mainstay of the Irish IT industry. Irish IT industry (2018) stated that the IT firms in Ireland are using the local talent and have been quite successful in terms of IT business which is able to meet the national and global customer demands. The Irish industry is poised for a brighter forecast given the labour availability, IT offerings amidst the life cycle curve requires the production centric tools and techniques to achieve greater level of yield that show the capabilities as a firm.

The issue is important for the sector that is maturing and stabilising, the research contribution is significant. The analysis of the level of the Irish IT engineering services leading the nation against its competitors is dependent on several factors when lean principles and practices has already benefitted other sectors. The importance of the research right now therefore is high, as evaluation of best practices would contribute to close the gaps in the practices existing in Irish IT engineering services. It would also help the smaller (SME small and medium enterprises) (Thomas et al. 2008), medium and larger Irish IT firms to learn from different practices in lean domain while trying to improve the time, cost and knowledge triangle in achieving competitive production costs.

1.2Research aims:

To find out and analyse the implementation of lean tools and techniques in IT engineering service industry in Ireland. This is the main research objective which has been further broken into the following research objectives as mentioned below.

1.2.1Research Objectives:

- To find out about lean principles and implementation practices
- To find out the challenges in implementing IT engineering services industry and lean implementation strategy
- To evaluate the appropriateness lean tools and techniques in IT engineering services industry in Ireland
- To find gaps and suggest best practices in lean implementation IT engineering services industry in Ireland

1.2.2Research Questions:

RQ1: What is the current state of adoption and usage of lean principles practices in the software industry?

RQ2: What are the challenges in implementing lean methodology adopted in IT engineering services organizations?

RQ3: Which are the tools and techniques in lean in IT engineering services organizations that benefits in IT engineering services organizations in Ireland ?

RQ4 :Which are the best practices that lean offers in IT engineering services sector that Irish organisations can benefit?

1.3Research scope:

The scope of the research is the upper and the lower limits of the research subject area with respect to the IT engineering service sector and Ireland. The possibility of accomplishing the research aim is dependent on access to the IT engineering service provider companies in Ireland, the identification of the respondent groups, ability of the respondents to comprehend the research aims to their past experience in the Irish company. The criticality of the research achieving the goals is defined by the scope where the access of responses is confidential and with consent in order to achieve the research outcomes. The research scope is also dependent to the extent the research results is illustrated, analysed and comprehended to meet the research aims and objectives.

1.4Thesis structure:

The research is divided into several chapters which is outlined as follows-

Chapter 1- This chapter opens up with the introduction to the topic as how the lean application to the different industry emerged and why IT sector adopted it readily. The chapter also discuss in depth the rationale and justification for pursuing this research topic explaining the whys, what and hows. The research aims, research objectives, research questions is laid down in the process. The scope of the research is outlined in this chapter defining the upper and lower limits of research aims and objectives to be met.

Chapter 2- The literature review chapter two discusses the different theories, models and frameworks that forms the part of this chapter. Lean principles origin in Toyota, the emergence of lean in the services sector, and lean tools that is applied with the different variable they measure. The later stage of the chapter critically discussed about the application of lean in IT, creating value, eliminating the seven wastes in this sector. Attempts are made to align the existing research title to justify the previous research in order to find gaps that forms the hypothesis.

Chapter 3- The research methods are discussed here, as it lays down the design and obstacles to achieve the research aim and objectives. Different stages of research process, like research philosophy, research design, research approach, primary and secondary research methods is discussed with justifications. It finally leads to the proposed choice of methods to collect the data to understand the research problems. The identification of the sample size and its justifications is given to understand the respondent groups that revolve around the research topic and objectives. The choice of the appropriate research instrument is selected for collecting the appropriate data from the Irish IT team. The data collection strategy and data analysis is also laid down in the research methodology chapter, which is the important part for the research process. The limitations and validity of the entire primary data based approach is also highlighted in this chapter.

Chapter 4- The data collected as per the primary research methods is analysed. The research portrays the collated data in the raw form which is processed for better illustration and understanding with perspectives of the research title. The use of graphs, charts, and tabular form of expression is used for discussing and depicting the trends from the respondent's data. The findings and discussions for each question is done with proper justifications and assessed to the extent the hypothesis is met by linking it with the specific studies of authors discussed in the literature review.

Chapter 5- The last and the final chapter of the research outlines the emerging issues and the final conclusion that collates all that is relevant in the responses. The existing gaps found in the research is identified and research objectives are triangulated to meet the research aim. The recommendations are based on the best practices of lean in IT sector, which is recommended for the Irish IT engineering service firms engaged in the study.

1.5 Summary of chapter:

The above elements in the chapter one leads to the next level of literature review where all the past research related to lean principles, practices implementation is discussed and aligned to the IT industry.

Chapter Two

Literature Review

2. Introduction:

The literature review describes the past research that helps the synthesis of the topic with narrowed down approach. The criticality of the theories, models, framework help the discussion about the variables associated in the research to be further probed. The current research uses the lean principle based tools which is applied in a service centric business environment. Therefore, lean is defined, with the explanation of its principles, the eight types of wastes, the implementation of lean at pre and post phases with challenges faced. The sector is defined on which the research is intended, and the categories of the IT engineering service support systems is outlined with multi-tiered support system that has evolved and how lean is deployed in this sector is discussed. The service components and the lean tool adoption as an appropriateness is explained. The IT engineering service is a new domain and the application of the lean in manufacturing sector applied to IT engineering service is discussed below critically requires the lean principles to be tested with Ireland context. Also, In order to put a light on the ethical considerations, It has been made sure that the business ethics are followed without harming any feelings of the people involved.

2.1 Lean definition:

Lean term was used to define the manufacturing principles followed by Toyota in its loom at WorldWar II, also called Toyota Production system (TPS) (Toyota Motor Corporation, 2006). Lean is often linked to the transformation strategy using tools to shift away from old practices toward improvement. Bicheno and Holweg (2009) defined it as a strategic tool towards redefining competitiveness, lean benefits is likely to affect organisations in long term. The word lean was coined by Womack and Jones (2005) which has specific methodologies to transform organisations that has a purpose, process and people supporting it. This helps to define the customer value by minimising the waste systematically, that translates to lesser cost, time, effort deployed to create more value for the customers (Gray, 2007). Hong et al. (2014) argued that the goal of lean in manufacturing process evolved in bringing enterprise level improvements and its application in services sector brought the customer suppliers integration in workflow process to create services delivery to happen on demand, on time. Lean also helps organisations to define and understand the customer value

and design new processes, embedded with activities that are designed to continuously increase it. The lean activities predominantly eliminate the defects or errors, reducing rework and time-cost factor making production process to be streamlined. Consequently, it leads to lesser stoppages, wait times due to defect rework and smoother flow in production at enterprise level is possible. Richerson (1999) argued that it is not a quality certification, a static choice, but a continuous process engaging individuals to bring in improvements in all work processes. The discussion necessitates to understand the principles that govern the lean, which is discussed in the next section.

2.2 Lean principles:

The lean principles actually aids in bringing the changes that focuses on the existing practices significantly. It forces the management functions to separate the actual practices from the technologies, processes with new approaches to same task, where it is able to optimise the flow and create value. Wei (2009) acknowledged that in a production environment (manufacturing or service) lean is able to create processes that can isolate each activity, human contribution, rationalise the cost, time factors, identify and eliminate defects. The five principles of lean is to define value, map it to the value stream, creating flow in the production process, establish pull and monitor/control to pursue perfection.

Piercy and Rich (2009b) argued that lean principles also help to achieve higher quality in output, as faster throughput times using a much simpler and accurate approach to task is possible. Lean defines 'muda' a waste minimisation approach in manufacturing system, 'muri' overburden which is another type of waste, and 'Mura' which is unevenness in the workload and processes. Spear and Bowen (1999) defined the TPS to show four rules which sums up the lean approach to work processes. Firstly, the authors stated that all work needs highly specified, sequenced, interlinked with time stamps and for definitive outcomes. Secondly, they stated customer supplier connection to be short, direct and defined in straight responses without ambiguity. Thirdly, the product and service creation must be simple and direct. Lastly, the fourth point they recommended is that lean is scientific, that is measureable, quantifiable, at macro and micro level operations in any organisation. However, Maleyeff (2006) argued that in order to achieve the above tasks must be specified with roles defined for a failsafe delivery. Communications need to be direct two way process, across hierarchies, departments while production process to follow simple input-process-output paradigm that helps lean to value add and simplify. Lee (2008) added that problems in the firms gets identified and adopting a hypothesis based problem solving methods aids in

systematic elimination of the non valued added activities that reduces time, effort, cost factor. The lean application therefore has more application in the practical sense in the industry, which turns the discussion to understand how organisations are defining value added, non value added work in terms of wastes.

2.3 Seven wastes of lean:

Waste identification is an important part of the improvement process and organisations are trying to define following categories - value added, non value added but needed, non value added and not needed. Staats et al. (2011) argued failure to identify waste is a bigger challenge, and using resources; employees, managers these can be accomplished more effectively. Seddon et al. (2011) argued that for any organisation, in the given work area, defining value is a critical function. Once identified, value added steps is an activity that transforms the operations in that work area to an output as per customer requirements. However, lean states all the above is acceptable when it is also done right first time (RFT). Lee (2008) stated waste is non value added but needs a step to identify along with value identification. Any activity classified as no valued added to the existing production process is a waste and sharing this method amongst all employees, suppliers distributors has helped manufacturing firms to streamline easily. Staats et al. (2011) stated that activities may be 'required' as a compliance issue, legal issue, or customer preference, or 'necessary' due to current requirement. The different types of wastes in lean has been labelled scrap in manufacturing have been expanded as lean application in different industry sectors emerged strongly.

Qu et al. (2011) identified seven types of 'mudas' -

- defects (the effort spend in inspecting the defects and the time taken in fixing it)

- Over processing (which results from poor tool usage, product design related activities)

- Over production (more production against the actual demand)

- waiting (waiting for right moment for next production stage to begin, time-loss during production shift change)

- motion (people or equipment movement required for production processing)

- inventory (items during production, or work in progress WIP)

- transport (movement of products which is not required in performing processing)

The addition to the above, the eighth muda by Womack and Jones (2005) was proposed, as lean application in services domain showed that producing something which is of no use to customer specifications is also a waste. Eliminating all wastes is not possible as production that is continuous is likely to produce a flow and the issue in an IT engineering service that operates (24X365X7) needs further probe. The above lean concepts, principles and types of waste has been proven in other sectors like manufacturing sector which tangible benefits. Therefore the importance of the lean methods, tools in business applications requires more attention that is discussed below.

2.4 Lean implementation strategy:

The link of lean and TPS is evident as organisations wanted to increase quality of output by minimising the defects. The lean approach in mass production in Toyota was possible only due to the typical Japanese management style which is very different from western management concepts and principles. There is a fundamental challenge for employees and management to understand lean concept and adapt to their own organisational area. Hsieh et al. (2010) explained that 'Lack of understanding' is one area as knowledge gap in pre-implementation phase exists, while in the second phase during implementation employer-employee coordination in teams requires a culture factor to overcome lean implementation barriers.

Pre-implementation phase:

Therefore lean is a journey driven by philosophy, and is not a fixed goal (being lean) and deploys a mix of tools to bring around an all-round improvement. Pettersen (2009) stated that there is no fixed lean management implementation process, while Womack and Jones (1996) cited sequence that is important. Lean is viewed as a waste eliminator, and it succeeds only when awareness in organisation spreads. Role of team, employee leader communication level, employee engagement at pre-implementation phase helps to succeed. Planning and scheduling activities 'as is' and setting goals to achieve 'to be' at structural level is needed, while Angelis et al. (2011) argued behavioural scepticism to be avoided especially about benefits.

Implementation stage issues:

Unlike TPS which has two pillars – CI (continuous improvement) and respect for 'people' to build an employer employee long term mutual trust, lean seemed to be too technical approach that focussed on technicality of methodology based application. Womack and Jones (2005)

stated that firstly, lean implementation in any stage of production either in manufacturing or services essentially tries to find 'seeking profit'. The author argued that often lean is more of a tool, intended to measure performance quantified in (time, cost, effort paradigm), in order to realise the benefit. Therefore profit of production and operations translates to flow, pull (demand) embedded with improvement at continuous basis. Secondly, 'tool orientation' of lean is important as value stream mapping (VSM), visual control, standardisation of the work process in the production helps to attack the existing problems (Tapping and Shuker, 2003). Hence, the focus in on 'man, metrics and method ' which the employees use to contain the problem of waste identification, and analysis to chart a path for improvement. This can be linked to business continuity as customer and supplier relationships a part of tactical operations should not be disrupted. Moyano-Fuentes and Sacristán-Díaz (2012) stated implementation evaluation of lean to be assessed, for SIPOC and identify wastes, standards, benchmarks to be compared.

In an IT and ITES organisation, it can be related to downtime, employee skill and competency development, capacity bottlenecks, metrics (KPIs key performance indicators), profits, training issues. Third aspect of lean implementation is related to the 'technique adopted' in order to bring in the change process (intended) in the organisation. The transformation of production system towards pull(demand) driven framework requires the human factor involvement. In an organisational perspective, the concept of development requires the 'soft HR' to aid quality, cost, productivity, safety issues to be resolved. Delbridge and Whitefield (2001) defines implementation as a journey and that application of the lean tools should have sustainable outcomes; though much of it depends on managing external and internal environments.

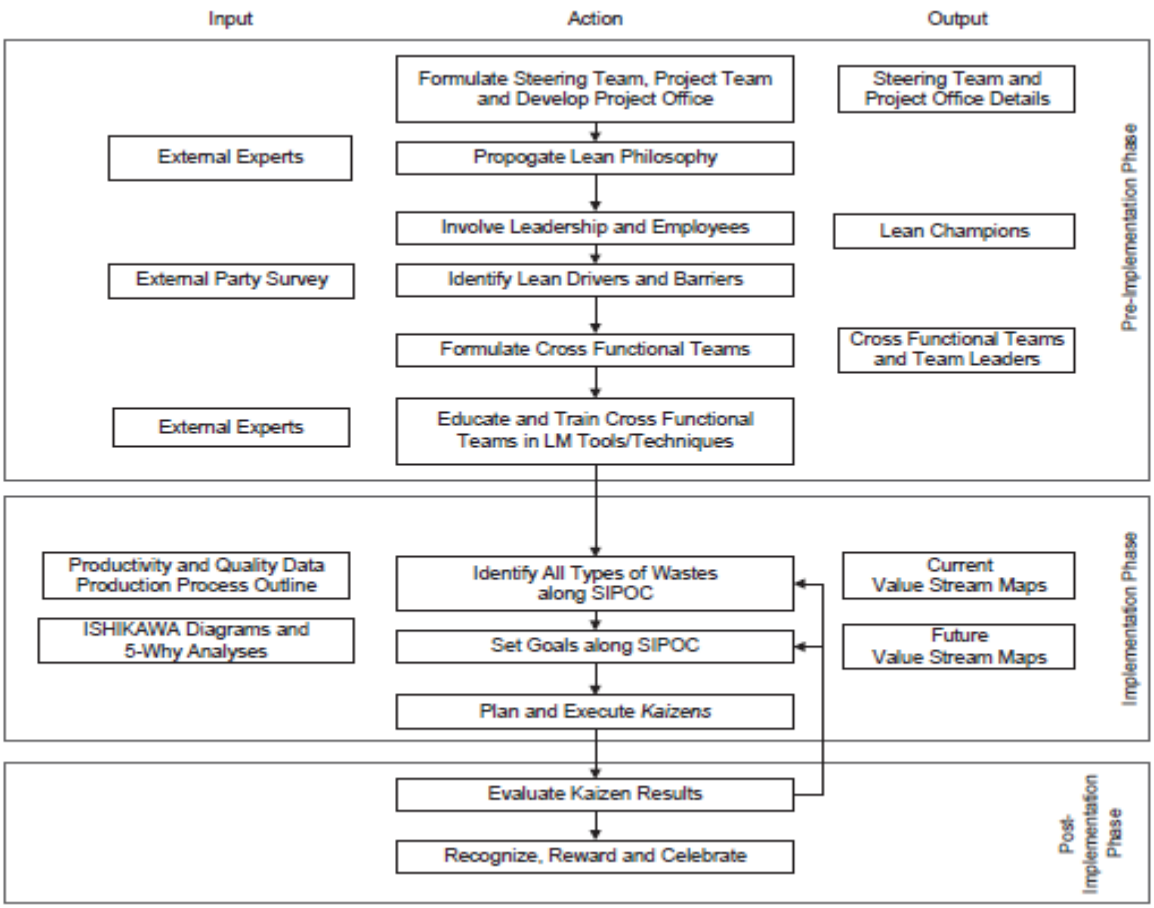

Figure 1: Lean implementation methodology

Source: (Tapping and Shuker, 2003)

Post-implementation phase:

Swank (2003) argued post implementation lean failure in west has been quite frequent, as it requires consistent efforts to perfect rather than to treat it as stop gap arrangement. CI is an issue as it links the probability of degree of lean implementation to be successfully contributing to profitability and waste reduction indicators. Post implementation also requires employees to be patient about the outcome indicators, as it may not match as per expectation of goals set. Ahlstrom (2004) argued about CI as a method involves – challenge, Kaizen and Genchi Genbutsu. The challenge that is immediate and long term for lean to succeed and sustain depends on how employees deal with it. Kaizen is the spirit of continuous innovation at micro level which is evolution for the organisation wide improvement. Lastly, Genchi Genbutsu relates to making right decisions to reach goals at best possible speed. Cuatrecasas (2004) acknowledged that all of these can work better for lean implementation when there is

collaborative team based effort in problem solving and empowerment to improve respective work areas.

In an IT industry which is service centric, the aspect of team work helps to resolve the labour intensive complexities involved and breaking the traditional mindset of top driven approach to a more empowered employee in teams (Cuatrecasas, 2004). Delbridge and Whitefield (2001) confirmed this stating that it helps free flowing knowledge and sharing culture that helps collaboration to aid the problem solving. Conversely, the leadership involvement in traditional form of authoritarian directives also needs to change to make lean implementation to be successful. The greater involvement and dialogue to bridge the gap of employer-employee communication, and shift the supervisory skill level to participatory is related to organisational culture and team environment. It is evident from the above that the lean as new wave to problem solving approach is not easy to implement as it is an all round method, presenting challenges at every stage within organisation which also impacts the suppliers and vendors as well. This discussion now explores the lean in the services sector, that is important to test the applicability and the adaptation challenges in defining the lean principles appropriately.

2.5 Challenges in implementing lean in services sector:

Womack stressed on the 'lean thinking' for every participant in order as lean tools were adapted to service based operations. The author added that waste in manufacturing is more visible while in services it is not so pronounced. Liker and Morgan (2006) argued that against the aggregate business goals and performance parameters, the organisational ability to apply lean principles using different lean tools in service sector has similarity in seeking competitiveness in output as manufacturing sector. Hanna (2007) highlighted that service improvements is dependent on the knowledge factor as the redesign of service delivery model or identify customer service requirement standards requires the organisational level ability to translate the need into a feature which is deliverable. However, Tapping and Shuker (2003) argued that often achieving the intended improvements is difficult as lean delineates from a quality tool. It goes beyond the tactical performance output metric measurement tool but is more strategic in its approach in resolving the operations. Hines et al. (2004) argued lean in services pertains to knowledge work which is very different from manufacturing settings, This is relevant in the IT software design as customer is bound to change it when improvement has happened half way. Thus knowledge is required and in services model in IT, the task uncertainty factor is not limited to the client requirements as satisfaction has a

bigger part added to it. Secondly, knowledge in the work processes and their connections is invisible, that is a challenge for employees, managers to identify problems and resolve them effectively using lean. The research focussed on the IT engineering services sector, which requires a detailed explanation in terms of structures, processes which constitutes it. The next section describes in detail the sector, the type of categories of support that is available, and how multi tiered approach has come as a practice as a need in the industry.

2.6 IT engineering service sector:

The IT engineering service support is provided to the users of the technology products and/or services that have problems in terms of consuming it. The IT helpdesk emerged in 1980s, while the 'IT service desk' concept emerged out of ITIL framework. ITIL defines service desk as a collection of best practices to support the IT service management, which is a single point of contact between the service providers and the customers (retail or corporate). Andres-Lopez et al. (2015) argued that helpdesk contains the basic level tactical ticket functions while the service desk model in IT industry is more matured one that defines, classifies and fulfils it with a strategic approach. Asnan et al. (2015) stated that in order to make the organisation be credible and efficient in providing IT support it should incorporate the values and corporate goals into actionable outcomes that benefits end users. Delbridge (2005) added further that this requires a service strategy, as the service component defines the levels of IT functions aligning business goals and meet customer demands as well. Bicheno and Holweg (2009) stated that in IT, services is a concept of bundle of activities, that is designed to provide value to the customer using value stream mapping.

Following the ITIL core processes, Ming-Te et al. (2013) defined that

i) Service strategy – It needs the corporate to design service offerings, classifying in each segment, what they offer, which benefits the customers to choose what they want.

ii) Service design – The new offerings in the service in a new platform creating superior delivery system pertains to the services design. Companies engaging to improve the process of delivery that meets enhanced customer needs on an ongoing basis is fine tuning the services design.

iii) Services transition- this is related to the minimal disruption when the client order of migrating the IT services is attended by an IT engineering service provider. The

agenda is smoother transition from old to new technology domain without disrupting the actual business operations.

iv) Service operation – The continuous tactical support which is provided by any IT engineering services firm through monitoring and control actions for eliminating end to end production stoppage factors.

v) Continual service improvement – The use of IT processes to seek development of the existing levels of service in hardware, software building credibility by addressing opportunities.

The support provided is usually done phone, email, web based chat support, smart phone apps based which have a turn around time (Lee et al. 2008). Larger organisations with higher level of customer base term it as an 'incident' where users get a log in based support with a traceable alphanumeric reference.

2.6.1 Categories of support:

The type of support in the IT engineering service sector varies as it can be classified as

i) Call in- This is a situation when the customers calls in and the customer pays for the 'Time and materials' IT support. Therefore for hardware replacements of electronic devices, computers, network equipment, the customer pays for the product and also the associated services required to replace and re-install the item at a pre-agreed or negotiated rate.

ii) Block hours – This is a type of classification of service in IT engineering service where the customers have the liberty to block number of hours by purchasing it on an agreed price (Gray, 2007). This can be standard non reduced rate, which the customers can purchase for a fixed number of hours to be consumed in a year or month. This is a flexible approach to resolve customer problems and without incurring monthly fixed bills.

iii) Managed services – This is a list of well defined services that defines the service type, response and resolution times for an agreed fee (fixed fee) (Wei, 2009). In some cases, the support can be not only for specific issues, but at project management level which can range from disaster recovery, vendor management, backup of the software, malware scanning, for a monthly or yearly fee.

iv) Crowd sourced technical support – The IT support has evolved and it uses social networks within the firm and outside to exploit the best available services in the

domain/sector. This predominantly uses discussion board approach and uses resources across locations to reduce the cost factor.

Many of the support services is based on the remote customer service, which uses internet, PC for trouble shooting. It uses software to be installed in user's PC, that helps to diagnose variety of physical and software health, network issues, security issues from a different country.

2.6.2 Multi-tiered support system:

It is evident that business which have adopted the IT as the backbone infrastructure is seeking to align the platform to integrate to the existing company level functions. Service desks are therefore the support system of IT engineering given to the organisational clients. It renders automation of firm level capabilities which extends to 24X365 support for the customers (Bujak et al. 2012). Staats, et al. (2011) explained that in IT engineering services, the first level service desk (Tier 0) offers a ready solution that are based on the typically standard queries of what, how, when which resolves the queries. It is generally solved by FAQs (frequently asked questions). The second level is (Tier 1) or an advanced level where the prospect or an existing consumer logs in a query, to procure more information. The third level is in-depth technical support that forms the (Tier 2) where the use of specific domain based knowledge is used to resolve the issues by the support personnel. The Tier 3 is the highest level of technical resources in an IT engineering service support that has the authority to identify and resolve any level problem or even engage in a new future creation Piercy and Rich (2009b). They are specialists who are highly skilled who can identify root causes, have multiple domain knowledge, a part of the design team of product. The Tier 4 is a level where the outside support is provided by vendors and partners, which shows organisation moving up the value chain by outsourcing functions of maintenance of software support, printer support (hardware support) (Seddon et al. 2011).

2.7 Lean tool and technique application in IT engineering service sector:

The IT engineering support system requires the software and hardware to create solutions for the customers. This typically in a customer centric or enterprise centric IT environment, involves the activities of e-transition, use of web and mobile telecommunication technologies, process improvement, security, network, product life cycle analysis (Staats et al. 2011). All of these are directed at project management level to bring about lesser cost, time, resources (employee deployed) in an IT perspective. Kundu and Manohar (2012)

argued that at elemental level it eliminated the errors, defects but at a higher level it is enabling organisations to identify threats, risks like downtime, better integration using alternative options to aid the business continuity process (BCP) in IT firms. Ward and Zhou (2006) argued that the adaptation of continuous improvement (CI) incrementally helps to address issues and problems and eliminate them systematically. Ward and Zhou (2006) further added that lean in IT leads the micro components of different IT programmes to be integrated at enterprise level for a bigger process improvement in terms of organisational capability. Qu et al. (2011) identified the waste types in services:

Sl.no.	Type of wastes in service	Significances
1	Service Design waste	no response to customer needs and resulting unnecessary excess features
2	Service Item waste	flaws in service process
3	Service Ability waste	does not make full use of service capacity
4	Service Process waste	low efficiency work
5	Service Delay waste	phenomena that waiters or customers wait

From the industry production sector, lean has also been mapped in supply chain with involvement of the third party logistics firms to make global supply chain management (GSCM) to be effective. Seddon et al. (2011) stated that lean has evolved over time as applications in healthcare, space, retail has been done extensively. In the quest to design and deliver a system better, lean also have been adapted in service organisations with systems approach.

Bicheno and Holweg (2009) defined service wastes in the following manner –

i) Delay – this is a customer based waiting scenario that happens when the queues are large and responses from the organisation is not happening as per corporate promise. It is also a wait when internal customers (employees) wait for one process to stop in order to start the other.

ii) Duplication – This is related to the duplication of work in terms of services offered, data, repeat of information, answering queries from different sources from same organisation.

iii) Unnecessary movement- This pertains to services being routed and queued several times, as services design falters, lack of one stop solution, or poor service ergonomics.

iv) Unclear communication – The waste of seeking clarification amidst the confusion of product/ service offered and used by client, wasting time to find location or misuse.

v) Incorrect inventory – Services which is a part of portfolio but out of stock, client unable to consume what was needed, substitute products/services offered instead of what was intended for consuming.

vi) Opportunity lost to retain/win customers – This is a failure of the organisation level commitment to establish the rapport, ignoring the customers, unfriendliness and rudeness.

vii) Errors in service transition – This relates to the defects in the services bundle, or services lost while creating or delivering service to a client for consumption.

viii) Service quality errors – This is inadequate service quality in the service processes.

It has IT centric challenges as lean principles in IT needs to overcome challenges in process based environment with implementation barriers (Ward and Zhou, 2006). Successful implementation has been found to create smoother delivery of IT service delivery model spanning different departments, to meet the client criteria. Lean approach helps to identify the focussed delivery of what client needs, and also that fact that it tries to find out a root cause in a task that can be measured, quantified, in terms of work processes. Kundu and Manohar (2012) argued that typically employee and management knowledge level about lean tools is found to be the first barrier, though implementation process in all stages is process centric barrier that follows soon after. The manner of work processes undergoes a significant change in lean approach, and adjusting to work requires an open mind able leadership to accept the changed approach. Mo (2009) added that smoother flow of production process in IT engineering service platform, is possible due to application of lean tools. For a service helpdesk, or even for IT solution project, FMEA (failure mode effective analysis) is the key tool to understand VOC (voice of customer) against the service delivery offered. Lean reduces time to service at each order request to service delivery cycle, manages optimal resources with right competencies in order to offer the best available solution for clients (Toyota Motor Corporation , 2006). Lean isolates time (wait), cost, by justifying actual production cost to provide service against the client contract rate. Hence, better CTQ (critical to quality) in service production of IT engineering helpdesk is possible for organisations which are using process based mapping of each activity in service creation of tasks. Mo (2009) added that process based approach helps order to delivery to be mapped in a sequence of activities in production area, which follows a linear sequence across departments, locations that affects the responsiveness to customer request. IT knowledge is core to the service

delivery and hence, managing this throughout the production helps the firms to gain much higher productivity.

IT industry has defined its own process improvement measures with ISO 9000 that pertains to quality management systems (QMS). The CMMI (capability maturity model integration) was proposed by CMU (Carnegie Mellon university) is a framework that aims in aligning the product, service development for clients, create service establishment and management, and product-service acquisition (Widman et al. 2010). Stemming from software industry, CMMI model framework is divided into 4 categories, 12 capabilities, 25 processes. The maturity levels is where the organisations are able to migrate their capabilities at enterprise level- with level 1 as the initial phase and level 5 is the optimising the highest level. There is a new model published in 2018, which offers core process areas in the area of acquisition, services and development.. The orientation of the production process of IT services towards quality metrics, documentation every accomplished activity and using a defined framework helps to standardise the service creation and service design process (Mahanti and Antony, 2009). In a service environment in business, this is important as lean based methodology simplifies the service creation process, identifying the value added steps, non value added (needed steps and not needed steps).

2.8 Appropriateness of lean tool adoption in IT engineering service sector:

For an IT engineering service creation industry, the adoption of lean practices and deploying the right tool to assist operations is necessary. The most common defects in this sector is redoing the work, in the service creation process that has not met customer defined requirements. It can also be order changes as per customer, or service design errors, order entry errors from customer side. Albliwi et al. (2014) stated that IT engineering service industry is labour intensive and hence, employee turnover adds to the list of examples of errors. Mahanti and Antony(2009) stated that standardisation of activities, work practices is needed at office level in order to collate the list of errors in a service environment. He et al. (1996) stated responding to defect or error minimisation is an organisational capability, which is closely linked to the employee capability and procedures to rectify it early. In an IT engineering service business overproduction does not happen as single window operations from customer initiated query sets in motion employees, to work on a service request. The workflow sequence in this sector is IT enabled as ticketing function and delivery confirmation, customer satisfaction post consumption of service is all accomplished on IT platform (Ward and Zhou, 2006). Mo (2009) argued that the appropriateness of lean is to

identify errors in a IT environment early, and prevent early processing, resource allocation in IT teams is directly related to resolve a customer issue(s). He et al. (1996) defined that waiting is an error that is symbolic in this sector, as system downtime, system response time, approval from others, waiting for information from customers are affecting the IT engineering service model. Mahanti and Antony (2009) reported that lean appropriateness in IT engineering service requires cross trained multi tasking to reduce wait times in service queues. Widman et al. (2010) added that work balance is required to spread work load and bring in resource deployment for optimal use, of people, IT hardware equipment to aid a service creation process. This standardisation process required in service requires information or data centric decisions that are available in the entire IT engineering service supply chain (demand from customer and supply from employees). Mo (2009) argued that the lean methodology works only when the motion in creating servicing activity is done, that requires activities to be interlinked to role assigned for each employee. The balance in this sector, requires to eliminate multiple approvals, duplication of efforts, in service delivery process. Higher level process analytics for cost of servicing in IT engineering sector for each customer can be a data-centric approach to understand nature of problem and average man-hours spent to resolve it. Lean of redesigning need to analyse the offered service parameters to the clients, and hence redesigning portfolio and adhering to critical to quality factors, is important to streamline and bring excellence in the enterprise level functions and activities (Albliwi et al. 2014). Therefore it is evident that to succeed and achieve the set goals, it requires employee involvement for knowledge application at the work area, along with participative leadership, open communication across hierarchies to facilitate the problem solving culture for lean practice adoption. Kundu and Manohar (2012) acknowledged that change in work methods and process is a requirement in order to intensity the fault finding mission to make operations streamlined to aid flow in the order to delivery continuum. This is a learning phase for the teams, departments and sharing the problems across the enterprise that helps to get ideas, innovations. VSM enables to map all activities with time, number of employees, output quality, to meet the customer requirement (Tapping and Shuker, 2003).

2.9Conclusion:

The above discussion shows how the lean along with the quality principles is being deployed in IT software and hardware sector, has evolved into supporting a IT engineering service based organisation. The above discussion shows that lean has benefitted other sectors in the industry, while it required to understand the fundamentals of IT engineering service support.

The nature of service delivery that met the client expectation sets have no significant research or empirical study available for the Ireland based companies. There is no clear research that shows the multi tiered model in the IT engineering service platform and the benefits the service platform have realised deploying lean principles. There are different types of lean techniques deployment to bring in improvement process in the final output, while it is not a static model which makes it more important for the organisations in IT engineering services to explore lean deployment. This is a research gap and the importance of probing the lean application in the sector (IT engineering service) hence forth becomes more pertinent now.

Chapter Three

Research Methodology

3.0 Introduction

Research methodology refers to specific techniques, or procedures used to identify, select, process and analyse data/information relating to chosen area/topic (Kothari, 2004). It is a science of how a research needs to be carried out in terms of investigation, data collection, and analysis to resolve the research problems. It involves the procedures that researchers follow to describe, explain and predict phenomena.

The area of investigation in the current research is the implementation of lean tools and techniques in IT engineering services industry in Ireland. Therefore, a set of research methods, sampling, data collection procedure, and analysis is required to collect data relating to the phenomena. However, the researcher needs to follow a specific worldview based on which each element in the research methodology is selected, and such selection is justified. Included in methodology is the research design signifying the type of investigation/enquiry to be followed in line with the extent of existing research that already exist in the chosen area.

3.1 Current research proposition

The current research methodology includes specific choices made with regards to the research philosophy, research approach, design and the data collection methods. The following table provides a brief summary of the choices made as to the chosen worldview by the research, the approach and type of enquiry undertaken, data collection method and strategy, instrument, and sampling process, and the justification for making such choices --

Components of research methodology	Choices made	Brief justification for the choices
Research philosophy	Interpretivism	Using the interpretivist worldview allows gaining in-depth insights into the implementation of lean tools by interacting with the human subjects (managers of IT engineering service firms).
Research approach	Inductive	Inductive approach helped to add value to existing knowledge, and develop new theories by identifying

		the nature and extent of lean implementation in IT engineering service firms, an area which is currently a knowledge gap.
Research Design (Type of enquiry)	Exploratory	Exploratory research was followed as full clarity about the research problem was not there, and a flexible, informal approach to data collection was required. Exploratory research helped to follow qualitative methods to data collection, explore the problems, and identify the best methods to resolve the problems.
Data collection Method	Qualitative	Following the interpretivist worldview, inductive approach and exploratory research supported the implementation of qualitative methods which help to collect rich, in-depth and subjective data that provides illustrative answers to the research problem. Qualitative research provides a holistic approach facilitating the investigation and discovery of new ideas and concepts based on human understanding and subjective thoughts arising out individuals' real life experiences.
Data collection strategy	Interview (Telephonic, semi-structured interviews)	Interview was found to be inexpensive, convenient, and a flexible strategy to collect data from six managers of IT engineering service firms through interaction, information sharing, and rapport building. Telephonic as well as face-to face interview was conducted along with mail reverts of few. Due to respondents busy schedule to make the interviews less time consuming certain questions have been asked through google forms as well, and transcripts of the interviews were prepared for reference during data analysis.
Instrument	Open ended	The instrument to collect data was 'questionnaires',

	questionnaire	designed in the form of semi-structured, open ended questions. Open ended questions allowed the participants to openly share their views, insights, and experiences about the use of lean tools in the industry.
Sampling	Non probability, purposive sampling.	Non probability, purposive sampling was followed to select six managers from IT firms in Ireland such as Accenture, NTT, and other lean consultancy firms like Lean vis ltd, Scrum alliance, TeamBDS and InMotion. Purposive sampling helped to intentionally choose managers with at least five years of experience in IT engineering service firms.

3.2 Research philosophy

Philosophy relates to the distinct beliefs, values, and attitude of the researcher in relation to the surroundings and the world where life exists. Epistemology and ontology are two distinct philosophical viewpoints relating to what is generally acknowledged as an individual's worldview (Uddin & Hamiduzzaman, 2009). Epistemology is concerned with the study of knowledge, what constitutes true knowledge, and how to extract such knowledge. On the other hand, ontology is the philosophical standpoint that revolves around the nature of reality as well as the different entities within the domain of reality (Bridges, 2010).

3.2.1 Positivism

The philosophy of positivism relates to exploration of social facts in a scientific manner as used in natural science. From the epistemological viewpoint, using observation and reasoning, positivists tend to understand and interpret human behaviour, and it is necessary to experiment to arrive at true knowledge (Saunders *et al.* 2009). From an ontological viewpoint, positivism assumes that knowledge can be quantified and studied objectively. Researchers maintaining the positivist worldview are more likely to conduct quantitative research to collect data that can be statistically tested. Positivism also assumes that knowledge that is valid can only be generated based on direct observation by human senses, and this would entail that ability of the researcher to evaluate and confirm what can be perceived as knowledge (Kuipers, 2013).

3.2.2 Interpretivism

Interpretivism, as opposed to positivism, considers the inclusion of human subjects important to understand their subjective views, opinions, experiences of the external world. Interpretivism supports the implementation of inter-subjective epistemological and ontological belief that social reality can be subjectively construed (Saunders *et al.* 2009). Interpretivists believe that knowledge and meanings that people attach to social events or phenomena are acts of interpretation (Rubadeau, 2015), and that there exist no specific path or pre-determined techniques to gain access to true knowledge. In practical terms, the followers of this philosophy attempt to access knowledge through social constructions associated with human subjects such as language, communication, shared meanings, and consciousness (Rubadeau, 2015).

3.3.3 Realism

Realism presumes that the existence of objects and entities in the world is independent of human mind. Realism, when applied in the area of social science, takes the form of critical realism to combine events occurring in social phenomena with the universal philosophy of social science to describe the periphery between social and natural world (Kuipers, 2013). From an epistemological standpoint, realism assumes that the researcher should observe phenomena to verify the authenticity of facts (Kuipers, 2013). Meanwhile from an ontological viewpoint, realism considers the researcher to be an objective observer whose existence is interpreted out of social condition.

3.2.4 Pragmatism

Pragmatism assumes that the implementation of a particular position, such as positivism or interpretivism in a social research is not realistic (Morgan, 2007), and the differences between these philosophical viewpoints should be discarded (Peters, 2012).While other philosophies have a distinct set of assumptions and beliefs of their own, pragmatism considers a more practical approach to enquiry into social events or phenomena.

Pragmatism supports the integration of different worldviews in a single research, and following mixed methods to data collection and analysis (Peters, 2012). This is possible by combining the quantitative and qualitative approaches to data collection, following the ab-ductive reasoning, i.e. integrating deductive and inductive processes respectively. The advocates of pragmatism, therefore, follow an abductive process, i.e., moving forward and backward between inductive and deductive processes, and thereby connect theory with data

(Bridges, 2010). Researchers follow pragmatism to convert human observations into theoretical underpinning, followed by evaluation of these theories through testing (Rubadeau, 2015).

3.2.5 Justification for following Interpretivism

Interpretivists do not consider true knowledge to be objective, measurable, and independent of human reasoning. Interpretivists gain access to data through social construction such as language, consciousness, reasoning, and shared meanings (Peters, 2012). Researchers following Interpretivism philosophy try to gain a deeper understanding of human experiences, social structures, social events, and values and meanings that people attach to these aspects (Peters, 2012). Interpretivist researchers interpret the meanings that the research subject attach to events and gain access to true knowledge based on social construction such as consciousness, shared meanings, language, and communication (Rubadeau, 2015). The philosophy of Interpretivism entails three basic principles (Saunder *et al*. 2009); that the social world is constructed and individuals give subjective meaning to its existence. Interpretivism also considers that human being as research subjects possess consciousness, and human behaviour is influenced by knowledge they possess about the social world that exist in association with human beings. Interpretivism assumes that research is driven by human interests and the researcher undertaking the study is a part of what needs to be observed.

The current research followed the 'interpretative standpoint in order to carry out a subjective analysis of 'descriptive' and 'meaningful' information obtained through human reasoning, consciousness, and shared meanings (Rubadeau, 2015). As supported by the Interpretative philosophy, qualitative data was collected from the research subjects through interviewing and understanding the meanings that the interviewees (subjects) attach to events such as implications of implementing lean tools in IT engineering service firms, the benefits and challenges, and future endeavours.

3.3 Research approach

In social research, research approach refers to the process of either building theory to add value to existing knowledge, or test existing theories to validate existing assumptions (Peffers *et al.* 2007). Inductive approach is suitable for studies where extant literature is insufficient and the researcher is not clear about the research problems. Therefore, qualitative research is generally followed to explore the problems, observe a phenomenon, develop tentative

hypothesis, study patterns, and develop knowledge (Peffers *et al.* 2007). On the other hand, deductive approach is feasible for studies where extensive theoretical dispositions exist, however, its validity need to be tested using a scientific approach (Harwell, 2011).

3.3.1 Inductive approach

Studies following inductive approach move from a specific to general process, thereby do not require theoretical assumptions to begin the research. The researcher begins the study with a range of observations, to arrive at generalised conclusions as a subjective outcome (Peffers *et al.* 2007). Based on specific observations, new theories and laws are created, and this comprises of scientific knowledge that did not exist before. Researchers' conductive inductive researches suppose that the observations they make, can be logically generalised into universal rules (Neuman, 2014). The worldview maintained by inductive researchers is that of an interpretivist, who make attempts to interpret the meanings that people attach to specific events, and facts being enquired.

3.3.2 Deductive approach

Studies following the deductive approach move from a general to specific process, and initiate with a comprehensive review of existing theories and conceptual frameworks, to test them using statistical data testing. The deductive approach aligns with the positivist standpoint which supports the use of quantitative methods to test assumptions, through data testing, and either validate, or reject existing premises (Harwell, 2011). Researchers following the deductive approach in social research identify the knowledge gaps that are present in existing literature, followed by the formulation of hypothesis/questions , data collection, data testing, and finally arrive at objective based outcomes, that validates theoretical underpinnings (Neuman, 2014).

3.3.3 Justification for implementing inductive approach

There exist dearth of research with regards to the Implementation of lean tools and techniques in IT engineering service industry, particularly in context of Ireland. Lack of research makes it necessary to follow the inductive process to explore and understand the extent to which lean methodology is followed in IT firms, its benefits, and the underlying opportunities and challenges.

Following the inductive process, the current research was initiated with key observations relating to the use of lean tools and techniques in general that required reviewing theoretical

underpinnings, therefore following an alternative approach to theory by collecting data. Theory, however does not guide or influence data collection, rather theories are derived from analysis of collected data, which requires spotting patterns of data. Finally, broad generalisations are arrived at from specific observations using inductive reasoning.

Deductive approach was not suitable for the current research because there was no scope to test existing theories/literature to confirm underpinning theories. Inductive approach helped to define, describe, and generalise how the use of lean methodology was made, or could be made in IT engineering service firms in Ireland, and what could be the possible implications.

3.4 Research Design, Strategy & Procedure

Research Design refers to a structural framework designed to conduct a study to resolve a problems that is already known, or still needs to be identified. Thomas (2010) explains research design to be a mixed bag approach that describes the type of investigation that need to be followed to collect either quantitative, or qualitative data, or a combination of both, i.e. mixed methods. As a master plan, research design deals with the planning, structuring, organising, and conducting the research in a systematic manner ensuring that the research validity is not affected (Allwood, 2012). It is also considered as an action plan based on which an enquiry is conducted into a phenomena that requires further investigation, with or without the involvement of human subjects, using primary or secondary research, to arrive at conclusive outcomes.

3.4.1 Exploratory research

Within the scope of research design, the types of enquiries that exist are exploratory, explanatory, and descriptive. **Exploratory research** is followed when full clarity about the research problems is not there, neither the researcher is aware of what needs to be investigated. Therefore, an informal, inflexible research is necessary to explore and understand the exact nature of the problem, define the problem, set the hypothesis/questions, and identify the best approach to resolve the identified problems (Reiners, 2012). Often, exploratory research is not an end in itself and gives way to descriptive research (Thomas, 2010). Exploratory studies aim at identifying ‘what the actual research problems are?.

3.4.2 Descriptive research

Descriptive research is formal, and usually followed when the researcher has fully clarity about the problems to be investigated, and procedures to be followed to collect data to resolve

the problems. It helps to gain better understanding of already identified problems by emphasising on the attitude, viewpoints, and opinion held by a group of people (Thomas, 2010). Descriptive studies generally have a large sample from which data needs to be collected, and the responses correlated with the characteristics of the population. This implies that descriptive research studies the characteristics of the sample and the overall findings are generalised to the population under study (Anyan, 2013).

While exploratory research concentrate on 'what' questions, descriptive studies emphasise on multiple dimensions and questions that require investigating into what, when, where, who, and how, of the problem/s. Descriptive studies involve collecting data associated with current phenomena, state of affairs, and situations that require immediate attention (Englander, 2016). It makes different kinds of comparisons, correlations and statistical interpretations using an inflexible, formal approach, and structured design. Descriptive studies starts with problem identification, followed by review of extant literature/underpinning theories, design of research instrument to collect data, selection of sample from an identified population, empirical data collection, analysis of data, and finally reporting the conclusive outcomes (Anyan, 2013). Descriptive design is however criticised by Sloman (2010) for its inability to maintain control over the variables, and difficulty in explaining the relationship between variables that impact the study.

3.4.3 Explanatory research

Explanatory research, referred to as casual research, generally provides in-depth understanding of phenomena studied earlier, using descriptive research. It aims to study, establish, and verify the relationship that exists between a set of variables (Willis *et al.* 2016). Explanatory research mainly has two-fold objectives – (i it helps to identify which variables are 'cause' and which are 'effect' and (ii) it explains the nature of relationship, or correlation that the variables share, and the forecasted outcome of such relationship.

3.4.3.1 Justification for following the exploratory design

The current research followed an exploratory design, as the nature of the problems was not clear at the beginning of the research. The researcher was not clear whether IT engineering service firms in Ireland used lean methods, or the extent to which lean tools and techniques were used, the benefits, opportunities, or challenges that exist. Therefore an informal investigation was necessary that could allow the researcher to explore the phenomena from multiple sources, review existing literature by focusing on underpinning theories and

concepts, research papers, case studies and reports that exist in the area of lean implementation in IT engineering services industry.

The choice of exploratory research is justified on grounds that the current study required an in-depth enquiry into phenomena that was not investigated earlier and hence a myriad of still needs to be discovered. The purpose of exploratory research in the current study was to –

(i) Get background information about the area under investigation by conducting a thorough literature review using qualitative research

(ii) Identify the nature of the problem, define the problem, and scope out the extent of the problem

(iii) Conduct further empirical enquiry into the research problems, to add value to existing knowledge and develop new theory

3.5 Research strategy

Research strategy refers to a logical plan or approach that facilitates the use of appropriate instruments and tools to collect data to resolve the research problems (Bryman, 2006). Strategies could differ on the basis of whether the research follows qualitative or quantitative approach or a mixture of both. Strategies to collect quantitative data include questionnaires, experiments, survey, case studies while for qualitative data; strategies include interview, observation, focus group, ethnography, grounded theory, and action research.

3.5.1 Research procedure

Research procedure refers to the systematic process followed by the researcher since the beginning of the research since its conclusion. Research procedure usually start with identification of problem/s to be investigated, and subsequently choosing the right set of approaches, research methods, data collection strategies and analysis that constitute an action plan (Kothari, 2004). Research procedure is generally a part of the overall research design, and varies depending on whether the research is exploratory, descriptive, or explanatory, and whether quantitative or qualitative data collection needs to be followed.

3.6 Data Type (Primary versus Secondary data)

Primary data involves the collection of up-to-date, first-hand information that is not available of public domain (Ketchen *et al.* 2008). Primary data is collected for well defined, specific problem in hand, using strategies and procedures that fit best into the problems. Primary data

collection involves some kind of interaction with individuals, groups, or communities, referred to as research subjects who share their attitudes, views, experiences or emotions, either through physical presence or remotely (Bryman, 2006). Since primary data necessitates interactions with human subjects, it involves more complexity, expense, time and budget as compared to secondary data.

Secondary data is information, knowledge, and assumptions made by previous researchers for similar study, or purposes other than research such as administrative records, official statistics, or discourses that provide underpinning research materials. It is however, second information available in the public domain that needs to be extracted or archived using specific criteria or key words search. At the same time, it is essential to evaluate the credibility of the source, and the relevancy and quality of secondary data.

3.6.1 Secondary data

Following the exploratory design, secondary research involved the collection of qualitative data by extracting journal articles, books, and other published data from credible academic sources (academic database) such as Google scholar and Emerald. The journal articles and other published studies were obtained by putting specific key words such as, lean, lean methodology, lean tools and techniques in IT engineering service industry (Ireland)in academic database. The **inclusion criteria** involved selecting published materials that were not more than 10 years old and strictly meant for academic purpose. The **exclusion criteria** were avoiding journal articles, and other materials more than 10 years old, and those meant for non-academic and commercial purposes.

3.6.2 Primary data

While secondary data helped to extract relevant journal articles and books to conduct a critical review of existing literature, and develop the conceptual framework. At the same time it helped to conduct a background study and discover the research problems that required further investigation, thereby expressed using research questions/objectives in the introductory chapter. Primary data was collected by implementing a qualitative approach involving the collection of subjective information that could be thematically analysed, interpreted, and evaluated to develop new knowledge domain.

Primary research involves the collection of quantitative data, or qualitative data, or a combination of both using mixed methods. The characteristics of both ‘quantitative’ and

'qualitative' data, the relative strengths and weaknesses of each method are discussed in the following sub-sections -

3.6.2.1 Quantitative research

Quantitative research helps to collect numerical information that can be put to statistical testing to measure the findings using objectification. The quantified outcomes either validate or reject alternative knowledge claims through theory testing (Harwell, 2011). The overall process to conduct quantitative research is analogous to studies undertaken in nature science, wherein the final outcome is similar to law like generalisation. Used in case of social studies, quantitative research makes use of pre-tested statistical models or techniques to analyse data, and arrive at objective based results. Cresswell (2014) explains that three historical trends exist in quantitative research, namely, (i) formulation of research design, (ii)data testing/measurement, and (iii) statistical interpretation. Therefore, quantitative research involves a scientific enquiry into a phenomenon using pre-determined instruments, statistical interpretations, and testing, rather than inclusion of human reasoning or judgments.

As categorised by Neuman (2014) quantitative research includes three distinct types of studies, namely, (i) Experimental research, (ii) Descriptive research, and (iii) casual comparative research. Each of the aforementioned methods are followed to measure variables (studied in the literature review) on a sample of subjects, and consequently, signify the relationship among the variables using statistical effects, such as correlations, differences between means, relative frequencies, with the purpose of theory testing. Quantitative researches mainly follow the deductive approach implying that the research starts with theoretical studies, hypothesis building, data collection and testing, and eventually theory confirmation/rejection.

3.6.2.2 Qualitative research

Qualitative research is naturalistic (Bryman and Bell (2011) and takes place in a natural setting to understand human behaviour, lifestyle, mindset, values, beliefs and perceptions in their interaction with the social world. Qualitative research is a more holistic approach involving the investigation and discovery of new ideas and concepts based on human understanding and subjective thoughts arising out individuals' real life experiences (Allwood, 2012). Enquiry about any social phenomena is undertaken in natural environment through observation, interaction, and exchange of information, interpretation, and similar social exchange process involving social actors', including the researcher.

Qualitative studies include purposeful narratives, description, and illustration of opinion obtained from the subjects which necessities the researcher to get immersed in the social environment, phenomena, or event, even if it is to some extent.

3.7 Quantitative data collection strategies

3.7.1 Experiment

Experiment is a quantitative data collection strategy used in social research to test the relationship between variables. Experimentation is also used to identify and test the impact of one variable on the other, in which the variable being impacted is dependent variable while the one that does the impact is the independent variable (Saunders et al. 2009). Experimental research is conducted scientifically and followed in social studies where the independent variables that need testing may be subject to manipulations, and any changes done on one or more than one dependent variable is measured. The results of experimentation are observed by the researcher, to test the hypothesis, and disclose facts that are known. The researcher undertaking experimental research also draws conclusions linked to any factor on the group being studied and generalise the outcomes from a specific sample to a larger population (Saunders et al. 2009).

3.7.2 Survey

Survey as a data collection strategy fits into the paradigm of both qualitative and quantitative research design. Quantitative surveys involve pre-determined, structured, and closed ended questions that include a set of options to be chosen from, while responding (Harwell, 2011). Closed ended questionnaires include theoretical concepts and variables studied in the literature that need to be tested scientifically. The closed ended options included in questionnaires seek to capture the attitude, beliefs, motivation, choices as well as demographic characteristics of the participants. On the other hand, qualitative survey is conducted in the form of an interview, generally using open ended, unstructured, or semi-structured questions. The core advantages associated with survey is that it is cost effective, flexible as it can be conducted online as well as offline, and suitable to collect voluminous data in a limited time period (Bhattacherjee, 2012). However, there exist possibilities of getting biased response and flawed information if the survey participants fail to understand the questionnaires.

3.8 Qualitative data collection strategies

3.8.1Interview

Interview, as a data collection strategy refer to a conversation with the intention to collect descriptions of (real life-world) the subjects (interviewees) with regards to the understanding of the meanings of the phenomena/event being studied (Gill et al. 2008). Opdenakker (2006) describes interview as an extendable conversation between interviewer and interviewees with the purpose of gaining in-depth information regarding the problems, subject or topic, and through which the phenomena can be interpreted in terms of the meanings that interviewees attach to the same.

Interviews could be structured, semi-structured, or unstructured. Structured interviews are usually organised around a set of pre-designed questions including closed ended options that directs the participants to answer in either 'yes' or 'no'. It hardly provides any scope to the participants to narrate their views, emotions, or experiences, and justify their answer. Structured interviews are therefore similar to self-administered questionnaires followed in quantitative research, involving variables that need to be revisited and tested.

Unstructured interviews include open-ended questions that may not necessarily be pre-determined, and can be modified or tailored during the course of the interview. It allows greater freedom and flexibility to both parties, interviewees and interviewer, as regards to the planning, organising, implementing, and administering the interview questionnaires and content (Turner, 2010).

Semi-structured interview, as explained by Gill et al. (2008) is a flexible version of structured interview and usually reflects a mix of both structured and unstructured questionnaires.

The strength of semi-structured interview is that it allows the interviewer to achieve depth by getting immense opportunities to probe the participants, cross-question, interrogate, and expand the interviewees' responses (Opdenakker (2006). Anyan (2013) suggests maintaining a checklist to cover the relevant areas that require probing, or seeking the views of the participants. Checklist allows the researcher to conducting in-depth probing, track the progress of the conversation, and ensure that the interview is within the parameters traced out by the research aims and objectives. This helps to maintain control, and validity of the instrument.

3.8.2 Focus group

Focus group, similar to interview, involves questioning a group of participants rather one-to-one questioning as done in case of interviews. Focus group requires that a group of participants, usually ranging from 5 to 10, or more come together in a pre-decided venue to present their respective views, on the topic/agenda under discussion.

The researcher plays a crucial role from the very beginning till the end of focus group interview by taking up the role of a 'facilitator' to organise, question, probe, and ensure equal participation from all members (Neuman, 2003). Focus groups usually involve discussion in groups where few members may try to dominate others, force place their own views while trying to subdue or disallow others to speak. As a facilitator, the interviewer needs to use tact, diplomacy, and negotiation with members to get responses from all corners, value the opinion of each member, while making records of the conversation going on (Jansen, 2010). The main advantage of focus group is that it helps the researcher to gain deeper clarification about any issue or area that may have been missed out in an interview (Thomas, 2010). It also helps to gain access to creative ideas that arise out of brainstorming and discussions among experts, or members concentrating on a particular issue. The main disadvantage is the likelihood of focus group members getting involved in conflicts, or disputes due to disagreement among themselves and getting deviated away from the issue under discussion. This could affect the quality and validity of the research findings.

3.8.3 Observation

Observation is a data collection strategy in the qualitative paradigm in which the researcher observes the behaviour and attitudes of individuals, and groups in their natural setting (Gill et al. 2008). Observation is a non-experimental form of enquiry which does not require manipulating the research variables to reach the desired outcomes (Cresswell, 2014). It may involve participant or non-participant observation wherein, the former necessitates the researcher to get immersed into the natural context, and phenomena under enquiry, and consistently observe the behavioural aspects of those being observed without the subjects being notified (Cresswell, 2014). Observation without notifying the participants ensures that they do not become self-conscious, and act their natural way in any situation. This helps to maintain validity of the research instrument. On the other hand, non-participant observation strategies involve case study, archival research that do not require much interference of the researcher.

3.8.4 Case study

Case study follows a holistic approach to qualitative data collection, especially where the researcher needs to carry out deep and thorough exploration of a particular phenomenon, or an event, activity, or program (Noor, 2008). Qualitative case studies are exploratory in nature, and help to analyse phenomena in a social context, especially when the boundaries between such phenomena and context is not clear.

In a case study research, a specific case or a number of cases need are examined distinctively, and evaluated to arrive at conclusive outcomes (Yin, 2009). Case studies may involve fully secondary research, i.e. review of empirical studies published in journals, or conducting primary research from a chosen organisation. In the latter case, it may involve studying the behaviour of subjects, interviewing, or surveying, and documenting their experiences associated with real life events while working in the organisation chosen for the case study.

3.9 Data collection method followed in the current research

3.9.1 Interview (Qualitative data collection)

Interview was found to be the most feasible as compared to observation, focus group, action research and case study, as it was not only cost effective, but allowed telephonic conversation with the participants. It helped to collect in-depth, elaborate, subjective information through open ended questions asked individually to each participant over the telephone, without having to organise, or visit any pre-decided venue. Therefore, telephonic interview was conducted from 3 managers (operations department) working with the same IT engineering service firms, from where the employees were surveyed.

3.9.2 Interview questions' design

The interview questions were open-ended, and semi-structured. Open ended questions provided ample opportunities to the interviewees, i.e. the managers of IT engineering service firms to openly elaborate on their opinion and insights, and share their critical views regarding the use of lean tools and techniques in engineering service industry. Open ended questions did not restrict the participants to express their attitude and beliefs in predetermined options as given in closed ended questions, usually meant for quantitative data collection. The interview questions were carefully designed in order to seek answers to the research gaps, and underpinning the research questions and objectives formulated in the first chapter.

3.10 Data Analysis

Subjective data collected from the managerial interview were carefully interpreted by going the transcripts prepared during the conversation. While analysing the data, the responses of participants against each question were compared and contrasted with each other, and the emerging views were highlighted upon. Also, the discussions were made in triangulation with the theoretical studies carried out in the literature review, and the research aims, and objectives crafted in the initial chapter. Analysis of the results and findings obtained from the interview was done under specific themes that underpinned the research problems and questions formulated in the first chapter.

3.11 Sampling

Sampling is the process involving selection of a fixed or predetermined number of individuals (sample) from a population (Bryman and Bell, 2011). Saunders et al. (2009) suggests that the sample should be a fair representative of the entire population so that the findings can be generalised from the sample to the entire population.

Probability sampling includes sampling techniques such as simple random, stratified sampling, and cluster sampling while non-probability sampling comprise of purposive sampling, convenience sampling, quota sampling, and snowball sampling. Probability sampling techniques are usually free of bias, and provide equal opportunity to each individual in the population to be selected. On the contrary, non-probability sampling involves some form of bias, and researchers' prejudice in choosing sample that are either conveniently available, or most appropriate the area being investigated.

In the current study, non-probability, purposive sampling technique was implemented to choose six managers working with various IT and consultancy firms in Ireland such as Accenture, NTT etc. One manager were chosen from each of the six companies, and purposive sampling ensured that the managers had at least five years of work experience in the IT industry, and knowledgeable about lean tools and techniques.

3.12 Research schedule (Gantt chart)

The research was undertaken in a predetermined time schedule with specific timeline maintained for each activity. The following Gantt chart highlights the key activities of the research in the form of milestones set on a weekly basis. Use of the Gantt chart helps to

complete each research activity in an orderly manner ensuring that there are no potential delays, and the entire dissertation is submitted on time.

Main activities	**1st week**	**2nd -3rd week**	**3rd - 4th week**	**4th -6th week**	**6th - 8th week**	**8th -10th week**	**10th -11th week**	**12th week**
Topic selection								
Literature review								
Research methodology								
Case studies- qualitative data collection								
Interpreting and triangulation								
Data analysis and findings								
Conclusions and Recommendation								
Proof reading, compilation and Final submission								

Chapter Four

Qualitative Findings

4.1 Qualitative responses: [R= Respondent]

Qs1.: Do you believe that lean adoption helped your organisation to become defect or error free (zero waste) in production?

R1 stated that like manufacturing, services in IT engineering sector have adopted Lean principles not just to become defect free but to bring in more tangibility in services component to clients they serve. The respondent agreed that for a SME IT consulting firm, lean is more systematic common sense approach to task challenges and that yields results into more surer predictable outcomes. The respondent added that creating service on demand over IT requires them to understand if service delivery design is a waste.

R2 stated that lean and improvement in IT engineering has to go both ways each benefiting over time resulting greater control over management. The respondent added in IT perspective they convince clients to implement, which helps them to align processes and activities for a fruitful practice based outcome eliminating errors. R2 added that they do ask themselves the '5 whys' to understand different perspectives, opinions to identify the problems occurring in the IT engineering service delivery system, and move on to much more analytical the 'Ishikawa' tool.

R3 highlighted that in an IT engineering service firm currently handling a banking project, the primary aim is to be efficient in service delivery which is a competitive advantage. As lesser errors to redesign any service is lesser cost of manpower engagement in payroll that leads to higher client satisfaction which lean adoption helps. Respondent added that lean helps to define waste (defects) and redundancies, like service ability that depends on the employee competencies is a waste (not able to fulfil the customer order fulfilment criteria).

R4 agreed that lean in combination with other quality tools delivers better customer satisfaction. In both software development and IT enabled services platform lean combined with agile or le-agile helps to work on reducing the technical errors against time, cost challenges in a project. The first issue is to balance aggregate workload within employees in different processes, and to identify the lean principle based wastes in existing production

systems. The respondent stated that any delay affects the production hence identifying the service delay waste is an important criteria for the firm in order to be efficient.

R5 stated lean made their IT engineering service processes to be more efficient, which is not defect free, but more focussed project delivery and outcomes that resulted into customer satisfaction. This is not exactly defect free but more of making the processes to be more efficient by eliminating them. Detecting the wastes as per lean principles helps to map the processes input/output to be more streamlined. R5 added that lean helps to define service waste types which can be either a design waste affecting delivery, service ability waste, service item waste, service delay waste, or a service process waste.

R6 stated that lean transforms the processes in their company to make customer be satisfied for a longer period of time. Therefore lean streamlines and modifies the existing techniques of IT service delivery process to meet the customer requirements. The lean principles offer a systematic approach to find the value added and non value added elements, seven types of wastes to be contained before IT engineering services goes for final customer delivery. Service item waste as described by the respondent states the flaw or defects in the service process.

Qs 2: What steps were taken to eliminate the barriers of lean tools at pre and post implementation phases in your company?

R1 stated that the challenge is to define the variable of a problem for lean to be quantified. And the next challenge is to scale up the processes, activities to meet a desired goal based outcomes. This is challenging as approach of management to teach all employees in all IT engineering process and expecting outcome post implementation is impossible. The lean itself is perceived as a tough tool to be mastered, across the organisation, though the implementation phase and problem solving stage is the hardest when behavioural (attitudinal) resistance has been overcome.

R2 stated that transforming from existing state of problems and deploying new methods is a real challenge. Lean in organisation requires two way approach, the organisation needs to learn all tools, in order to implement right tools at right instances at live projects in order to overcome barriers, to assist the change process for a fruitful outcome. The employee attitude to learn lean principles and implement in everyday work practices in their task area is a challenge, that becomes evident in their behaviour during learning and post learning lean implementation phase.

R3 stated the challenge for lean implementation is to choose and apply the right tool in right situation to overcome the problem. Lean also value adds to the reduce cost, time factors to the existing processing capabilities in operations and is very much radical bringing in huge changes. The first step is to educate the senior, middle and then the junior team members, as in an IT engineering services, the multi-tasking in product/process is important as a process or activity owner. Therefore right information and knowledge at all levels of hierarchy helps to design IT engineering service delivery which avoids structural waste like wait time, or knowledge gap for customer delivery.

R4 who stated that the lean can be deployed everywhere, as in their company right from order taking, order processing and order delivery processes with interlinked activities, lean improves all of it. The respondent added it is more of a removing a technical issue, operational issue, that can be related to the cost of improvement. Pre implementation barriers of knowledge amongst all employees, and post implementation barriers are fine tuning to get the right results that the company aimed for. However post implementation of lean challenges also exists as the flaws in the post deployment is under utilisation of the service capacity from the organisation offering IT engineering services.

R5 respondent stated that barriers of lean tools implementation is the challenging situation, how it works, or it does not fit, or how to realise the benefits of the lean implementation is a huge challenge. The respondent stated that frequent training sessions, workshops about lean tools and its application helps to disseminate the knowledge about lean techniques and its implementation in different IT engineering service departments, processes and sub processes. The tangibility in the deliverance of performance requires the indicators to be defined, that helps users to identify what and how to leverage right lean tool application in order to attain the performance objectives.

R6 stated that lean requires a team based approach not only within company but also in the customer premises, creating a shared common goal. Thus overcoming the knowledge gaps is necessary for lean to succeed while deploying right tools to overcome business challenges consistently is also a barrier to be overcome. The respondent added that lean failures is bound to happen, and achieving goals requires strict lean based methodological approach for meeting improvement strategy based outcomes. Understanding the customer requirements is crucial as the customer needs the IT engineering service design to meet the delivery criteria.

While lean is also important to find the flaws in the existing IT engineering service systems, resulting into lower efficiency in the aggregate work output.

Qs 3: What are the tools and techniques of lean methodology deployed in your company and what are the resultant benefits?

R1 explained that IT engineering services with the use of technology has become totally pull (demand) centric that eliminates the option to over or under production of a service. However, the capability to produce the IT service in terms of offering for multiple clients at the same time, requires to optimise delivery balancing the man, machine, skill combination. However, the most important is the lean tool to measure the problem, making it tangible and maintain the flow using Kanban, JIT. The benefits is less waiting time, and ability to create 'on demand' service that lean has helped by defining the value components in end to end service supply chain.

R2 explained that lean in an IT engineering service platform seeks continuous flow of elements, activities leading a final delivery to the external customers. The lean methods does bring in changes making the internal activities to be customer centric in nature, and making it efficient. This relates to lesser time to serve, without mistakes, which is the value discovery by the team as to how to implement it efficiently for the customer in lesser time and cost.

R3 stated that quality department helps to align the production to be solution centric meeting the customer requirements. It has tremendous impact on post sales situations as capturing the VOC voice of the customer is critical for designing the solutions delivery of the IT engineering services. The role of lean tools is to straighten and streamline making the customer delivery to be short (time) with consistent delivery (capability), cutting the flab (lesser manpower) to produce the same output in IT engineering services, in the context of the business. The respondent added that it also helps to detect anomalies like fraud at the customer side, streamline upstream and downstream activities by mapping the time, cost, manpower factors, which gave qualitative improvement at customer side.

R4 stated that the lean is more of a control factor to avoid or curb those wastes that is happening in the entire system. For their company, the application of lean tools have led to structural changes in the manner it was done previously leading to better outcomes with lesser time, cost and resources (manpower) to accomplish a task. The most commonly used is Ishikawa, (cause and effect) and 'takt' time reduction for any services offered to the clients.

For a project scenario, load balancing is also used while for the bigger picture VSM is used, for the optimal ratio of resources deployed against the time factor.

R5 respondent stated that VSM is an appropriate tool as it helps the people in roles, to define the time they will take, with pre-requisite competencies, that helps to tackle the problems identified in the IT engineering service sector. As a company, looking to cut waste in terms of man hours, over or undersized teams, defining service process with quality, lean tools like JIT helps to bring in more agility. However, the lean needs to define metrics like efficiency, capacity, demand in the work flow helps the daily and agile methods are important here as flow of service, as demanded by customers is important to be met (by date and time).

R6 stated that continuous flow of the sequence of activities is what they try to achieve in their company and being an IT engineering service, the ability to achieve it requires to use specific lean tools at right business context. VSM helps a lot in process mapping of service origin, service creating and in service delivery phases linking resources, time, cost into accountability. This lean tool also helps to reduce wait times, the non-value added elements making it more streamlined overall. In this perspective the reduction of time is done with the use of 'takt time' concept to reduce the lead times in each service activity done by the organisation. The challenge however was to eliminate the wait times in each project cases for all the clients at all the time, which was tough as continuous service creation support process enabled by IT infrastructure helped, but it required right mix of team (multi-tiered) to produce customer satisfaction.

Qs 4: Have you been able to identify gaps, address them with lean interventions to bring about a companywide work process change?

R1 stated that lean approach to work processes makes value and non-value added tasks evident. Even the customers feedback help the lean deployment to show, what is needed and what is not. Thus the key contribution of lean tools is to make process eliminate the non-value added, making the effort contribution against time to be more supple, using fewer resources. The respondent stated that any customer feedback is a gap, to be fulfilled in the process of IT engineering service delivery. Translating the customer voice into service features is an organisational level capability in IT engineering service platform that tests the

R2 explained that lean uses quality centric tools, which has quality principles governing them. Thus the continuous flow in service production context remains a gap. As an organisation they are unable to restrict 'wait times' to eliminated fully. This is highly relevant

for the IT engineering service platform business but bringing in improvements requires problem identification (gap identification) capability, focus and vision on which lean transformation tools and techniques can produce desired results. The gaps at the customer delivery process, has been time based mostly which lean tools of like FMEA (failure mode effective analysis) has helped the company to rectify a failed implementation of lean.

R3 stated that the use of lean is a critical tool for improvement of production process efficiency. This is the right tool for gap identification internally and externally (while servicing customers). The tool application though hard to implement results in right kind of IT engineering service delivery output once the agreed goals are set. Lean interventions like VSM helps to allocate people to task activity spreading and balancing the work load evenly to produce continuous delivery capabilities. Lean is actually help in a scientific approach which enables to identify gaps and resolve the problem on a permanent basis.

R4 respondent added that the lean root cause analysis (RCA) helps to broadly understand the problem and go deeper into it with the actual cause to be identified. This helps tremendously either to bring in the process wide changes in the organisation, to make service delivery in the IT engineering service field to be streamlined. Understanding the customer's requirements in the first instance (RFT right first time) helps to reduce the waste element of redesigning the service delivery process adding value to the customer side.

R5 explained improvement of processes using lean requires the problem identification as the first step. This is also the gap in the existing service creation process, or the technical process in the IT engineering service helpdesk that pledges to satisfy the customers. Lean principles are the pillars that has helped the respondent organisation to identify the service wastes that pertains to the quality of IT engineering service delivery system.

R6 added that the role of lean in gap identification with Ishikawa tool is an unique one, and has helped them and also its customers to align the IT helpdesk services to meet the customer side problems to be identified as well. This is the first step to make process to be value added, waste free and all stakeholders getting higher level of efficiency abiding by lean principles. The gaps are mapped by lean tools and for employee and the organisation as a whole the challenge is to overcome the challenges as soon as possible to enable the service delivery process to be more efficient.

Chapter Five

Discussions and Implications

5.Introduction:

The findings in the previous chapter shows that lean deployment in the IT engineering service sector with respondents from different verticals relating their experiences in an open ended interview.

5.1Discussions:

The responses from the respondent group working in different verticals of IT engineering service show that businesses that are seeking to be efficient is using lean more as a efficiency seeking application. The application of lean based principles in existing work process that have service component enabled by IT, and related to IT infrastructure for business helps at micro level to define a waste (or a defect as in manufacturing industry). However, the lean application to identify eight types of wastes is dependent on the actual practices implemented in the organisation at all levels of hierarchy. The responses however were from different respondent in different roles in IT engineering service firms, which predominantly used 'value added' terminology for defining any activity which is of use or of no-use. Each respondent stated that the efficiency and effectiveness of delivery to their client matters the most, on-demand which is without delay through the service delivery design. This pertains to the making the process to be direct, short that reduces employee (number) man-hours and better realisation of the approaches to realise value.

It implies that the business purpose and fundamentals to serve the customers must be justified, as the cost of producing the service with customer defined quality, must be lower than the actual billed cost of the service to the client. The aspect of lean in the company requires a team based approach to disseminate the knowledge across the hierarchy while the challenge of learning and implementing it in all the task area is important for an end to end to support across departments and teams. The involvement at individual employee level is required even though they service the clients using IT enabled platform. At employee and at organisational level efficiency is what everyone seeks that linked to how organisations define IT engineering service design. Deploying lean tools to this IT engineering services in order to show efficiency in knowledge application (ability) and inability being a waste requires a team

based effort. This is translated as lesser time taken, lesser cost to service and controlling cost of quality to make the output meet the order fulfilment criteria. Therefore in an IT engineering service environment the need to develop fail safe services depend on how effectively the lean implementation has helped knowledge dissemination to overcome the problems in IT engineering service production platform.

It is evident from the responses that all of them are using a demand (pull) centric service delivery system that captures the client or customer requirements which follows a SIPOC route to execute an order. This is a process centric approach to IT engineering service and the service portfolio entails the involvement of different suppliers (hardware, software analytics) along with the in-house employees that constitutes the final service delivery to the clients. Therefore the design of this customer centric system has customer initiated actions for order, setting the customer initiated order criteria to be accepted as a (RFP request for proposal) by the companies offering the service. The order fulfilment criteria is based on competencies of the team which the respondents are a part of, the estimation of cost to serve, within time frame and cost of quality to meet the quality of final delivery of IT engineering services. This is movement of the service components by the employees eliminating the non-value added (wastes) knowledge, service design, wait time, structural service design in IT engineering services to meet order fulfilment criteria of customer at any given point time. All of these is possible with an approach that takes employees and their knowledge of lean in their task area where lean is able to show visible benefits.

At pre and post implementation of lean knowledge matters most as every individual employee undergoing lean training need to contribute in their own task area. This is important for the outcomes perspective, as in a process mapped framework, the contribution of all employee towards final input is counted. The next level of challenge in a multi-tiered IT engineering support system is the ability to overcome delay as more internal stakeholders engaged to produce a solution, time taken and cost incurred in man-hours is more. Therefore, designing a service supply chain that is lean, requires to adopt lean principle based design to cut out the excess.

The respondents wanted uninterrupted flow of work in the organisation to the client side for which lean principles are found to be indispensable. For most of their fact finding missions about problems, the respondents stated the use of the root cause analysis, deploying the Ishikawa diagrams. The respondents wanted to explore problems and challenges of lean

principle based tools in the organisation as well in the client side. In few of the responses, the respondents wanted to align their delivery of IT engineering services to meet the client/customer side requirements as well. The wanted to share the value add in the services model to be replicated to the customer side, which is SIPOC being extended. The result is better realisation of the value of services, bringing in the agility factor from respondents to meet the client requirements to eliminate problems faster. Overall it provided better customer experience and satisfaction scale. The respondents showed preference for VSM (value stream mapping) where the value is defined in IT engineering design as delay, wait, unnecessary movement of task to inappropriate employees, unclear communication being present across hierarchies, and losing opportunity to retain the customers with IT delivery service standards. In a service continuum, where the hardware and software works together, the service as an outcome is dependent on the employee knowledge, process delivery design which affects the organisational level commitment to the respective customers. In some responses, the organisational level commitment to improve customer operations have showed deploying lean in client side as well that is helping to align service processes, with roles, tools to measure 'wastes' types to maintain the continuous flow in the service capabilities to the clients. Agile process is the movement of the service creation capability without delay, wait times to meet the customer order fulfilment criteria. Some of the respondents referred to it as 'on-demand' as routing the service deliverables amidst queues, avoiding duplication, is value added service for customers. The implication of the above responses show that organisations at large have been able to utilise the principles of lean intervention tools as appropriate and necessary in the Ireland IT engineering services sector.

The continuous flow in the service process in IT engineering service sector is a challenge as it depends on the design of the service elements and the employee orientation towards lean to avoid the wait time, delay. The service components in this sector is mostly competency based as knowledge drives the employee capability to produce a service while the structural systems of IT engineering service (IT platform) enables to link organisation delivery to the client side. Lean interventions therefore is based on the application of lean tools at the right stages of the business operations. The aim is to produce services on demand, as per the customer specifications, which requires the company wide change in the processes and activities. The orientation of the employees and managers need to be aligned towards lean philosophy that helps to guide them to find out the waste (different types) in the existing production system. The current gaps as per the respondents vary in the range of quality of

service non-conformance, wait time to receive the service, delays at structural level which missed the order fulfilment criteria. Lean helps to find the gaps in the entire customer initiated order and operations supply chain process clearing the confusion of who produces what, within the time frame designated. It creates a radical change in the approach to work, as the demand (pull) centric operations environment in the IT engineering service uses technology as a platform to deliver the service. The service capacity at operations level from the organisation is dependent on the parameters of uniform lean knowledge and which is when applied to specific situations is able to capture and identify the customer needs. The organisation level capability to deliver what they promise and the complaints, feedbacks of customers pertains to gap, but enabling lean principles deployment to close those gaps is a competency.

5.2 Implications:

Lean is a principled based approach when in action requires the employees, management driven philosophy reflected in their approach to work output. Lean in the IT engineering services have transformed the micro and macro (organisational level) specific problems into opportunities of improvement. In reality, it is translating the non-value added task into a value added one, by eliminating the waste component. However the most striking feature of lean in IT engineering services is the ability to map the activities with task based roles allocated balancing the aggregate work load evenly in the end to end service supply chain. It uses the SIPOC framework to link the stakeholders with identification of all activities interlinked adding value in each stage till the service creation process reaches the customer for final consumption. The framework uses humans, and their competencies in any work area against time, enabling the operations to be quantified that segregates the output based definition to label over production, under production, over processing, waiting, delay. IN overall lean defines the objective of IT engineering service to produce which is of use to the customer leaving the rest of the employee, organisational actions not within customer requirements to be a waste. Hence, it allows to amalgamate the inputs of time spent, effort by employees, cost to produce a service to be quantified that justifies the business purpose of profit. The lean tool orientation of total process to be customer centric has helped to design a path for service delivery process which is not static but can be improved upon time as and when needed. Hence, for IT engineering service sector, as the customer demands change in the service standards, the criticality of the lean principles approach to task modification and rescheduling a delivery amidst queues requires immense integration. VSM (value stream

maps) is a favourite tool in lean that has helped current service operations, processes and sub process to adapt to an improved or higher level. The use of root cause analysis, the Ishikawa diagrams to ask the '5 Whys' to understand the origin of problems is identified as the organisations face the process centric challenges. The implementation barriers of lean knowledge of tools to identify variables, for mapping productivity elements exist in every phase. For IT engineering service firms that has IT as the backbone of the service delivery process, creating the demand (pull) embedded in the service design required to find the gaps in the service strategy, transitions, operations to meet the continual customer service requirements. In a large organisation, IT engineering service support can vary with managed services, call in, block hours format that needs equally capable operations team to meet the credibility of the brand promise to all its customers. The whole lean exercise is to avoid the service failures which have legal clause attached in case of failure to respond to vendor, initiating a disaster within the contract period.

Chapter Six

Conclusions and recommendations

6. Introduction to the final chapter:

The last and final chapter concludes the respondent replies and the gaps in the research by linking the research objectives set in the first chapter. The theories discussed about lean principles helps to establish the fact of tangible benefits in the manufacturing sector. The research undertaken to assess the lean tools and techniques impacting the IT engineering services sector here in the Ireland perspective have been concluded below. The section contains the triangulation of literature, responses found and if the research objectives are being met. This section also outlines the gaps and the best practices borrowed from other sector to facilitate the IT engineering services to deploy lean methods.

6.1 Objective linking:

- ***To find out about lean principles and implementation practices***

  The literature review revealed lean based principles to be closely linked to the quality (TPS Toyota production system) with its origin happening in manufacturing sector. It has led to integrated improvements at structural and process level in different sectors wherein the output realised is a customer value. The people accepting lean processes have a purpose and goal making lean a strategic tool for improving the workflow processes. The organisations using lean is looking to reduce the rework/redoing issue where centrality of customer centric operations has revolutionised the production processes. Qu et al. (2011) research seem to be applicable in this findings that lean defines eight wastes and delivers definitive outcome once the tools and methods are applied systematically eliminating the wastes in the services sector as well. In implementation phase, learning about lean and implementation phases need all round communication and employee involvement to align the cost, time and human effort quantification to be justified which is similar to Albliwi et al. (2014) findings in literature review. Lean contains the waste with the following tools like Ishikawa, VSM, ‘5 whys’, CI ‘continuous improvement’, also requires organisation culture to create a production environment that supports multi tasking, collaboration for uninterrupted production. Lean shows the agility to reach goals at optimal speed with team, improvements based on challenge. Kundu and Manohar (2012) seem to agree in

literature review, that in a service perspective, lean knowledge, in the work process context needs to define a service strategy, backed by design, and organisation ability to support services transition, during service operations leading to a continual service improvement level. In services, wastes defined by lean is service design waste where the resulting needs does not meet the customer requirements. Seddon et al. (2011) findings seem to confirm the responses that the service items waste that is a flaw in service process, service ability waste which is not fully utilising the service capacity, service process waste that is low efficiency in the work, and service delay waste in which customers had to wait to avail the service.

- ***To find out the challenges in implementing IT engineering services industry and lean implementation strategy***

  The respondents showed that lean learning process at organisation wide perspective is a behavioural challenge, though the greater challenge is to implement the right lean tool in IT engineering services stages at elemental level. It is more complex when the service provider is engaged into client transition of services. The adaptation of existing process towards lean is a process based approach where functional department dissolves to be motion centric of the demand (pull) initiated by the customer order. The organisational level of the service capabilities starting from customer ends with the customer is mapped with employees serving it, adding value at each stage. Widman et al. (2010) findings in literature review seem to match the findings that the challenge is to standardise the same output level in terms of quantity and quality as an organisational capability requires fixed activities measurable into quantified objectives and corresponding results. In IT engineering service domain the ticketing function, delivery confirmation are service touch points which require service design to eliminate non value added tasks, or elements that increases cost of quality. Borrowing from CMMI, smoother flow or agility in the entire service supply chain requires open two-way communication, understand VOC (voice of customer), develop the capability to translate customer requirements into service deliverables. The challenge is to reduce the 'takt' time, that affects total lead time in each service activity (order to delivery). Lean helps to isolate time, effort and cost elements in all the tasks that make the service to meet customer order fulfilment. Bicheno and Holweg (2009) literature review seem to meet the responses that the task based challenges is to avoid duplication of efforts, waiting of customer or delay to produce a service, while higher level challenges include errors while service transition is going

on, delay in the responding to customer request. In most of the cases the service design needs attention to meet customer requirements and eliminate unnecessary features. Adoption of lean at the customer side is a value added strategy but the IT engineering service firms also face challenges to align the service delivery process to create an uniformity in the entire system. In a multi tiered system, firms have to reduce time against a ready solution in IT engineering services where part of the services are outsourced from a vendor.

- ***To evaluate the appropriateness lean tools and techniques in IT engineering services industry in Ireland***

  The lean tools and techniques which has been deployed by the Ireland IT engineering service sector shows VSM (value stream mapping) to be the most popular organisation level (high level) tool to integrate the 'takt' time and lead time issues. In most of the responses, this tool helped to identify the delays, restrictions, or track the higher inventories (more tasks for one employee) which cause the delays in service delivery to be visible that is similar to the findings of Qu et al. (2011). The results for identifying root cause problems are done by Ishikawa (fish bone analysis) where the core issue is broken down into sub issues. However, in VSM it allows to map current state and also the 'to be' state that the organisation aims to achieve. Indirectly the organisation offering IT engineering services is also trying to contain the 'cost to serve' parameter as optimising IT engineering service, manpower and man-hours spent is important, due the sector is labour and knowledge intensive domain. The lean principles based approach helps to contain the 'cost of quality' as rework/redesigning the IT service delivery design is achieving process based efficiency. This reflects in making the outcomes to be efficient meeting the customer promise and expectation set. FMEA (failure mode effects analysis) was also cited by respondents as a tool as it is being used to identify and anticipate the failure of the IT engineering service delivery detection in the form of a reliability improvement tool for operations as per study by the research of Staats et al. (2011). The results also showed workload balancing 'Heijunka' which is levelling the aggregate order flow to spread evenly to all employees to create a uniformity of task completion and flow for final service delivery function. The waste identification of the services domain has benefits which the Ireland IT engineering service firms have confirmed though this is a dynamic

situation as every moment client requirements change and Ireland firms need to adjust to the same.

- ***To find gaps and suggest best practices in lean implementation IT engineering services industry in Ireland***

The respondents stated that complexity in the IT engineering service increases when the services offered is often outsourced from vendors. In a situation of sudden demand of service, volumes rise while production levelling is needed and if it is outsourced the challenge to reduce supplier's time to service is not in their control. Few firms in Ireland did offer lean at customer side as well, that aligns both organisations to feel the responsiveness in the supply chain (demand –pull) about a service. The middle and lower employees in Ireland IT engineering firms need to understand that lean is not a static objective but keeps on changing as per business requirements. Therefore the ability to develop organisational wide capabilities to respond or become responsive improves the customer satisfaction level at client side. Better alignment of man, machine and methods require FMEA based approach and sharing of data within stakeholders, about IT engineering service KPIs (key performance indicator) about production process. This is a gap as only few companies have initiated lean at client side, share data to take advanced stage decisions to identify risks/threats that plague the system. The firms are not able to be responsive enough for a BCP based service recovery option that helps the clients to get back in shape, if services are disrupted. The issue of outsourced multi tiered vendors associated with the Ireland based IT engineering firms makes the situation more dependent and complex.

Some of the best practices from the IT and ITES industry is the data driven lean practices where the concept of sharing and collaborating between stakeholders which reduce time to take tactical decisions resulting in more responsive service delivery process capability. While sharing data and collaboration with external stakeholders, the multi vendor and multi tiered IT engineering model helps to build certain level of the confidence and better structural ability to address the business and operational level risks and threats.

6.2 Final Conclusion:

The above study shows the literature review based previous studies and the status of lean implementation in the IT engineering service sector in Ireland. The current study does not

reveals in detail to what extent the lean tools have benefitted in terms of mapping production efficiency though most ideal lean tool is (VSM value stream mapping). Therefore in the services sector, the use of VSM being used by most of the responses show that services sector has been able to directly associate its activities related to process centric development, scheduling and planning for a streamlined delivery (uninterrupted) to the customers of Ireland IT engineering firms. Practical applications of lean tools like Ishikawa, Root cause analysis, '5s', production balancing 'Heijunka' has been evident from the respondents which shows advanced level of the lean application in a process centric environment. This is leading also to JIT in terms of responding to the customer requests, engaging through collaboration to implement lean at customer site that links VSM of the Ireland IT engineering firms with that of the customers. Use of FMEA mentioned shows concern to avoid threats and have BCP (business continuity plan) to create smoother flow for the service creations to improve efficiency and productivity in the Irish IT engineering firms. However, there are scope of improvement as the firms are still not yet fully developing lean application as an enterprise wide practices including the external stakeholders. The research concludes that services lean application differs due to the context of wastes in services is different than that of the manufacturing sector. The use of tools to a limited extent has affected the services design and service delivery efficiency from the customer satisfaction perspective. However, the lean benefits have shown the universality in its application usage and yielding benefits, despite the implementation challenges at the structural and process level.

6.3 Recommendations:

A. The Ireland IT engineering service firms need to adopt finer principles in their existing operations to benefit in the long term:

i) Create a system (separate) that helps to resolve the customer's problem at the earliest by using a collaboration with outsourced vendors and clients.

ii) Not to waste customers time hence create multi channels for services to be consumed by clients.

iii) Develop capabilities to capture client requirements in a dynamic mode and create systems to translate needs into service features.

iv) Develop process centric capabilities in Ireland IT engineering service that is responsive (agile) ‘ what is wanted, where it is wanted and when it is wanted’ for all the services in the company portfolio.

v) Engage into continuous mission to find stable sustainable solutions, identify waste, improve and cut down on time, cost parameters.

The above suggestions require phased wise launch with the employee, management and stakeholders (external) in confidence.

B. In order to develop capabilities for IT engineering service firms in Ireland to develop rapid lean design capability to address the dynamics in the business environment as found as gaps, the following are the stages –

i) Create work cells that comprises of cross sectional team representations through which the service process creation will happen.

ii) Create relationship between these cells which offers resolution to problems to clients that are complex in nature.

iii) Offer expert solution to the new service process design and creation for addressing a new customer requirement using heavy coordination of skills, competencies.

iv) Develop the ability in the individual and team level capabilities to segregate capability to deliver for differential order requirements and their variability. This is to be managed with a base load team and standby of specialised skill set team on rotational duty throughout 24 hours cycle of 8 hours shift each.

6.4 Limitations:

The lean application and deployment in this research shows that the responses did not obtain the lean deployment challenges and tools during service transformation from any Ireland IT engineering service firm. The research could have gained more insight if the employees who are the part of the lean implementation team in Ireland IT engineering service firms took part and shared their insights about the challenges faced. In addition, it was difficult to take lengthy interviews because of the time schedule of the respondent.

Considering the word limit, it was impossible to provide the detailed data on the questions asked from the respondents through Google Forms though the information has been provided

in brief under discussions chapter. The short time duration due to the academic nature of the research limits the scope of the research.

6.5 Future research opportunities:

Future studies in this lean topic can be related and extended to the extent it is being deployed in public administration, supply chain and logistic, healthcare or in teaching sector. The analysis of the lean principles and tool adoption in each sector can throw insightful light to understand the extent the lean implementation have taken place. The issue here is to relate the existing service sector area and translate the extent lean benefits the other service sectors as well in Ireland. There is automation in the IT and IT engineering services sector going forward and mapping the use of lean methodology of tools deployed to understand how this sector copes with technology driven automation would be a possible research area for future.

Chapter Seven

Reflections on Learning

What did go well?

In my opinion, all the elements of the study are vital starting from introducing the topic, working on the research questions, reviewing the literature, deciding the methodology, collecting primary information, analysing the data and finally suggesting recommendations etc. As Albert Einstein has rightly said "If I had an hour to solve a problem and my life depended on it, I would use the first 55 minutes determining the proper questions to ask" and I truly believe that I've followed it really well, since I've incorporated more time in working on my questionnaire and collecting information from the respondents. Apart from that I have also worked very hard on the literature review especially collecting secondary data using latest references. Also, the topic chosen is deeply into project management and requires in-depth knowledge of Lean methodologies, which made me pursue further certifications and helped me in adding more value to my profile.

What did not go well?

Time management

The most important aspect wherein I faced difficulty is managing the time given for the completion of the study. Firstly, the festivals were not considered while making the plans along with the lag time of the interviews with the respondents. Secondly, the time for proof reading all the chapters were not considered at an initial stage.

Better Planning

The above mentioned issue occurred because of lack of organisation and proper planning. Usage of further planning tools would have been made a difference like making proper plan using Gantt chart, maintaining to-do list for everyday tasks and completed milestones.

Consultation with Supervisor

I could have incorporated more time for consulting the supervisor and taking his inputs which should have been considered while making the research plan.

To summarise, though it has been said that "the biggest room in the world is room for improvement", if I'll get a chance again I would like to work on these discrepancies and provide greater value to the companies in the industry.

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Appendix:

Table. Lean principle for services - Adapted from Selau et al. (2009).

Author	Lean characteristics developed to service operation
Bowen & Youngdahl (1998)	- Reduce the performance trade-offs - Make the value-added processes flow and implement customer-driven system - Eliminate losses in the value chain of activities, from development to delivery - Increase customer focus and involvement in the development and delivery processes - Empower employees and teams
Swank (2003)	- Reduce the performance trade-offs - Make the value-added processes flow and implement customer-driven system - Eliminate losses in the value chain of activities, from development to delivery - Increase customer focus and involvement in the development and delivery processes - Empower employees and teams - Segregate activities by complexity - Publish / present performance results
Sánchez & Pérez (2004)	- Elimination of losses - Continuous improvement - Multifunctional teams - Just-in-time delivery - Involvement of suppliers - Flexible information systems
Ahlstrom (2004)	- Elimination of waste - Zero defects - Pull instead of push - Multifunctional teams - Decentralization of responsibilities - Verticalized information systems - Continuous improvement
Womack & Jones (2005)	- Solve the customers' problem completely by ensuring that all services operate and work together - Do not waste the customers' time - Provide exactly what customers want - Provide what is wanted, exactly where wanted - Provide what is wanted, where wanted and when wanted
Jones (2006)	- Specify what creates and what does not create value from the customers' perspectives - Identify all the steps needed to design, order and produce the service along the flow to focus on losses that do not add value - Make those activities that create value flow without interruptions, return or fragments - Do only what is driven by the consumer - Strive for perfection, continuously improving services and value stream
Sarkar (2007)	- Application of the DEB-LOREX model showing all the organizations' processes and ensuring sustainability. Use of five elements: people, processes, partners, troubleshooting and promotions.
Bicheno (2008)	- The new wastes: making the wrong product to be efficient, human capital, inappropriate systems, energy and water and natural resources. - Seven wastes in customer service: delays, duplication, unnecessary movement, lack of clarity in communication, wrong inventory, missed opportunities and mistakes. - Fourteen office wastes: screening and research, inappropriate measurement, low load, high load, inappropriate prioritization, interference, inappropriate frequency, startup and end off, mistakes, errors or lack of appropriate knowledge, communication error, sub-optimization, wait, improper presence and inappropriate tradeoff.

Questionnaire:

Qualitative questionnaire for managers

Name:

Designation:

You were a part of the Lean implementation team – _____ (proceed only marked YES)

Qs1.: Do you believe that lean adoption helped your organisation to become defect or error free (zero waste) in production?

Qs 2: What steps were taken to eliminate the barriers of lean tools at pre and post implementation phases in your company?

Qs 3: What are the tools and techniques of lean methodology deployed in your company and what are the resultant benefits?

Qs 4: Have you been able to identify gaps, address them with lean interventions to bring about a company wide work process change?

The above questionnaire did involve some other questions as well which has been answered through google forms to gain some initial knowledge on Lean -

Qs 1. Do you agreed that Lean application in all work processes in IT engineering service is highly specified sequenced, timed towards quantifiable outcome and problem resolution?

Qs2. Do you agreed that Lean implementation integrate the production(operations) and customer connect enabling a continuous flow in IT engineering service architecture ?

Qs3. Lean allows to define all eight types of wastes in IT engineering service and helps to control them with tools?

Qs4. Did the use of Lean methods faced barriers, in terms of knowledge application by employees to achieve outcomes in the IT engineering service industry?

Qs 5. Did you face challenges in changing existing work practices, and adopt lean tool based techniques in your work area ?

Qs 6. Do you believe that Lean reduces cost of quality (COQ) and solves the CTQ (critical to quality) issues in IT engineering service production environment?

Qs 7. How far do you agree that Lean thinking helps in defining value, value stream, flow, pull, perfection (lean principles) in IT engineering service ?

Qs7. Have you noticed that Lean brings change in work methods, work processes in IT engineering service ?

Qs 8. lean has given the IT engineering service production to reach a continuous learning phase, enabling innovation and growth?

Qs 9. Do you believe that lean application has improved productivity, efficiency and effectiveness of the organisational capacities in all IT engineering services processes?

Qs10. As an employee, do you agree that lean implementation needs empowerment, professional organisation culture, participative leadership to build all round commitment for improving baseline indicators in IT engineering service industry?