Lean Construction between theory and practice: A case study of the Irish Construction Industry

Dissertation submitted in part fulfilment of the requirements for the degree of Master of Business Administration – Project Management

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Declaration

I, Ameya Vilas Kharade declare that this research is my own original work except wherever I have acknowledged and referenced the work of others. It has never been presented to any institution or university for the award of degree or diploma. This work is fully compliant with Dublin Business School’s academic honesty policy.

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Abstract

Lean manufacturing is a well-known management philosophy and has found widespread application in the industry. Lean Construction applies the same philosophy to construction activities. The reception of Lean in construction was lukewarm initially and it has been slow to open to academic debate. This could be due to the fact that Lean being a manufacturing based philosophy was considered incompatible with construction. In any case, more and more companies across the world are beginning to take up Lean for various reasons. This study was conducted in the Irish Construction Sector with an inductive and qualitative approach and hopes to examine the differences between Lean Construction in theory and in practice. Primary qualitative data was collected through semi-structured interviews with personnel involved with Lean construction in Irish Companies. Secondary qualitative data was obtained through Lean Construction Ireland’s open source company case studies. The data was then coded and analysed using the software NVivo 12.

Lean Construction is mostly implemented in textbook fashion especially in the area of achieving work flow balance. In the areas of value creation and to a degree, waste management however, it’s a different story. Seminal literature on Lean argues that value is best left up to the client to decide but the constant changing of value by the clients complicates value creation according to this study. On the subject of waste management, the Lean concept of ‘Do it right the first time was found to be impractical in a construction context as some form of waste will always exist.

As things stand, there is little academic literature on the topic of Lean Construction in the Irish Construction Sector. This study hopes to fill this gap in the knowledge through the opinions and experiences of those involved in this field.
Chapter 1: Introduction

Why the Construction Industry is important.

The construction industry is closely interconnected to the other sectors of the economy and that makes it a very important sector to a country’s economy (Oviedo-Haito et al, 2013, p. 1). It plays an especially key role in strengthening the economies of developing countries by helping reduce unemployment (Bajjou et al, 2017, p. 172). The construction industry made up of 10 per cent of the European Union’s economy in 2007 just before the onset of the Great Recession (European Construction Federation, 2007 as cited in Oviedo-Haito et al, 2014, p. 1). According to forecasts by the UK government as part of its ‘Construction 2025’ industrial strategy report the global construction market will grow by up to 70 per cent between 2013 and 2025 (HM Government, 2013 as cited in Sarhan et al, 2017 p. 2). According to a Market Line report, the Irish construction industry has experienced a boom in recent years, reaching an unprecedented growth peak of 29.2 per cent in 2016. According to forecasts, the industry will continue to follow a strong growth trajectory, despite losing some of that dynamic (Market Line, 2017, p. 8).

Room for Improvement?

While the construction industry may play an important role in the national economy, it is constantly a target for criticism for its inefficiencies, low rates of productivity and profit margins, in comparison to other industries (Egan, 1998; Koskela, 2000 as cited in Sarhan, Pasquire and King, 2017, p. 12). It is also seen as progressing more slowly in comparison to other sectors (Sarhan, Pasquire and King, 2017, p. 13). Besides this, the construction sector is also known to be one of the largest environmental polluters, physical waste producers, and energy consumers throughout the lifecycle of its projects (Huovila and Koskela, 1998;
Construction companies can improve their competitiveness by increasing work efficiency through a systematic reduction of process wastage (Al Aomar, 2012, p. 105).

**Lean Construction**

Upon looking at the problems faced by the construction industry, Lean management seems to look like the perfect solution for it. Lean is a management technique which aims to eliminate waste and synchronize necessities in order to, on the short and long term, meet the requirements of the market (Georgescu, 2011, p. 4). Developed originally from the Toyota Production system, it has since found use across various sectors. Some studies have argued that Lean methods have been found to be quite effective at reducing costs (Miller, Packham and Thomas, 2002, p. 67) while others argue that it is difficult to implement Lean practices in the construction industry since the original purpose of Lean was quality improvement in the manufacturing sector (Sullivan, 2011, p. 209). However, the success of the initiatives also depends on the level of accuracy in implementation. Lean construction is being taken up by more and more companies (Steinhaeusser, Elezi, Tommelein and Lindemann, 2014, p. 1); as such it would be interesting to learn from their experiences and find out how Lean is applied in the industry. A lot of studies have been conducted across the world to study the application of Lean in by different companies to find out more about their successes and shortcomings; however, there are very few such studies conducted in the Republic of Ireland. That is what this study will attempt to do.

**Lean Construction in Ireland**

There has recently been an increased interest in Lean practices in Ireland. Organizations such as Lean Construction Ireland have taken a keen interest in propagating the awareness
of Lean for the Irish Construction Sector. This research will broadly focus on the Lean journey of the Irish Civil Construction companies in using methods associated with Lean in their projects; the challenges they faced and the future opportunities that will emerge from their experiences with Lean. Parallels will be drawn with theoretical Lean concepts to find out how differently or similarly they are translated into practice. It can then be discerned whether lean concepts are implemented in text book fashion or if they are modified to suit the immediate needs of the industry. In the latter case, what are the implications? That is what this study will explore.

**Rationale for the proposed research**

Lean Construction has been slow in opening to more critical debate (Jørgensen & Emmitt, 2008 as cited in Gao and Low, 2014, p. 666) in comparison to Lean manufacturing which has been a subject of numerous studies (Dahlgaard & Dahlgaard-Park, 2006 as cited in Gao and Low, 2014, p. 665). However, mentioned above, interest in Lean construction has recently taken off in Ireland with two of Ireland’s leading construction companies, BAM Ireland and SISK group (Marketline, 2017, p. 24) incorporating Lean Construction elements into their business (Lean Construction Ireland, 2018, p. 1). Besides, its awareness is being propagated further through events organized by organizations such as Lean Construction Ireland. As mentioned above, there is a lot of literature that suggests that going Lean helps in increasing a firm’s competitiveness by improving process efficiency by bringing down unnecessary expenses and increasing the value. However, implementation of Lean is only one part of the journey and long term sustainability of the changes caused by the Lean initiative is what presents a greater challenge (Green et al, 2008 as cited in Nesensohn et al, 2016, p. 1). Although the awareness of Lean in the Irish Construction sector is now greater than before, it can still be said that it is still in primordial stages. This is evidenced by the fact
that there are few academic studies carried out about Lean construction in Ireland. Therefore, this study will hope to plug the gaps in the existing knowledge about the progress of Lean in the Irish Construction Sector.

**Research Questions**

What are the differences between Lean construction in theory and in practice? What are the implications of the differences?

**Sub Questions:**

1. What are the driving forces behind Lean initiatives in the Irish Construction Industry?
2. What is the senior leadership’s perception of Lean in the Irish Construction Sector?
3. What is the general perception of final value in the Irish Construction Sector?
4. What are the things most commonly regarded as waste and how is it managed?
5. How much internal resistance is encountered when implementing Lean?
6. How is workflow variability mitigated?
7. What is the Irish Construction Sector’s take on long term sustainability of Lean?

**Originality of this research**

Very few academic studies have been conducted in Ireland to assess the successes and failures of Lean methods in the Construction Sector. Although there have been many events organized by the not for profit organization: Lean Construction Ireland and where some of Ireland’s leading construction companies such as SISK and BAM Ireland among others have shared their Lean journey. However, the lack of academic studies in this area leads to small gaps in the knowledge which can be filled to some extent using the findings of this research.
Recipients

The main purpose of this research is to enhance the understanding of Lean Construction from a theoretical viewpoint. As mentioned before, construction activities are about to increase by a significant margin in the upcoming years and this will provide many companies with the opportunity to test out new methods. Numerous studies have shown that Lean methods have proven effective at increasing overall efficiency (Sarhan, Pasquire and King, 2017, p. 14). Lean construction has only recently taken off in Ireland and this study can definitely play a small role in getting companies to adopt Lean techniques. This will help in improving process efficiency and cutting down extra costs thereby driving profits up. As such, the findings of this research will benefit the following entities:

1. Irish companies who are considering adopting Lean construction
2. Consultants and experts involved with Lean construction in Ireland.
3. Lean Construction Ireland in their efforts to increase the awareness of Lean construction across the sector
4. Academics researching Lean construction

Research Approach

This research is qualitative in nature and was conducted by a mix of primary and secondary research methods. The primary method of data collection involved in-depth interviews with managers, consultants and academics involved in Lean Construction. Secondary methods involved performing a literature review of academic materials on the topic of Lean construction from all across the world; along with this, archival research consisting of exploration of case studies conducted on various Irish firms about their Lean Journey was conducted in order to gain an overview of
**Time**

This research was conducted over a period of 3 months or roughly twelve weeks starting from the 4th of June to 26th of August 2019. Due to the short period of time allotted for this study to be carried out, a cross sectional approach was taken as opposed to a longitudinal one which would have required longer to complete (Saunders et al, 2015, p. 200). A large part of the time was taken up by attempts to reach individuals involved with Lean initiatives in Irish Companies. Since the researcher had no prior contacts in the Irish Construction industry, all attempts to reach the potential participants were made through LinkedIn which took a while.

**Limitations**

*Small Sample Size*

The main limitation of this study was the small sample size as the response rate from those contacted was low due to the researcher having no prior contacts in the Irish Construction Industry. Only six out of twelve people contacted responded to the request of participation in the research. Of the initial six, four individuals agreed to share their thoughts over the phone or Skype while the responses from the remaining two arrived too late for their opinions to be recorded and analysed. Although they provided wonderful insight into their respective experiences with Lean Construction and its application, the findings of this study cannot be generalized to the entire industry.

**Structure of the Dissertation**

This dissertation will be organized into four main chapters apart from the brief abstract in the beginning.
Abstract: This section will provide a brief overview of the study that was conducted and inform the reader about the topic of Lean construction.

Chapter 1: This chapter will provide the reader with a background to the topic of Lean philosophy and its applications in various sectors. Besides this, the reader will be informed about the rationale for conducting this research, its originality and the potential recipients of the study that can benefit from the results.

Chapter 2: This chapter will delve deeper into the subject of Lean construction and explore what other previously conducted studies have to say on the topic of Lean construction and how it all fits in this context.

Chapter 3: This chapter will go over the methodology adopted by the researcher in order to gather and analyse data for the purpose of this study besides addressing any ethical concerns and limitations of the study.

Chapter 4: This chapter will go over the findings of the study that were obtained through the methods.

Chapter 5: This chapter will involve an in-depth discussion about the findings of the study and how they answer the research questions asked before.

Chapter 6: This chapter will make conclusions based on the data and the discussion and provide directions for further expansion of the research.
Chapter 2: Literature Review

Introduction

Quality management as a profession is quite an old one; we see methods that appear to be predecessors to modern quality improvement philosophies as far back as the late 1700s with Benjamin Franklin’s “Poor Richard’s Almanack”. Over time, they evolved into well-known improvement philosophies such as Six Sigma, Lean Manufacturing, and Total Quality Management as quality gained more and more importance. Over the past 30 years, there has been an increased demand for quality management curriculum (Ahire and Golhar as cited in Sullivan, 2011, p. 216). These are all collectively known as “continuous improvement initiatives” which are designed to implement quality improvement on a continuous, ongoing basis (Mclean, Anthony and Dahlgaard, 2017, p. 219).

Over the years, many companies have employed quality improvement initiatives with mixed results (Mclean, Antony and Dahlgaard, 2017, p. 219). The success rate of these initiatives varied from company to company and was affected by factors such as competence of people involved, management style, focus of attention, organisational culture, resources, level of knowledge and skills of employees, organisational priorities, management priorities, turnover rate, market pressures etc. (Sajid and Moosa, 2010, p. 754). As the name suggests, Lean manufacturing arose in the manufacturing industry and has since then been successfully implemented all across the industry and beyond. Just like in Lean manufacturing, Lean construction hopes to eliminate wastes within a process and thereby helps in reducing costs (Sarhan, Pasquire and King, 2017, p. 14).

While Lean Construction does not have one official definition, the Lean Construction Institute defined Lean construction as “a production management-based project delivery
system emphasizing the reliable and speedy delivery of value” (Lean Construction Institute, 2012 as cited in Al Aomar, 2012, p. 106). However, as with any tool, the level of expertise with which it is wielded determines how successful it can be. Often times, questions have been raised regarding the effectiveness of Lean; however it has also been found that underwhelming or opposite results stem from imperfect implementation or unrealistic expectations (Omran and Abdulrahim, 2015, p. 53).

The construction industry’s activities and its relatedness to the other sectors of the economy make it a very important sector to a country’s economy (Oviedo-Haito et al, 2013, p. 1). The construction industry made up of 10 per cent of the European Union’s economy in 2007 just before the onset of the Great Recession (Oviedo-Haito et al, 2013, p. 1). However, the construction industry is also a target for criticism for its inefficiencies, low rates of productivity and profit margins, in comparison to other industries (Egan, 1998; Koskela, 2000; as cited in Sarhan et al., 2017 p. 2).

**The Irish Construction Sector**

The bursting of the housing bubble during the Great Recession resulted in housing supply being limited for the past decade (MarketLine, 2017, p. 7). However the residential construction sector has since experienced a rebound and this has allowed activities to take off from a “low base” (MarketLine, 2017, p. 7). Besides residential construction, other non-residential activities have also posted impressive growth rates. The residential segment however was the industry's most lucrative in 2016 accounting for about 69.7 per cent of Irish Construction (Marketline, 2017, p. 10). This was primarily a result of increased household income during the preceding years and a consequent increase in demand. However current forecasts predict deceleration and will likely cause a decline in the industry
value by 2021 (Marketline, 2017, p. 12). To cope with the problem of the increasingly stagnant residential construction sector, the National Asset Management Agency plans to construct over 20,000 residential units by the year 2020 (Marketline, 2017, p. 8). But regardless, commercial construction will continue to be the main factor driving growth (Marketline, 2017, p. 8).

The Lean philosophy

**Background**

Lean philosophy originated in the manufacturing industry inspired by the Toyota Production Model as Toyota became a major player in the automotive industry (Steinhaeusser, Elezi, Tommelein and Lindemann, 2014, p. 1). TPS was in-turn a product of owner Eiji Toyoda’s visit to the Ford Manufacturing plant in Detroit (Sullivan, 2011, p. 210). There he realized that his company can maintain a decisive competitive edge while utilizing minimum resources (Sullivan, 2011, p. 211). The term “Lean” was first coined much later however; in 1988 by John Krafcik in his 1988 article “Triumph of the Lean Production System” (Gao and Low, 2014, p. 665) and later brought into the spotlight by James Womack, Daniel Jones and Daniel Roos through their work “The machine that changed the world”. Womack and Jones; both experienced in the manufacturing industry based Lean thinking on two main pillars: value and waste (Womack and Jones, 2003, p. 16). However as later studies describe, there is much more to Lean than just waste and value.

**What exactly is Lean?**

Anyone remotely familiar with Lean knows that it works by eliminating waste known by its Japanese term “muda”. In the process anything that does not add value to the organization but takes up expenses and space is discarded (Cherrafi et al 2017, p. 4482). Liker (2004)
provides a rather interesting conceptualization of the Lean system through a pyramid model which can be considered applicable to the construction industry’s complex procedures (Gao and Low, 2014, p. 665). In his model, Liker divided up the 14 original tenets of the Toyota Production System into 4 categories which he termed the 4 P’s; not to be confused with the 4 P’s of marketing. These 4 P’s are: Philosophy, Processes, People and partners, and Problem-solving

![Pyramid Model for Lean](image)

**Figure 1** The 4P model for Lean as suggested by Liker in 2004


Liker (2004) points out that an imbalanced focus on the either of the P’s leads to Lean initiatives not being as effective in those companies. For instance, usually too much emphasis is laid on the process element while the other P’s are neglected (Gao and Low, 2014, p.668)

**Philosophy:** The philosophy element of the pyramid forms the base of the pyramid as shown above and it encourages the company leadership to have a long term vision rather
than focus on short term goals and make decisions accordingly (Liker, 2004 as cited in Gao and Low, 2014, p. 669). The significance of this element must not be overlooked; as often is the case; if Lean is to be sustained.

**Process:** This layer of Liker’s pyramid is focused on the operational aspects of the original Toyota Production Model (Liker, 2004 as cited in Gao and Low, 2014, p. 670). This element is mostly focused on the everyday processes happening on the ground. It helps in improving efficiency in operations; achieve reduction of waste, balance out the work flow and manage over production (Liker, 2004 as cited in Gao and Low, 2014, p. 670).

**People and Partners:** This element provides guidance in relation to the people and partners throughout the process. According to Liker (2004), mechanisms need to be put in place in order to facilitate more collaboration among all stakeholders. Besides this, this layer also requires decisive leadership and for them to actually be present on the ground in order to be able to identify any potential problems (Ohno, 1998 as cited in Samudio, Alves and Chambers, 2011, p. 41). The importance of this layer cannot be underestimated as in the absence of the human aspect; the initiative would not be complete (Gao and Low, 2014, p. 674).

**Problem Solving:** This top most layer of Liker’s pyramid encourages smart work rather than hard work (Clarke *et al*, 2013, p. 638). First of all, it encourages the leadership to lead from the front; a process which is also known by its Japanese term “Genchi Genbutsu” (Ohno, 1998 as cited in Samudio, Alves and Chambers, 2011, p. 41). Besides this, it encourages decisions based on consensus rather than an authoritarian top down decision making process whereby workers are given freedom to express their ideas and propose innovative solutions. Lastly it encourages a complete commitment to continuous improvement by
means of using every problem as an opportunity to improve (Liker, 2004 as cited in Gao and Low, 2014 p. 677)

Even though Lean started out in the manufacturing industry, it has since then found applications in many non-manufacturing sectors (Gao and Low, 2014, p. 664). Applications for Lean have been found in sectors varying from healthcare (Dahlgaard, Pettersen and Dahlgaard-Park, 2011 as cited in Gao and Low, 2014, p. 664) to the service sector (Alsmadi, Almani and Jerisat, 2012 as cited in Gao and Low, 2014, p. 664) and most importantly, construction.

**Transferring Lean concepts to construction**

![Figure 2 The basic tenets of Lean (Source: Lean Construction Institute)](image)

There is a lot of literature arguing for either side on whether or not Lean thinking can be successfully implemented in a construction context (Salem *et al.*, 2006, p. 168). On the surface, the manufacturing and construction industries may appear to differ in many ways; the most obvious difference being the end product (Salem *et al*, 2006, p. 168). There are also other factors such as, on-site production (Schemener, 1993 as cited in Salem *et al*, 2006, p. 168).

However Bowen and Youngdahl (1998) argue that construction has elements of both production and service and thus Lean thinking can be applicable (Howell, 1990). There are however a few instances of commonality in manufacturing and construction. The Lean construction institute gives 5 basic corner stones of Lean Construction: Optimization on the whole, Removal of waste, Focus on Process and Flow, Value Generation and Continuous improvement and most important of all, Respect for the people (Lean Construction Institute). When combined with Liker’s pyramid model shown above, it produces an interesting cocktail of ideas.

*Liker’s philosophy element in Construction*

**Continuous Improvement**

As mentioned above, the philosophy element of Liker’s pyramid is further divided up into a further four elements: constant purpose, customer focus, self-reliance and long term perspective (Liker, 2004 as cited in Gao and Low, 2014, p. 670). Of these 4 elements, constant purpose can be translated into construction using another method prescribed by Ballard and Howell (1997): the Plan, Do, Check, Act system. To start, First-run studies are conducted in order to modify or re design critical assignments (Ballard and Howell, 1997, as cited in Salem et al, 2006, p. 171). After this, these re designed operations are studied in more detail in order to brainstorm for new ways to doing something. The Plan Do Check Act system is crucial in the development of these first run studies. The first stage: the “Plan” stage involves brainstorming of ideas in order to get rid of steps deemed unnecessary. The second i.e. “Do” stage involves testing the ideas discussed in the plan stage, the “Check” stage involves measuring the outputs and the final “Act” stage involves the implementation
of the new now proven method as the standard. According to West (1998), both individual and team contributions must be honed in order to realize the full extent of continuous improvement (Salem et al., 2006, p. 171).

Liker’s Process element in Construction

Work Flow Variability and the Last Planner System

In manufacturing, there is an every present problem of fluctuating demands (Santos, 1999 as cited in Gao and Low, 2014, p. 668). In lean manufacturing, the problem of flow variability is solved by a process known as production levelling. Production levelling ensures that through small adjustments made to the production cycle, the effects of fluctuating demand levels can be controlled. With the batch size reduced, demand fluctuations can be managed by making small adjustments to the production volume and the resources allocated. Surprisingly, flow variability also affects construction; untimely completion of one trade can delay the project. Besides this, there are other factors at play in construction that don’t have a parallel in the manufacturing sector (Koskela, 2002 as cited in Somersson et al., 2012, p. 36). Thus the key to improving on-site construction is better management of flow of materials, resources and information (Jongeling and Olofsson, 2007 as cited in Somersson et al., 2012, p. 36). In order to help address the problem of flow variability, the “Last Planner” system was developed in order to facilitate a timely completion of plans (Ballard, 2000 as cited in Salem et al., 2006). The Last Planner system as described by Ballard (2000) consists of four levels of planning, namely: the master plan, phase plan, look-ahead plan and the weekly plan. It involves daily huddle meetings in order to track the progress of plans and remove any potential barriers if encountered (Ballard, 2000 as cited in Gao and Low, 2014, p. 668). Last planners operate at an operational level ensuring the completion of individual
assignments. In the event of delays the planners must be able to track the reasons behind these delays and take the necessary measures in order to identify the root cause of the problem and ensure to prevent future recurrence. Although it is pointed out that the Last Planner system has commonalities with the Heijunka principle and process standardization prescribed by Liker (2004), the latter concepts are difficult to transfer into construction. This is due to the fact construction contains a variety of elements that require different amounts of time to complete (Gao and Low, 2014, p. 672).

Eliminating Defects at the Source

Jidoka is the Japanese term for never letting a defect progress to the next stage thus building quality into the process (Liker, 2004 as cited in Gao and Low, 2014, p. 673). It is postulated in Lean manufacturing that defects must be cut off at the source in order to prevent them from magnifying over the span of the process; this process is termed: Process Variability Autonomation. However, in the case of construction, defects are difficult to identify before installation and thus, efforts are traditionally focused on conformance when it comes to quality in construction. In manufacturing, autonomation can start with simple visual inspections wherein workers can identify and contain root causes in their machines. This can be followed by fail-safe devices known as “Poka-Yoke” devices in Japanese which can automatically prevent defects from carrying over to the next stage (Shingo, 1985 as cited in Salem et al, 2006, p. 169).
Figure 3 An example of a fail-safe or “poka yoke” device being used

Source: Bajjou et al, 2017, p. 174

Since Lean primarily focuses on defect prevention, this idea can be imported from manufacturing by means of implementing fail-safe actions on the site to “get it right the first time” (Milberg and Tommelein 2003 as cited in Salem et al, 2006, p. 170). Other research however points out that “Do it right the first time” is not applicable in construction as it is in manufacturing and there will always be some waste in construction as every project is unique (Simonsson et al, 2012, p. 36).

Waste in Construction

According to the Lean Construction Institute, the construction sector is highly inefficient and has a production/waste ratio higher than that of the manufacturing sector (Bajjou et al 2017, p. 170). As shown in the figure below, while roughly 12 per cent of the activity in the manufacturing sector fits into the waste category, that number jumps up to 53 per cent in the construction sector.
In regard to both the construction industry and the manufacturing industry, “waste” can fit into the following seven categories: defects, delays, over-processing, over-production, excess inventory, unnecessary transport and conveyance of materials and equipment, and unnecessary motions and movement of people (Al Aomar, 2012, p.106).

Waste in the construction industry can be defined in three different ways: 1) Physical waste in the form of damaged or over-ordered materials (Sarhan, Pasquire and King, 2017, p. 13). 2) Process waste in the form of non-value adding activities such as delays, rework etc. (Sarhan, Pasquire and King, 2017, p. 13) and some special cases such as accidents. It was estimated in the study that value creating activities accounted for only 5-10 per cent while 30-35 per cent of activities were support based and the remainder of 55-65 per cent
activities were non-value adding or “waste”. Studies conducted in the United States and some Scandinavian countries found that up to 30 per cent of construction involves rework and labour is used rather inefficiently at 40-60 per cent of capacity. Accidents accounted for 3-6 per cent of total project costs however they are unavoidable so that fraction can be neglected, and at least 10 per cent of materials are wasted (Al Aomar, 2012 p. 108).

Similarly, in the Abu Dhabi, UAE: which over the past decade has become a hotbed of high rise construction; late delivery and lengthy approval process were at the top of the list of construction wastes. The top 10 wastes range from work interruptions to late delivery and represent 46.5 per cent of construction wastes (Al Aomar, 2012, p. 109).

![Figure 6 Things commonly regarded as waste in construction.](source)

Quality and efficiency can be drastically improved simply by taking waste out of construction (Egan, 1998, p. 15 as cited in Sarhan, Pasquire and King, 2017, p. 14). Lean project management is focused on implementing the guidelines of Lean Project Delivery System (LPDS) which was developed by the Lean Construction Institute (Ballard, 2008 as
cited in Al Aomar, 2012, p.300). One of the tools prescribed in order to get rid of waste forms a subsection of the process element of Liker’s pyramid; Visual management. Easy as it sounds, visual management involves using Building Information Modelling or 3D visualisations of the process in order to minimize waste and detect abnormalities. Besides this, there are the 5S techniques which became part of the mainstream Lean thought in the 1990s (Kobayashi, Fisher and Gapp, 2008 as cited in Gao and Low, 2014, p. 673). These five S’s which were originally named in Japanese but have English equivalents are: Sort (Seiri), Straighten (Seitou), Standardize (Seiso), Shine (Seiketsu) and Sustain (Shisuke). In Construction, the five S system facilitates a more efficient flow of materials between warehouses and the field thus eliminating a lot of waiting and transportation wastes (Dos Santos et al. 1998 as cited in Salem et al, 2007, p. 170). Another approach to waste management is the standardization of all activities. However since the tasks on the construction site vary (Nakagawa, 2005 as cited in Simmonson et al, 2012, p. 37), the concept of “Do it right the first time” cannot be applicable to construction.

**Value creation in Construction**

Of all the elements of Liker’s pyramid, value addition has been discussed extensively in the construction context (Diekmann et al, 2004 as cited in Gao and Low, 2014, p. 670). When first explained in a Lean context, value is best left to the customers’ perception (Womack and Jones, 2003, p. 16). In lean construction, products and services are designed to bring the maximum value for the end-customer (Ballard et al. 2001). Yusuf, Gunasekaran and Dan (2007) point out that every level of a construction firm must have a congruent perception of adding value for the customer (Gao and Low, 2014, p. 670). However, according to a Danish study, while the practitioners were generally focused on value delivery, the perceptions of value were inconsistent across the industry (Wandahl, 2013, p. 1027). In practice, it appears
that different stakeholders of the process have different ideas regarding the most efficient means of achieving the best desired value (Wandahl, 2013, p. 1027).

![Figure 7 The vast difference between perceived value among different stakeholders in the construction industry. Source: Wandahl, 2013, p. 1027](image)

Value however lacks a precise definition and the definition and understanding of value changes according to the project features and authors’ perspective (Salvatierra-Garrido et al. 2012 as cited in Drevland et al, 2018, p. 32). Value creation historically has accounted for a lower percentage of the process (Sarhan, Pasquire and King, 2017, p. 13). Another study noted that only 11.4 per cent of the time on construction site created added value (Pappas, 1990, p. 24 as cited in Bajjou et al, 2017, p. 171) while yet other Swedish studies gave more optimistic observations that the operations creating added value represent 30 per cent of time spent on a construction site (Pappas, 1990, p.25 as cited in Bajjou et al, 2017, p. 171).

**Liker’s People and Partners element**

**Transparency and collaboration between stakeholders**

As early as 1911, philosopher Frederick Taylor called for a “non-adversarial” environment in order for efficiency tools to work best (Sullivan, 2011, p. 212). Thus, the key to improving
on-site construction is an efficient flow of materials, resources and information between various stakeholders of the project (Jongeling and Olofsson, 2007 as cited in Somersson et al, 2012, p. 36). In order to achieve this, Liker (2004) prescribes a healthy, stable and long term relationship consisting of mutual respect. To pursue joint objectives in operational procedures, (Evans and Jukes, 2000 and Bemelmans et al., 2011) recommend an optimized supplier base, cooperative goals and relationships (Gao and Low, 2014, p. 676)

**Respect for People**

Respect for everyone involved is a key aspect of Lean. While Lean places emphasis on team effort, respect for the individual is also important in Lean culture (McLean and Antony, 2014, 16 p. 372). Lean’s proposed purpose of reduction in expenses leads many companies to misinterpret it as ‘less employees needed’ (Douglas et al, 2015, p. 971) In case of such misinterpretation, the disregard for employees reduces enthusiasm among them as they consider it unimportant to pay heed to a philosophy that considers them expendable (Douglas et al. 2015, p.971).

**Lean in Practice and Commonly Encountered Problems**

Broadly speaking, there were two main obstacles encountered in Lean’s application to the construction. The first of these has to do with inadequate knowledge of Lean and an unclear idea of the final product or value in the construction industry (Bertelsen 2002; Koskela 1992 as cited in Sullivan, 2011, p. 212).
Inadequate Awareness of Lean

According to a study conducted in Abu Dhabi, UAE it was revealed that only about 32 per cent of the surveyed companies were familiar with and/or using lean techniques. Studies showed that cost reduction using lean techniques can be substantial compared to the traditional project management approach (Al Aomar, 2011, p. 106). However, there are other studies that found that construction industry remained unaffected no matter what philosophy was used. The organization’s ability to change is listed as a major factor in the successful implementation of Lean (Sullivan, 2011, p. 210). Three primary reasons listed by (Sullivan 2011) as to why lean implementations fall short of delivering results include: employee resistance and unrealistic expectations from clients. It is difficult to persuade people used to a certain way of doing things to a completely *modus operandi* (Sullivan, 2011, p. 210). Employees are prone to be very sensitive to change because of job security concerns. The central role of management is often underestimated; as is the importance of

<table>
<thead>
<tr>
<th>Items</th>
<th>Score</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate knowledge and skills</td>
<td>3.80</td>
<td>0.868</td>
</tr>
<tr>
<td>Lack of organizational culture supporting team work</td>
<td>3.60</td>
<td>0.863</td>
</tr>
<tr>
<td>Inability to measure performance of the team and to gauge the team progress</td>
<td>3.58</td>
<td>0.866</td>
</tr>
<tr>
<td>Individual needs and personal differences of team members</td>
<td>3.53</td>
<td>0.726</td>
</tr>
<tr>
<td>Defined focus</td>
<td>3.47</td>
<td>0.968</td>
</tr>
<tr>
<td>Lack of capability of team to maintain alignment with other team</td>
<td>3.42</td>
<td>0.965</td>
</tr>
<tr>
<td>Lack of group culture, shared vision and consensus</td>
<td>3.33</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.53</strong></td>
<td><strong>0.894</strong></td>
</tr>
</tbody>
</table>

Figure 8 Commonly encountered problems with Lean implementation

Source: (Omran and Abdurahim, 2015, p. 54)
proper instruction, training, the time needed to apply the change and the level of effort needed to yield results (Sullivan, 2011, p. 210).

**Unclear motivations and Internal Resistance**

McLean and Antony (2014) state that there is a large number of companies that embark on their Lean expeditions merely due to external pressures and the need to “join the bandwagon”. This often results in companies overestimating their capacity to transform internally as they fail to convince employees of the usefulness of the new initiative and thus produce inadequate results (McLean and Antony, 2014, 16 p. 372). According to observations by Liker (2004), the turning of Lean implementation into a “bureaucratic exercise” defeated the purpose of understanding the extensive “transformation of culture” needed. Although there is a natural resistance to change, adequate awareness of Lean as elaborated before is the pre-requisite to minimize internal resistance and engrave Lean into the company culture as prescribed (Zhou 2016, p. 473).

**Misunderstood interpretation of Kaizen (Long Term Improvement)**

Regardless of the size of the organisation, most of them expect to reap the benefits in the initial stages of implementation. This confidence is rarely well founded (Amhad, 2013) and highlights a lack of understanding of a central pillar of Lean, continuous improvement (Bhasin and Burcher, 2006). Indeed, Lodgaard et al. (2016, p 595) found from their research that ‘Companies often achieve significant short-term results when implementing lean, before the implementation processes ultimately fall apart’ as practises and processes return to their pre-implementation stage, a view reinforced by Brown et al. (2016).
Lack of alignment of objectives

Scientific philosopher Frederick Taylor (1911) postulated that the efficiency tools are rendered ineffective if used in an adversarial environment (Sullivan, 2011, p. 212). Since the value of a product can be determined easily in manufacturing, the goals and objectives of various parties involved: suppliers, producers, users etc. can be aligned naturally. However, this natural alignment is absent in the case of construction an overemphasis on marketing instead of the actual value (Bertelsen 2004; Horman et al. 1997 as cited in Sullivan, 2011, p. 212) leads to the creation of the previously mentioned “adversarial environment” among the parties involved (Anvuur and Kumaraswamy, 2007 as cited in Sullivan, 2011, p. 211). This leads to substantially higher transactional costs. Thus, it is of paramount importance to make sure that all involved parties’ objectives are well aligned before Lean is applied to construction.

Issues due to fundamental differences between manufacturing in construction

Despite many similarities, some areas of the manufacturing industry and construction industry are inevitably different and it is in these areas where translating Lean principles from manufacturing to construction become a challenge. In the long term, both construction and manufacturing strive to add value to their products via high returns on investment (Salem et al, 2006, p. 169); however the means employed by each sector vary. In manufacturing, the lifecycle of a product on the market is long enough to develop related research and training capabilities. In construction however, the project duration is the only phase where research and training can be conducted and is also difficult to justify (Salem et al, 2006, p. 169). There are three major aspects of construction which don’t have an equivalent in manufacturing; they are, onsite production, one-of-a-kind projects, and complexity (Koskela 2002). Howell (1999) states for example that unlike manufacturing;
where errors can be fixed by acting directly on the production and observing the results; construction must rely on inspections during or after the completion of the work in order to identify problems. As a result of this, the final result for that specific project is unchanged and tracing the source of the problem is difficult due to the independence of different activities and high risk factors. The construction industry can therefore conform to the idea of building quality into the product however, in practice, getting things right the first time is difficult and the industry devotes approximately 25 per cent of the paid labour time to work after the completion of the project in order to make observations (Ballard and Howell 1997 as cited in Sullivan, 2011, p. 212).

**Literature Conclusion**

In conclusion, Lean appears to be a solution for a wide range of problems currently plaguing the industry such as flow variability, lack of alignment of objectives and overall inefficiency. The effectiveness of Lean is well documented in the manufacturing industry; however its adoption into the construction industry is fairly recent. Even though the two sectors have different processes and different quality parameters, there are some commonalities where Lean can fit in. With tools such as the Last Planner system, the ever present problem of flow variability; which surprisingly affects construction just as much as manufacturing; can be mitigated. With the help of 5S, an environment can be formed wherein all involved parties can work more efficiently in tandem with one another. This would invariably lead to the two things that are Lean’s “calling cards”; reduced waste and increased value. However, as things stand, in practice things are a little bit different. As of now, the awareness of Lean in the construction industry is meagre and it is often used as a short term measure primarily to reduce costs; something that is contrary to one of its teachings that it be implemented as a long term measure. Just as with other quality improvement methods, accuracy in
implementation is one of the key factors in ensuring the success of an initiative. There are many hindrances in implementing such initiatives since they require a certain degree of cultural change within an organization. Lean’s principles likewise need to be implemented throughout the organization and that thus encounter the natural resistance to change.

Recently, many companies in Ireland and other parts of the world have taken up Lean construction and case studies of their experiences are just becoming available. As expected the Lean initiatives employed by Irish construction firms seem to mimic the patterns pointed out by the existing literature on the topic.
Chapter 3: Research Methodology

Introduction

Scholarship cannot agree on one best philosophy to conduct business research (Tsoukas and Knudsen, 2003 as cited in Saunders et al, 2015, p. 126) and each philosophy brings something unique to the table (Saunders et al, 2015, p. 126). As such, the ontological, epistemological and axiological implications of each philosophy were explored in order to come up with the most suitable one for this research.

This section will introduce the methods employed in conducting the research. Besides this, an analysis will be conducted to explain the reasoning behind why the method of primary data collection was chosen. After that, a detailed description of how the data was collected and analysed will be provided; the criteria according to which the population was chosen; potential ethical issues and research limitations will be elaborated.
Research Design

Following the layers of the “research onion” as shown by Saunders et al, the research philosophy, approach, strategy, time horizons and data collection methods were employed in order to conduct this research.

Research Philosophy

At the first layer of the research onion, there are 5 different philosophies to consider and the interpretivist stance was chosen. Interpretivism get commonly associated with qualitative research (Lincoln, 2011 as cited in Saunders et al, 2015, p. 168) and is applied to studies with a level of complexity which cannot be conclusively researched using numbers (Saunders et al, 2015, p. 141). Interpretivist philosophy suggests that there are no universal realities but different interpretations of reality influenced by personal beliefs, culture, ethnicity, etc. Primary data generated in these studies cannot be generalized since it is
heavily impacted by personal viewpoint and values (Saunders, Lewis and Thornhill, 2015, p.140). For business researchers, it involves looking at organizations from the point of view of different people (Saunders et al, 2015, p. 140). The interpretivist stance is also commonly used for studies conducted in a specific geographical context and can be beneficial for the research population as well (Saunders et al, 2015, p. 141). As such, it is difficult to measure the “mainstream results” for lean because each company adopts different principles, and the dynamic environment cannot isolate full responsibility for successes or failures (Sullivan, 2011, p. 211). There are many ways of interpreting the success of Lean initiatives. Insights into the implementation and success of a particular Lean initiative can be better gained by conducting in-depth interviews with the people involved in the process. Positivist research philosophy cannot be applied here since it cannot be decisively affirmed at this point that the differences between Lean on paper and in practice has negative consequences or not. Since most of the data collected in this study won’t be quantifiable, the philosophies primarily associated with quantitative research won’t be applicable here.

**Research Approach**

This research did not test a theory based on existent literature but rather sought to develop one by gathering data from the Irish Construction Sector; as a result, the approach to this research is Inductive (Saunders et al, 2015, p. 145). At these initial stages of the study, there was little knowledge available on Irish Companies’ Lean initiatives. A conclusion could only be reached after sufficient data was collected and analysed (Saunders, Lewis and Thornhill, 2015, p. 52). Although there are existing studies gauging the effectiveness of Lean in the construction sector, none were specifically geared towards the Irish Construction industry. As a result, no hypothesis was suggested which made deductive research methods redundant here. The data collected during the course of this study could easily be divided
into specific themes covering each aspect of Lean Construction and patterns observed therein helped in establishing a conceptual framework (Saunders et al, 2015, p. 145). Since there are a limited number of companies currently using Lean Construction in Ireland, differences between Lean theory and Lean practice could be explored by conducting in-depth interviews a relatively small population sample; something that is more indicative of an inductive approach (Saunders et al, 2015, p. 145). Thus by taking the inductive approach, the findings of the data provided insight into the differences between Lean Construction in theory and in practice.

**Methodological Choice**

A lot of thought was given on which method was to be utilized to conduct this research. On one hand, the qualitative method consists of collecting non-standardized data and interpreting meaning through words (Saunders et al, 2015, p. 165); on the other hand, the qualitative method consists of reaching a conclusion by means of collecting results in standardized data (Saunders et al, 2015, p. 165). While there are pros and cons of using both methodologies; it has often been pointed out (Creswell, 2003, p.5 and Walsh 2012) that using both methods in mixed proportions was the best way to go forward.

![Figure 10 The methodological choices facing a researcher](image-url)
This study explores an area which is too vast. As such, reaching a conclusion about the correct way of implementing Lean cannot be reached through numerical means but rather by gaining insight into the opinions of those involved with its implementation. However, since numerous companies were to be approached, there was a quantitative element to the study after all. Taking the above factors into consideration, this research was mostly conducted through a multi-method qualitative study.

**Research Strategy**

Many research strategies were explored to complement the selected research philosophy as there is a direct link between them (Denzel and Lincoln, 2011). A number of factors influenced the selection of a research strategy; some of these included the time horizon, access to potential participants etc. (Saunders et al, 2015, p. 177). The case of the Irish Construction sector was selected due to geographical proximity which would allow for a quicker access to participants in order to complete the study within 3 months’ time. This study was conducted on multiple organizations to study their particular Lean initiatives. The findings of this study will not be used to implement changes in a particular organization’s workings. This makes Action research redundant in this case (Saunders et al, 2015, p. 194). The data for this research could not be gathered by conducting experiments but rather by gaining insight into the workings of organizations practicing Lean. A conclusion about the implications of the differences between Lean in theory and Lean in practice could only be reached after the data has been collected from various companies within the industry. This left two possible choices for selecting a research strategy: The Grounded Theory approach or a Case Study. Since the dynamic environment cannot isolate full responsibility for
successes or failures (Sullivan, 2011, p. 211), a theory may not hold true under differing circumstances. This eliminates the option of using the grounded theory approach which leaves just the case study option open. However it was not possible to discover the implications of the differences between Lean in theory and practice by just conducting a case study of one specific organization. Thus this study was conducted as a multiple case study of organizations that have undertaken Lean initiatives. The selection of the case study option also complements the choice of interpretivism and inductive research methods (Saunders et al, 2015, p. 185)

In this age of digitalization, a vast amount of data is available in the form of archives and documents which can assist further in plugging any gaps in the information that cannot be collected through primary means due to time constraints (Saunders et al, 2015, p. 183). The not-for-profit organization “Lean Construction Ireland” is a loose association of construction companies in Ireland that adopted Lean and seek to avail the knowledge to the world in order to provide a better understanding of Lean (Lean Construction Ireland, 2018). An annual book of case studies was published in 2018 by Lean Construction Ireland which provided highlights of companies’ Lean initiatives. This document was used as a secondary source since its original purpose was presumably to promote awareness of Lean in the industry and not academic research (Saunders et al, 2015, p. 183). Since it is an open source document with instructions to reference it, there were no ethical issues in using it as a secondary source of information (Saunders et al, 2015, p. 182).

**Time Horizons**

The choice between a longitudinal time horizon and a cross-sectional time horizon was not too hard to make. Due to the limited time available to conduct this research, it was not
possible to conduct a longitudinal study in order to make observations over a long period of time (Saunders et al, 2015). As a result, this study is cross sectional and aims to gain insight into the opinions of respondents at this specific time when Lean initiatives have already undertaken for an average of 4 years among the various companies studied (Saunders, 2015).

**Research Population for Primary data collection**

The research population for this research includes company managers, consultants and academics involved in the implementation of Lean in the Irish Construction Industry. The credentials of these individuals are available through Lean Construction Ireland where they are often involved with events promoting awareness of Lean (Lean Construction Ireland, 2018).

**Sample**

This data could not be collected from individuals selected at random from the construction industry since they needed to possess specific knowledge about Lean implementation within their companies. Thus all random sampling techniques are redundant in this case. As a result purposive sampling was deemed as the best form of sampling that can be applied here. Purposive sampling involves the selection of specific individuals that are fit to provide the information needed to answer the research question (Saunders, Lewis and Thornhill, 2015, p. 301). Gaining access to high ranking employees in the industry was also a challenging task; to that end, the snowballing technique was used. The snowballing technique allowed for the unlocking of many sources of information upon gaining access to one source (Saunders, Lewis and Thornhill, 2015, p. 298).
Since the companies are involved with Lean for Construction and they advertise their use of Lean on their company websites, the assumption was made that there won’t be much reluctance to participate from their side. Even so, actually getting access to these individuals with few personal connections in the industry was a challenge. The interviewees were assured of anonymity and the scope of the study will be explained to them thoroughly. This study is exploratory the finding will either say “Lean is effective” or “Lean is ineffective”; as such there is no inherent bias which could lead to attempts to manipulate the data in any way.

**Participant Selection and Access**

Almost all of the interview participants are involved with “Lean Construction Ireland” a not for profit organization which promotes the awareness of Lean. An annual book of case studies was published by Lean Construction Ireland which contained articles by company managers briefly highlighting their Lean initiatives. Due to a high frequency of requests by students to organizations for research purposes and little to no contacts in the industry, physical or direct access was deemed impractical (Saunders et al, 2015, p. 222). Also, as an external researcher, it would have been all the more difficult to gain access. As a result, access was gained to potential participants using internet-mediated means wherein LinkedIn was used to contact them individually and ask if they would be willing to participate in the research. After this, a phone or skype call was arranged in order to conduct an in-depth interview. A total of 10 people in the industry including managers, consultants and academics were contacted to gain insight into Lean implementation. Out of the 10, 4 responded and agreed to an interview to shed light upon their companies’ Lean initiatives.
There are many different types of interviews to be considered in order to gain insight into companies’ Lean initiatives. However, a standardized interview would only generate obvious responses and thus would not produce as much insightful information for a qualitative study such as this (Saunders et al, 2015, p. 391). Thus non-standardized interviews were chosen and they were conducted in a one to one setting.

The interviews were semi-structured since they revolved around a few core questions; however depending on the respondents’ answer, some related questions were asked in addition to their personal input on Lean Construction in their respective companies. The interviews are expected to last no more than 10-15 minutes. The interviews were by phone or over Skype depending on the availability of the responder. The participants in the study were asked 5-6 basic questions pertaining to Lean in their respective companies. The questions were as follows:
1. When and why Lean was first adopted in your company? Was it driven by client demand or the need for cost reduction?

2. Which Lean tools were employed as part of the initiative?

3. What activities were discarded as waste as part of the Lean initiative?

4. How was the problem of work flow variability and objective alignment solved?

5. Did you encounter resistance from employees wishing to continue with the old ways? How did you solve that problem?

6. What would you say are among the most important things for a Lean implementation to succeed?

**Procedure**

The potential respondents were first contacted over LinkedIn and asked if they would be willing to answer a few questions on Lean Construction. After preliminary contact was established with the participant, a date and time was agreed upon to interview; it was then agreed upon that the call will be recorded for research purposes. The interviews were mostly conducted over the phone with one exception where a skype audio call was employed. After exchanging pleasantries, the questions began. Depending on the answers provided by the participants, the order in which the questions were asked changed or some follow up questions were asked in order to keep the conversation going smoothly.
Secondary Data

![Diagram of different types of secondary data](image)

The secondary data used in this research was a collection of case studies compiled by Lean Construction Ireland; these consisted of highlights of Lean initiatives conducted by different companies in the Irish Construction Sector. As such, it can be classified as a multiple source, longitudinal secondary source (Saunders et al, 2015, p. 319). The case studies contained data that can be classified as compiled data; thus both qualitative in the form of insights provided by the authors and quantitative in the form of numbers and statistics provided.

There is a constant worry when collecting secondary data that its purpose will be contrary to the purpose of the research (Saunders et al, 2015, p. 344); however that problem was not encountered in this case and since this collection of case studies was published a year before this study, the data contained can be regarded as mostly current (Saunders et al, 2015, p. 344). Furthermore, since the authors of the individual case studies were managers of those respective companies, the issue of reliability of the data is non-existent.
Data Analysis Technique

Many different analysis techniques exist in order to analyse qualitative data; the easiest was with the use Computer Aided Qualitative Data Analysis Software (CAQDAS) in order to minimize the effort of conducting the analysis manually (Saunders et al, 2015, p. 568). Qualitative data is usually subjected to a thematic analysis (Saunders et al, 2015, p. 579); to this end, the CAQDAS software NVivo was used.

Data Transcription

The primary data collected was primarily in the form of audio recordings of the interviews. As such, the first step to commencing the CAQDAS analysis was transcribing the data (Saunders, 2015, p. 572). Since most interviews bar one lasted for roughly 10-15 minutes, the process of transcription was not as difficult or time consuming. Nevertheless, data sampling was used in order to transcribe only those sections of the interview pertinent to the research (Saunders et al, 2015, p. 573).

Coding

![Diagram of coding types](source: Saunders et al, 2015)

Figure 13 The 2 types of coding that can be employed after initial sampling

Source: Saunders et al, 2015
Since qualitative data it cannot be analysed numerically (Tayler-Powell and Renner, 2003, p. 1), it was analysed by being divided up into relevant themes and recurrent words or phrases were assigned distinct codes. For the purposes of this research, the coding will progress from open coding to focus coding. The reason for choosing this path is that each tenet of Lean Construction shall be coded differently no relationships can be examined between each pillar of Lean implementation. Relationships between waste reduction, value generation, flow variability, leadership support etc. won’t be examined but rather these shall be treated as separate. As a result, Axial Coding is not applicable in this scenario (Saunders et al, 2015, p. 599). Through initial/open coding, the collected data will be “disaggregated” into conceptual units as the broad set of data will be narrowed down and focused (Saunders et al, 2015, p. 598). After this, the next stage will be focused coding wherein smaller codes will be assigned to larger parent codes which will enable an easy progression to thematic analysis (Saunders et al, 2015, p. 599).

**Thematic Analysis**

Braun and Clarke (2006, p. 78) consider thematic analysis to be the most accessible, orderly and logical way for processing large amounts of qualitative data. Besides this, thematic analysis’ compatibility with the aforementioned research methodology and strategy makes it all the more attractive option. In an interpretivist study such as this, thematic analysis can be used to explore different interpretations of a phenomenon (Saunders et al, 2015, p. 579) which is precisely what was done. Although some initial themes came from the literature review conducted above, most of the themes eventually used were derived from the data collected; something that is characteristic of inductive studies (Saunders et al, 2015, p. 579). The different factors related to Lean were analysed as separate themes and subthemes; these were as follows:
1. Awareness of Lean in the Irish Construction Industry

2. Circumstances behind initial adoption of Lean in Irish Companies

3. Lean tools employed within the company

4. Perceptions of waste

5. Perceptions of value by different stakeholders

6. Existence of work flow variability and tools used against it

7. Internal push back encountered while implementing Lean

8. Company Leadership’s perceptions on Lean

Based on these themes, a pattern can be found that could help in identifying how Lean is implemented in the industry and identify its deviations (if any exist) from text-book procedures thereby evaluating the implications of it.

Research Ethics

Concerns about ethics emerge at every stage of the research from planning, design, seeking access to potential participants, data collection, data analysis and reporting (Saunders et al, 2015, p. 239). During the course of this study all relevant ethical principles were followed; these were:

1. Participation in the research was voluntary in nature and the participants hold the right to withdraw at any time they wish

2. The respondents of the interviews were assured of privacy.

3. The respondents were provided with information regarding the study and its implications prior when the invitation was extended to participate; in line with the informed consent.
4. A strict maintenance of confidentiality of the data was observed with the assurance that it would be destroyed upon the submission of the report.

5. The data was not manipulated or falsified in order to agree with the purpose of the study in case of disagreements.

Since a large part of this research was internet mediated, online groups were joined but no “passive analysis” was conducted and members of the group were individually contacted to ask if they would be willing to participate in the research. Respondents of interviews will be interviewed only upon consent and be guaranteed full anonymity. Respondents will be given the option to withdraw at any time if they should choose to.

**Limitations to the study**

Arguably the greatest limitation to this study was the time limit as it dictated how many individuals it was possible to reach in order to carry out interviews. This study will try to include both large and small companies’ Lean initiatives; however access to the companies’ managers was be the deciding factor in determining the sample size will be large or small. Regardless of the sample size, the findings cannot be generalized to the entire Irish construction industry or to that of another country.
Chapter 4: Data Analysis and Findings

Introduction

In this chapter, all the information collected from in-depth interviews and secondary archival research will be reported and analysed. Since a large chunk of this section will contain original primary data, there will be no need to cite a source for it but data collected from secondary sources will be referenced.

Since this research will be using primarily qualitative methods, the data gathered from in-depth interviews and from secondary archival research will be analysed using the thematic analysis. The software tool NVivo 12 will be used to simplify the process of processing the data acquired through in the depth interviews.

Primary Qualitative Data

Figure 14 A word cloud produced through NVivo 12
Three in-depth interviews were conducted and transcribed as shown in the appendix. As previously mentioned, since the interviews were semi-structured, the themes were a mix of pre-conceived ones and those that emerged from the data. Focused coding was employed to divide the data into relevant themes which are displayed in the appendix below. A total of five themes were identified with each one containing sub themes which explored it in more detail.

**Secondary Qualitative Data**

Archival research produced the case study compilation produced by Lean Construction Ireland. Six company case studies were meticulously studied in order to find similar patterns to the ones found in the primary data obtained through interviews. This secondary data mixed in nature and thus its qualitative parts will be analysed using thematic analysis.

**Findings**

**Findings about Initial driving forces behind adoption of Lean**

It became apparent through the interviews and company case studies that the awareness of Lean is not as high as previously assumed but it is definitely higher than a few years ago. The key observation here was that in most cases Lean is adopted due to client demand. Secondly, it was observed through the interviews and company case studies that many of the times, companies implemented Lean only in a specific area of their business or only for a project (Lean Construction Ireland, 2018); again with client demand being the driving factor. However, all of the companies studied reported adopting elements of Lean into other parts of the business or integrating it into the business model as a whole after the initial positive results (Lean Construction Ireland, 2018).
However, client demand was not the reason for Lean adoption 100% of the time. One of the interviewees reported that the reason why his company adopted Lean was due to their own conclusion that their processes were woefully inefficient. Likewise, according to another interviewee, some of the Tier 1 companies in Ireland have started to see things separately from client demands and have become more proactive in this regard; in other words they are now beginning to use Lean to improve their own process efficiencies. The improvements are primarily in the area of safety, quality etc. (Lean Construction Ireland, 2018, p. 21).

Findings about Support from the Leadership

It was universally agreed in the in depth interviews and company case studies alike that leadership support was of paramount importance to ensure the success of a Lean initiative. However, it was pointed out by the author of one of the company case studies that in cases where Lean leadership happened on isolated projects for which Lean was implemented, the advantages of Lean did not seep across the organization (Lean Construction Ireland, 2018). This was corroborated by an interviewee that just a simple buy-in occurring in a project will not ultimately bring about as much benefit as originally needed.

Of all the companies studied, there was adequate leadership support for Lean initiatives in all but one company. One of the company case studies highlighted for example that Lean training sessions were conducted for not only lower ranking employees but also the CEO (Lean Construction Ireland, 2018). Almost all of the companies studied eventually began implementing Lean to other sections of their businesses which happened through leadership support.
**Findings about Internal Resistance to change**

Of all the respondents interviewed, none reported any level of push back from employees; however they did not rule out the existence of sceptics. This was confirmed to a degree by one of the other respondents that understanding Lean is one thing but explaining it to everyone else is a challenge. The interviewee went on to explain that the reasoning behind Lean implementation has to be explained well to the employees and since it brings about a certain level of cultural shift in the organization and thus it takes time to achieve.

According to one of the interviewees, what complicates matters when it comes to change in culture is the existence of parallel systems i.e. where Lean and traditional methods clash and that the lack of incentive can be named as the biggest culprit when it comes to resistance to change. However, companies reported in their case studies that eventually employees do seem to become enthusiastic when the mutual benefits of Lean become more apparent and some companies do offer incentive in the form of rewards (Lean Construction Ireland, p. 24).

**Findings about perceptions of Waste and Management**

As discussed in chapter 2, one of the principle wastes in the construction industry is waiting time. Likewise, one of the interviewees reported that as part of their Lean initiative, the primary forms of waste were: the waste of waiting, the waste of motion i.e. the waste of material transport. Another interviewee reported the main waste to be the disproportionate amount of time spent on orders of varying sizes. Predictably, most of the Lean initiatives are undertaken in order to find ways to minimize waiting time. The companies and interviewees reported using BIM visualization tools to this end and it does
result in reduction of waste; but it got harder the next time according to one of the interviewees since as there is lesser waste each time.

Apart from these usual examples of wastes, there were also other forms of waste that were revealed through the interviews and case studies; these were termed as “invisible wastes” (Lean Construction Ireland, 2018, p. 62). These included Inventory, Defects, and Over-Production, Transport, Waiting, Movement, and Over-Processing (Lean Construction Ireland, 2018). Besides these, time spent retrieving materials and setting-up the work were also classified under invisible wastes (Lean Construction Ireland, 2018).

It was pointed out by another interviewee that employees and those from the supply chain used to spend an excessive amount of time having meetings, doing meeting minutes and writing notes to each other when they should have been having stand up meetings, putting sticky notes on the wall and dealing with issues out in the field. Besides this, he revealed that there are multiple layers of bureaucracy consisting of supply chain subcontractors and sometimes they have sub-sub-contractors before you get down to the trades person. Each of those organizations carries supervision elements so there are supervisors reporting to supervisors reporting to supervisors.

**Findings about the Perceptions of Value**

As discussed in the literature review in chapter 2, the end value is best left to the customer to decide. Increased final value was almost always reported to be achieved by means of cost reductions however. This cost based perception of value according to one interviewee is the result of a legislative measure by the government of Ireland that requires projects to be awarded fundamentally based on the lowest tender price.
According to one of the interviews, in order to add value upstream or downstream, it is necessary to incentivise the other party by paying them based on value rather than actual output; something that doesn’t happen traditionally since the bounds of the contract prevent any further co-operation between the involved parties. This necessitates more transparency and collaboration between different stakeholders which is another important pillar in Lean.

**Findings about Transparency and Collaboration between Stakeholders**

Transparency is one of the most if not the most important aspects of Lean and in a way facilitates value generation to a large extent according to one of the interviewees. All of the companies that were studied reported that collaboration was the key takeaway from their Lean initiative (Lean Construction Ireland, 2018). Increased collaboration was reported not only between partners but also various units within the company such as the design team and the construction team (Lean Construction Ireland, 2018).

One of the companies reported that as a result of having a larger say in the construction project, their trade contractors were more willing to contribute towards the success of the project (Lean Construction Ireland, 2018). Another one of the companies stated that they reward their trade contractors for good Lean ideas thus also encouraging greater input from them. Increased collaboration between various stakeholders also results in improved work flow variability as implied by one interviewee who pointed out that material procurement got much easier after more transparency was achieved with the suppliers.

Another one of the interviewees revealed that a common data environment was set up where every party involved in the project: subcontractors, clients and their own staff
housed all our data drawings, communication correspondences etc. in a single repository that everyone has access to.

**Findings about Work Flow Variability**

As elaborated above in the previous section, a smoother work flow was achieved due to greater collaboration. More than one interviewee reported that they established a common data environment with other involved parties in order to facilitate an easier and quicker flow of information. One of the companies termed this in the case study as a practical example of a Lean process improving work flow by reducing an unnecessary waste of time in locating information (Lean Construction Ireland, 2018, p. 49)

It was elaborated in one of the in depth interview that weekly work plans are created and each delayed task is assigned a reason. If there is increased frequency of one reason, action can be taken in order to prevent or at least mitigate this issue in the future. This was also reported by one of the companies as their procedure apart from daily huddles in order to plan and coordinate their workflow to make it more stable. Overall, both the interviews and the company case studies reveal that the Last Planner system is mostly implemented in textbook fashion and it helps reduce the problem of flow variability.

**Findings about Long Term Sustainability (Kaizen)**

The overall perceptions about long term implementation of Lean seem to be positive from interviews and the case studies. One of the interviewees reported that they were constantly adopting the newest construction methods as part of their Lean initiative. Another company reported that they implemented a quality management system wherein they track performance improvements by means of assigning scores in the aforementioned system.
In most of the cases, companies reported backward integration of Lean further into their processes after success in the initial project if they didn’t do it before. However, one of the companies that were studied presented an interesting viewpoint in its case study that the elements of Lean are a natural quality in good planners and managers. According to them, the same effects as Lean can be achieved with traditional methods and that it is the people involved in the process that eventually bring about its successful conclusion.
Chapter 5: Discussion

Introduction

This chapter will involve an in-depth discussion about the findings from in-depth interviews and secondary research presented in the last chapter. To recall, the main focus of this research is in finding the differences between Lean in theory and Lean in practice and determining its implications for the industry. It was determined that a more in-depth study would be produced through qualitative instead of quantitative study. Likewise, the research was conducted with the help of in depth interviews with key personnel within Irish Construction companies that have been involved with their organization’s Lean implementation. The data collected through the interviews mostly corroborated with archival research of case studies compiled by Lean Construction Ireland as elaborated in the chapters above.

Overall, some differences were indeed observed through the study in between Lean theories and the way Lean is implemented in the construction industry. Many differences were trivial, some were more obvious. The findings are discussed in depth below in relation to the research questions and the literature review. Broadly, 5 themes were identified each consisting of sub themes through which explored each theme in more detail. The themes were loosely based on Liker’s pyramid model besides other Lean implementation guidelines that were described in the seminal literature on the subject of Lean Construction.

Initial driving forces behind Lean initiatives in the Irish Construction Sector

The literature review conducted in chapter 2 revealed that initial awareness of Lean in the construction sector is quite low (Al Aomar, 2011, p. 106). One of the three primary reasons (Sullivan 2011) as to why lean implementations fall short of delivering results include
unrealistic expectations from clients. The findings of this study revealed that client demand indeed is one of the leading reasons why Lean initiatives are undertaken in the Irish Construction Sector. But one of the interviewees revealed that there is a lot more work to be done in Irish Construction to make the client voice more clear. Clients from infrastructure and capital projects are only so informed about Lean so there is a lot of work to be done on educating the clients on true lean.

The organization’s ability to change is listed as a major factor in the successful implementation of Lean (Sullivan, 2011, p. 210). The results of this study revealed that companies have little prior knowledge of Lean and a large amount of time needs to be spent in order to educate the employees in Lean processes in order to use them effectively. However, this is an important part of the Lean journey and must not be neglected as the employees need to understand the mutual benefit provided by the initiative.

However the findings of this study also reveal awareness of Lean has indeed increased since its first introduction; some of the Tier 1 companies of the Irish Construction sector have increasingly begun adopting Lean separate from client demand in order to improve their own process efficiencies. This represents a clear paradigm shift from the earlier phenomenon of companies embarking on their Lean expeditions merely due to external pressures and the need to “join the bandwagon (McLean and Antony, 2014). However on average, the motivations behind the adoptions of Lean are still a mix of client demand and project specific initiatives.

It is also pointed out that Lean initiatives are better led internally rather than externally and in the latter case, the chances of employee dissatisfaction are greater (Clarke et al, 2013, p.
Lean initiatives conducted at companies studied in this research were all carried out internally with leadership support.

**Leadership perceptions of Lean**

As mentioned in the section above, support from the leadership is agreed upon as one of the most important pillars of Lean. But the central role of management is often underestimated; as is the importance of proper instruction, training, the time needed to apply the change and the level of effort needed to yield results (Sullivan, 2011, p. 210).

Under the philosophy element of Liker’s pyramid; which forms the basis of all other layers as; company leadership is encouraged to have a long term vision rather than focus on short term goals and make decisions accordingly (Liker, 2004 as cited in Gao and Low, 2014, p. 669). Likewise, it was pointed out in one of the company case studies that isolated project leadership cannot lead to the benefits of Lean seeping into other parts of the organization.

Many of the companies examined in this study had implemented project specific Lean initiatives. On this, it is commented in one of the company case studies that in such a case, the temporary benefits that are caused by the initiative die off with the end of the initiative (Lean Construction Ireland, 2018). To this end, it was pointed out by one of the interviewees that the leadership needs to lead by example in order for the benefits of Lean to seep down through the organization. He also pointed out that it was necessary for the company leadership to be present on the ground and make observations and identify problems on a regular basis; something that is in accordance with the Genchi Genbutsu principle (Ohno, 1998 as cited in Samudio, Alves and Chambers, 2011, p. )

While most the companies examined in the study started off with project specific initiatives, the strong support from the leadership is further evidenced by the fact that in most of the
companies studied, Lean initiatives invariably extended from the initial project level implementation to other areas of the business.

**Perceptions of Final Value**

Value lacks a precise definition and the definition and understanding of value changes according to the project features (Salvatierra-Garrido *et al.* 2009). The seminal literature for Lean points out that value is best left to the customers’ perception (Womack and Jones, 2003, p. 16). However one of the in depth interviews revealed that in practice, the final value is changed by the clients to suit their needs and it is almost always dictated by the cost factor rather than the quality factor. Unrealistic expectations from clients are one of the main culprits behind failed projects (Sullivan, 2011, p. 210). As mentioned in the chapter before, the legislative measure by the Irish government that mandates preference for lowest price tenders invariably leads to unrealistic tenders being put forth. This legislation is in many ways the anti-thesis of Lean and drives the more excellence focused organizations out of competition.

Yusuf, Gunasekaran and Dan (2007) pointed out that every layer of a construction firm must have a congruent perception of adding value for the customer (Gao and Low, 2014, p. 670). However, one interview in this study revealed that when trying to add value upstream or downstream, the stake holders are not always within the bounds of the company and it might be necessary to search externally to find the user upstream or downstream. And since there is an incongruent perception of value, this makes the process all the more difficult.

**Most common forms of waste and management**

Review of literature on this topic revealed that waste in the construction industry was mostly either physical waste in the form of damaged or over-ordered materials (Sarhan,
Pasquire and King, 2017, p. 13) or process waste in the form of non-value adding activities such as delays, rework etc. (Sarhan, Pasquire and King, 2017, p. 13). This is corroborated in the study’s findings that most common forms of waste were indeed delays and rework.

Bureaucracy is singled out a common culprit for delays. As mentioned before, Liker (2004) noted that often times; companies turned Lean into a bureaucratic exercise of “administering programmes of tools” for implementing Lean. As a result a lot of time is wasted in administration when they could have been solving tomorrow’s problems. This was termed by one of the interviewees as an unnecessary duplication of efforts where a disproportionate number of supervisors were assigned to observe the trades person who is the only one getting value adding work done.

Construction always has some quantity of waste and rework is one of the principle wastes encountered (Lean Construction Ireland, 2018, p.). While one of the principle tenets of Lean in the manufacturing industry is to “Do it right the first time”, due to the uniqueness of each project it is difficult to apply (Simonsson et al, 2012, p. 36). This was confirmed by one of the interviewees pointed out that construction always has some forms of waste since it does not involve standard operating procedures and the making of the same product. Thus it can be inferred that “Do It Right the First Time” is not entirely applicable in construction.

Transparency among stakeholders

As mentioned in chapter 2, efficiency tools are ineffective if used in an adversarial environment (Salem et al, 2006, p.). Ideally, the early involvement of all relevant stakeholders in the design phase is needed in order to generate to remove the aforementioned problems of flow variability and achieve the best final value. Also, ideally the companies in the supply chain would work better if they were paid for tenders; however
that does not happen according to one of those interviewed. In the traditional way, the contract will be in the way and parties involved will always stay within the boundary of the contract. As such, they will be less inclined to cooperate because it isn’t in their interest to be more efficient if they are paid a fixed price. Whereas if they were paid based on value rather than actual output then it would be in everyone’s interest to be more efficient because there will be more savings. There are still many obstacles in the way of that being more widespread in the industry and it goes back to the lack of incentive caused by fixed price payments rather than those based on values. If there is no reward, it is not in the interests of any party to build quality into the initial design phase which is important in the Lean context.

**Work Flow Variability**

As pointed out in chapter 2, variability affects manufacturing and construction alike. Variability in construction occurs due to deviation or misalignment as far upstream as the design phase. The Last Planner system was developed specifically to deal with this issue. Howell (1999) stated for that unlike manufacturing, construction must rely on inspections during or after the completion of the work in order to identify problems. As a result of this, the final result for that specific project is unchanged and tracing the source of the problem is difficult due to the independence of different activities and high risk factors.

While one of the in depth interviews confirmed that the existence several layers of bureaucracy does make it hard to act quickly; this problem can was mitigated at his company by creating a common data sharing platform and digitizing the process of inspection with the help of technology. Also, one of the interviewees pointed out that as part of the Last Planner System, it is in fact possible to trace problems through the system.
put in place that allows for a more proactive nature of work by tracking the frequency of common problems.

**Resistance to change from the Staff**

The organization’s ability to change is listed as a major factor in the successful implementation of Lean (Sullivan, 2011, p. 210). It is difficult to persuade people used to a certain way of doing things to a completely *modus operandi* (Sullivan, 2011, p. 210). As noted by Liker (2004), by turning Lean implementation into a sort of “bureaucratic exercise”, companies defeat the purpose of understanding the importance of ingraining Lean into the company culture (Liker, 2004, as cited in Gao and Low, 2014, p. 670). As discussed in the section above, little prior knowledge on Lean processes leads to the devotion of a large amount of time educating the employees on Lean concepts. It was pointed out in one in depth interview that Lean needs to be understood well enough and not be used as just another cost reduction tool. This was confirmed by another interviewee who pointed out that resistance is unlikely since the Lean tools are meant to make the employees’ jobs easier. He emphasized that these changes should not be pushed too quickly or forced upon the staff but a keen understanding of Lean has to be propagated before any change is made. So it can be inferred that what little resistance to change exists in the beginning is soon mitigated by a better understanding of Lean.

**Long term sustainability or Kaizen**

Lean encourages managers to base their decisions on a well-articulated long-term vision even if those decisions contradict what might be financially beneficial in the short term (Liker, 2004 as cited in Gao and Low, 2014 p. 669). However, most of them expect to reap the benefits in the initial stages of implementation (Amhad, 2013). ‘Companies often
achieve significant short-term results when implementing lean, before the implementation processes ultimately fall apart’ as practises and processes return to their pre-
implementation stage, a view reinforced by Brown et al. (2016). However, the results of this study point out that although many companies initially started their Lean journeys by implementing small scale Lean projects, most of them did end up integrating it with their business processes. As a result, any reverting of the processes is unlikely in the companies currently using Lean. For the most part, the interviews and case studies both seem to point in the direction that Lean might be more widely implemented across the industry.
Chapter 6: Conclusions

To recall, the main question this study was asking is that about the differences between Lean theory and Lean practice in the Irish Construction sector and the implications of the differences. There was no academic literature covering this topic and this study will attempt to cover this gap. To this end, the following observations about Lean Construction were made:

1. **What are the driving factors behind Lean initiatives in the Irish Construction Industry?**

   The current awareness of Lean in the Irish Construction Sector is limited but increasing steadily. The reasons behind Lean initiatives are still predominantly client demand and the clients themselves are not very well informed about Lean Construction principles themselves. However there are also many companies that have undertaken Lean initiatives of their own accord in order to make improvements in areas they think they lag.

2. **What is the senior leadership’s perception of Lean in the Irish Construction Sector?**

   While most Lean initiatives did start on isolated projects in the beginning, the companies have moved to integrate the concepts into other parts of their business. While it was pointed out that sceptics do exist, this backward integration is evidence that there is indeed strong leadership support for Lean integration.

3. **What is the general perception of final value in the Irish Construction Sector?**

   It was postulated in the seminal literature that value lacks precise definition and is best left to the client to decide; but its definition changes according to project features. This was confirmed through this study that clients indeed alter the final value of the project and that it is mostly cost based rather than quality based. Adding value becomes harder
due to different perceptions of value among different stakeholders; the study again confirmed this phenomenon in that adding value upstream or downstream meant going outside the bounds of the company where perceptions of value are different.

4. What are the things most commonly regarded as waste and how is it managed?

As described in the literature, the most common forms of waste reported for this study included waiting times, delays and material transport. Bureaucracy was cited as the prime culprit in the unnecessary “duplication of efforts”. However, one of the Lean tenets common in the manufacturing industry was described as being difficult to apply in construction and the results of this study confirm this. Construction will have waste in the form of rework so the “Do it right the first time” principle is inapplicable in construction.

5. How much internal resistance is encountered when implementing Lean?

The literature pointed out that Lean must be well understood and ingrained into the company culture in order for it to work; and most Lean initiatives fail owing to the fact that changes are either introduced too quickly or forcefully which causes employee resistance. The results of this study confirm that internal resistance was not encountered because adequate time was allowed for the explanation of Lean to the staff in order for them to understand its mutual benefits.

6. How is work flow variability mitigated?

The perceptions of flow variability in construction varied across the different interviewees and company case studies. Flow variability was purported to occur due to a misalignment of objectives between various layers of the organization. The Last Planner System and Data Sharing as prescribed in the literature are applied mostly in textbook
fashion and results are visible. Thus it can be said that this is the one part of Lean initiatives where concepts and practice align perfectly.

7. **What is the Irish Construction Sector’s take on long term sustainability of Lean?**

On the topic of long term sustainability, the seminal literature postulated that company leadership must sacrifice short term financial goals in favour of a long term vision. However numerous other studies pointed out that a large number of companies undertake Lean initiatives for short term gains and then revert back to the old ways. The results of this study show that while Lean was initially brought in for isolated projects, in most of the cases, it did trickle into the rest of the business eventually. This makes the possibility of reversion to traditional ways unlikely.

Overall, it can be said that Lean concepts and Lean practice align well except in the areas of driving factors, perceptions of value and waste management. The implications of these differences are not dire as some of these differences exist due to the fundamental differences between manufacturing and construction.

**Recommendations for further study**

The main recommendation for future study on this topic is a larger research population covering more companies. Due to lack of contacts in the industry coupled with time constraints, only four in depth interviews could be conducted and the rest of the data was found through secondary research. However, if a larger study can be conducted comprising of all Irish construction companies, the results can be more generalizable.
References


Available at:


26. Simonsson, P. et al. (2012) “‘Learning to see” the Effects of Improved Workflow in Civil Engineering Projects’, Lean Construction Journal, pp. 35–48. Available at:


Appendix

INFORMATION SHEET FOR PARTICIPANTS


My name is Ameya Kharade and I am an MBA student at Dublin Business School. You are being asked to take part in a research study which is attempting to find the differences between theory and practice in Lean Construction and its implications.

WHAT WILL HAPPEN?

In this study, you will be asked questions pertaining to your company’s adoption of Lean construction methods. The questions will mostly be centred on: when Lean was adopted, what was used before lean, how the implementation went etc. You will not be asked to provide any confidential data for this study and the data will be anonymised.

TIME COMMITMENT

For the purposes of this study, you will be asked to answer a few questions pertaining to Lean Construction at your company; the interview will last barely for 10-15 minutes.

PARTICIPANTS’ RIGHTS

You may decide to stop being a part of the research study at any time without explanation required from you. You have the right to ask that any data you have supplied to that point be withdrawn / destroyed.

You have the right to omit or refuse to answer or respond to any question that is asked of you.
You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study’s outcome. A full de-briefing will be given after the study). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

CONFIDENTIALITY/ANONYMITY

The data I collect does not contain any personal information about you.

FOR FURTHER INFORMATION

I or / and my supervisor will be glad to answer your questions about this study at any time.

You may contact my supervisor Mr. Paul Taaffe at any time at paul.taaffe@dbs.ie
INFORMED CONSENT FORM


PROJECT SUMMARY:

Lean manufacturing is a well-known management philosophy and its principles have been adopted in the construction industry as well. As Lean construction became more widespread in the industry, many success and failure stories emerged. Thus, finding out the differences between theory and practice in Lean construction will give us a deeper insight into the implications of it. This research aims to study Irish Construction firms using Lean and gain further insight into how Lean is on paper and how it is practiced in the industry and its implications.

By signing below, you are agreeing that: (1) you have read and understood the Participant Information Sheet, (2) questions about your participation in this study have been answered satisfactorily, (3) you are aware of the potential risks (if any), and (4) you are taking part in this research study voluntarily (without coercion).

____________________________________  ______________________________________
Participant’s signature                  Participant’s Name (Printed)

Ameya Vilas Kharade

Student Name (Printed)                  Ameya Vilas Kharade

Student Name signature

25/07/2019

Date
Interview 1

Conducted: 25/07/2019

1. Me: When and why did you first implement Lean? Was it just for a project or for company-wide implementation?

2. Me: Which Lean tools did you implement?

3. Me: What activities were eliminated as waste and what percentage of the process did they constitute before approximately?

4. Me: What is your perception of the final value of the project? Is it customer determined?

5. Me: How did you manage schedule and flow variability?

6. Me: How much internal resistance did you encounter when implementing Lean?

7. Me: What was your overall opinion on Lean? Do you think it was beneficial for long term implementation company-wide?

8. Me: That just goes in line with the continuous improvement factor of Lean right?

9. Me: To sum it up what would you consider as the most important factor in a successful Lean initiative?
Interview 2

Conducted: 30/07/2019

1. Me: Under what circumstances did Lean Construction first get introduced to the Irish Construction Sector? Was it client demand or voluntary?

2. Me: What are usually the main motivations of Irish Companies that choose to adopt Lean? For a project or company-wide?

3. Me: What is the general perception of the Final Value in the Irish Construction Sector?

4. Me: In manufacturing there is a problem of flow variability, how does this problem manifest itself in Construction?

5. Me: Many Lean tools exist to cope with problems such as Flow variability, Waste and Value management etc. are they usually implemented according to the book or are they modified to suit specific needs?
Interview 3

Conducted: 08/08/2019

1. Me: So let me start off by asking when you first implemented Lean at your company; was it client driven or voluntary

2. Me: So in the article you say it’s more about email reduction, you have lesser emails now thanks to the initiative?

3. Me: So which Lean tools did you start employing?

4. Me: I see so mostly visual inspection/observation kind of thing?

5. Me: So which other areas did you feel things have improved since you implemented Lean?

6. Me: So before you started with Lean, was there a lot of flow variability? Like things weren’t flowing as smoothly?

7. Me: So when you first started, was there a push back from employees who would say “oh we prefer to do things the old way” and those sort of things?

8. Me: So what was the most important thing you would say to ensure the success of this initiative? Was it due to support from the leadership?
Interview 4

Conducted: 14/08/2019

1. Me: So let me start off by asking you: what led you to first consider Lean? What was the driving force?

2. Me: What were some common forms of “waste” in the industry, the most recurrent forms of waste?

3. Me: With so many layers of organization involved, there must be a lot of variability in the work flow... How did you deal with that?

4. Me: So what are some of the other Lean tools that you used?

5. Me: How much push back was there from the staff sort of resistance to change in culture?

6. Me: So overall, through this experience, what would you say was the single most important takeaway, the single most important achievement so to say?

7. Me: So do you implement Lean across the business or just for those 2 projects.
Figure 15 A map of themes and subthemes used in NVivo

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<thead>
<tr>
<th>Name</th>
<th>Description</th>
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<tbody>
<tr>
<td>Efficiency</td>
<td>Process efficiency based on waste management and value creation</td>
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<td>Final Value perceptions</td>
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<td>Perceptions of Waste</td>
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<td>Initial Adoption of Lean</td>
<td>Driving forces behind undertaking the Lean initiative</td>
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<td>Business-wide implementation</td>
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<td>Client driven</td>
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<td>Project-specific implementation</td>
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<td>Internal Resistance</td>
<td>Push back from employees in the form of resistance to change</td>
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<td>Change in Culture</td>
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<td>Understanding</td>
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<td>Sustaining Lean</td>
<td>The future of Lean in these companies</td>
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<td>Support from Leadership</td>
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<td>Take on Continuous Improvement</td>
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<td>Work Flow Balance</td>
<td>Establishing a smooth flow of work across different layers of the organization</td>
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<td>Flow Variability</td>
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<td>Transparency and collaboration between Stakeholders</td>
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