CHALMERS
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Sustainable Lean Construction:

Processes to reduce nuisances for society created by an urban construction site during the production phase

Master of Science Thesis in the Master's Programme International Project Management

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Department of Civil and Environmental Engineering
Division of Construction Management
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

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ABSTRACT

Lean Construction connects construction practices with the creation of new values. Until now, most efforts have been used to deliver values for the client and the client's end product and little consideration has been given to the social issues. For this reason it is important to extend the perspective of the construction sector in order not only to address customer requirements but also to meet society's needs during the production phase. Therefore, two research questions are formulated in this study: "How can Lean Construction be extended to create sustainable values not only for client but also for society?" and "How could a construction company apply this new scope in order to reduce societal disturbances during the production phase while still benefiting from advantage of Lean Construction?". To be able to answer these questions, a research method has been designed based on a literature study, semi-structured interviews with relevant professionals and observations from different construction sites. By visiting these construction sites, findings on how disturbances affect the local neighbourhood are highlighted. Also results from interviews provide this research with relevant knowledge and experiences about both the Lean Construction philosophy and disturbances generated by the construction site. With this in mind, suggestions on how to expanding the Lean construction philosophy to take into account the disturbances for society, created by the construction sites, are proposed and these also permit a construction company to formulate a sustainable strategy based on the creation of social values.

Key words: Lean Construction, disturbances, social values, construction sites, sustainable values.

Hållbar Lean Construction: Processer för att minska störningar för samhället som skapats av en urban byggarbetsplats under produktionsfasen

Examensarbete inom International Project Management
NAVID AMIRIARSHAD & BLAS TORRES LERMA
Institutionen för bygg- och miljöteknik
Avdelningen för Construction management

Chalmers Tekniska Högskola

SAMMANFATTNING

Lean Construction sammankopplar byggproduktion med skapandet av nya värden. Hittills har de flesta insatser använts för att leverera värden för kunden och kundens slutprodukt och föga kraft har berört den sociala dimensionen under byggproduktionen. Därför det är viktigt att utvidga perspektivet och inte enbart beakta kundernas krav utan även möta samhällets behov. Således har två forskningsfrågor formuleras i detta examensarbete: "Hur kan Lean Construction utökas för att inkludera hållbara värden inte bara för kunden utan även för samhället?" och "Hur kan ett byggföretag tillämpa denna nya möjlighet för att minska samhällsstörningar under produktionsfasen och samtidigt dra nytta av de andra fördelarna med Lean Construction?". För att kunna besvara dessa frågor utformades en forskningsmetod baserad på en litteraturstudie, semi-strukturerade intervjuer med relevanta yrkesverksamma samt observationer av olika byggarbetsplatser. Besök på byggarbetsplatserna resulterade i en förståelse om hur störningar påverkar den lokala stadsdelen. Även resultaten från intervjuerna gav relevant kunskap och erfarenheter om både Lean Construction-filosofin och samhällsstörningar skapade av byggarbetsplatsen. Baserat på detta ges förslag på hur man kan utvidga filosofin om Lean Construction genom att beakta de samhällsstörningar som genereras av byggarbetsplatsen och därigenom minimera dessa. Detta möjliggör också för ett byggföretag att formulera en hållbarhetsstrategi som bygger på att skapa sociala värden.

Nyckelord: Lean Construction, störningar, sociala värden, byggarbetsplatser, hållbara värden.

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Also we would like to thank the employees of the company, where this thesis has been carried out, who answered our interview questionnaire and allowed us to interview them. We would also like to thank all interviews who develop their job in other companies and permitted us to interview them. They all contributed to our data collection, which has been the foundation for this master's thesis. We would especially like to thank our supervisor at the studied company, Director of the Research & Development department Christina Claeson-Jonsson, who provided us with necessary documentation, support and contacts.

Numerous of interesting factors, sub-questions and aspects outside our research questions were identified during the work. This implies that the studied company has an exciting future development in regards to Lean Construction.

Gothenburg, June 2015

Navid AmiriArshad & Blas Torres Lerma

LIST OF FIGURES

1. Introduction

In this chapter, the background and rationale behind this research is discussed. Furthermore, the problem identification is described and based on that, the research purpose and questions are stated. Additionally, a description of the layout of this Master Thesis is outlined and the delimitations are presented.

1.1 Background and problem identification

Lean Construction has attracted interest from the academic and industry sector since the early 1990s (Green and May, 2005). However, the origin of the Lean Philosophy started much earlier and it is not possible to describe it without referring the practices and ideas carried out by the Japanese car industry. These practices, inspired by the Henry Ford's theories, were specially developed by a Japanese Automobile company and these were known as Lean Production (Liker, 2004). This system became famous, among other things, by winning the award for overall and predicted reliability in the small car category during several years continually. Also, more than half of all this company's used cars are singled out as "recommended for purchase" compared with less than 10 percent in other car companies. This Japanese company has also dominated the most prestigious quality and long-term durability awards during many years. All these data showed that there was something special about this production system. According to Liker (2004) this production system can be briefly summarized through two pillars that support it: "continuous improvements" and "respect for people".

With the Lean Production model as a framework, Womack and Jones (1996) introduced the term "Lean Thinking" as a generic term to describe application beyond manufacturing. They stated that Lean Thinking comprises a complex set of ideas including continuous improvements, flattened organization structures, the elimination of waste, teamwork, the efficient use of resources and cooperative supply chain management.

In 1992, Koskela tried to introduce Lean Thinking Philosophy into the construction sector and reformulated its principles and practices to adapt them to the features of the building projects. It can be considered as the starting point of the Lean Construction philosophy. A decade later, Tapping et al. (2002) pointed out that companies that want to implement a Lean Construction methodology need to follow the followings principles: customer focus, culture/society focus, workplace standardization, waste elimination and continuous improvement / built-in quality.

Until now, most efforts have been put to satisfy the client requirements, waste elimination and continuous improvements. However, little consideration has been given to the social issues (Salvatierra-Garrido and Pasquire, 2011) even though it is vital to recognise the existing dependence for the output of the construction industry on society. It should not be forgotten that construction projects are built to meet a specific need of

society. For this reason it is important to open the perspective of the construction sector in order not only to address customer requirements but also to meet the requirements of society as a whole. According to Luoma and Junnila (2011), the top three research areas during 2000-2010 in Lean Construction have been project management, design management and cost, performance measurement and implementation. It means that social and environmental issues such as reducing carbon emissions, social insertion, environmentally friendly projects and their impact for future generations have not been adequately addressed yet.

According to Salvatierra-Garrido and Pasquire (2011), from the Lean Thinking perspective, the way of fulfilling the customer requirements is through the value generation process. Based on that, and in the previous reliance described between society and the construction industry, it is essential to expand the current concept of value from a local context (providing values for customer) to a global context (providing values for the society as a whole).

One of the most common social issues that is present for every construction project is the nuisance for society created by the construction sites during the production phase, and particularly for the local neighbourhood that develops its daily activities around these construction places. These disturbances can produce negative impacts to those who are directly exposed to them (Andersson and Johansson, 2012), and it can generate a negative perception of the companies that belong to this sector. The fact of focusing on this social concern, possibly by extending the concept of value within the Lean Construction philosophy, can make construction companies provide sustainable practices that contribute to improve the perception of this industry by society.

1.2 Aim and Research Questions

The importance of creating a wider view of value in the construction is driven by the need for sustainable development and the particular role of the construction industry within society (Salvatierra-Garrido, 2011, p. 19). This particular role might be extended to support all those activities that contribute to the sustainable development of society. Until now, society has not had a strong voice or its role has not correctly been represented in design and construction of new building projects. The same happens with environmental issues. Therefore, there exist a great opportunity to explore this knowledge gap and improve interaction between society and the construction industry.

Based on the research background, the problem identification and the previous statements, the objective of this Master Thesis is to analyse how Lean Construction could be extended and interpreted in order to create not only sustainable values for the client but also for society, and specifically the immediate neighbourhood around a construction site. Furthermore, the study aims to indicate how a construction company

could apply this new perspective in order to reduce societal disturbances during the production phase while still benefitting from the advantages of Lean Construction.

Research questions

The research questions of this Master Thesis have been written based on the following main aspects:

- The mutual reliance between society and the construction industry.
- The important contribution that Lean Thinking can have for improving the interaction between society and construction industry.
- The necessity of extending the value generation process from a local context (focused on fulfilling customer requirements) to a global context (focused on fulfilling the requirements of society considering a customers as part of this).
- The great majority of the construction sites generate disturbances for society during the production phase.
- Construction companies can apply the extension of the value generation process to reduce disturbances for the local neighbourhood in their construction sites.

Our research questions address:

1: How can Lean Construction be extended to create sustainable values not only for client but also for society?

2: How could a construction company apply this new scope in order to reduce societal disturbances during the production phase while still benefiting from advantage of Lean Construction?

1.3 Disposition

After having introduced the scope and aim of this Thesis, chapter 2 includes the theoretical framework in which the most critical aspects of the research are developed more in depth. In this chapter an extensive literature review examines aspects such as the concept of value and relation with Lean Construction, social disturbances caused by construction sites, Lean Construction perspective and relationship with society and the relationship between Lean Construction and the challenges of sustainable development. The methodology of this master thesis is described in chapter 3. The research approach is explained in order to give a clear perception of this to the reader. The methodology is followed by empirical findings in chapter 4 obtained from the data collection process. In the next chapter these empirical findings are discussed in relation to the theoretical framework. The discussion is divided into two sections in order to answer individual and appropriately the two main research questions. Finally, the conclusions are shown in chapter 6. Additionally suggestions for the studied company and areas for further research are presented.

1.4 Delimitation

This master thesis focuses on the disturbances produced during the production phase in different construction sites located in the area of the Gothenburg region. Therefore, this research identifies disturbances in terms of construction projects in the Gothenburg area, in other words, in an urban setting. Other type of disturbances produced during other phases of the construction projects are not considered in this study. Also other projects located in different areas have not been included due to the time frame of the thesis.

The aim of the thesis has not been to identify different disturbances but rather to study the effect of them. Therefore, a limited number of disturbances that has been studied and it is possible that some important ones have not been identified during the visits and thus not discussed. Finally, the research work including the observations took place during the first six months of 2015 where no hot, dry weather was experienced. Therefore, disturbances concerning dust and hot temperature are not discussed.

2. Theoretical Framework

2.1 Lean

Most of the construction projects are designed as a temporary production system. Therefore complexity and uncertainty in these projects take place and make work hard for people who are involved in these processes. According to Ren (2012) "Lean can be used as a concept, principles, a type of ideology or a method to apply to activities or an organization management's guideline".

Lean is a way to design the production system to minimize waste activities at the same time that maximize values (Koskela et al. 2002). According to Koskela et al. (2002) the concept of Lean can be explained by having the right resources in a place to do the right work for the customers with the right quality in the right time. This process is a respectful way for those who are participating in a work system, which includes stakeholders with different interests. Lean can be used as a methodology or theory tool for analyzing, designing and controlling different activities and applying them in an organization in order to give direction and to get better result in process (Koskela et al. 2002). In the same research the authors stated that Lean can also be used in the construction industry to create sustainable value in the design, social, environmental and ecological phases.

2.1.1 Origination of Lean

Nowadays manufacturers are facing global competition and they are aware of the importance of a modern management philosophy in order to achieve market advantages. Therefore, the most important keys in the market system are quality and productivity (Womack and Jones, 1997). These authors expressed that the Lean Production philosophy goal is to satisfy the customer by delivering the highest quality with lowest cost in the shortest time. 1980, Lean Production was wider spread through the introduction of the book *"The machine that changed the world"* (Womack, Jones and Roos, 1990). In this book, the authors mentioned Lean as a way of thinking that allows organizations to specify values in order to, at given request, create and conduct activities without any disruption.

From the term Lean and viewing it as a concept, method or principle, Lean Thinking (LT) emerged as a methodology that brings together the characteristics of a Lean Organization. In Lean Thinking the value has been largely connected to the waste.

Therefore, LT is defined as meeting customer requirement while minimizing waste. The concept of value in the Lean Thinking methodology has not been deeply investigated (Salvatierra-Garrido and Pasquire, 2011). In their article the authors suggest that this concept should be further investigated and also, more consideration should be given to social issues.

2.1.2 Lean principles

As Koskela (1992) mentioned, many companies tried to copy Toyota´s practices by using tools and methods in their production phases but without successful results. Liker (2004) stated that there are 14 important principles that are essential for understanding the Lean Philosophy, which are the followings:

- Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.
- Create a continuous process flow to bring problems to the surface.
- Use "pull" systems to avoid overproduction.
- Level out the workload (work like the tortoise, not the hare).
- Build a culture of stopping to fix problems, to get quality right the first time.
- Standardized tasks and processes are the foundation for continuous improvement and employee engagement.
- Use visual controls so no problems are hidden.
- Use only reliable, thoroughly tested technology that serves your people and process.
- Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.
- Develop exceptional people and teams who follow your company's philosophy.
- Respect your extended network of partners and suppliers by challenging them and helping them to improve.
- Go and see for yourself to thoroughly understand the situation.
- Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly.
- Become a learning organization through relentless reflection and continuous improvement.

These principles of Lean Production suggest that specific Lean tools could result in some improvements such as more efficient productivity, reduction of the cost and higher quality of the product.

2.1.3 Lean Production and Lean Construction

As Shook (1998) expressed, there are three major phases' shifts from industrial production to the modern world. These phases are craft production, mass production and Lean Production. In this report, Lean Production is considered. Shook (1998) stated that Lean Production reflects the way of thinking about the production within some organizational cultures rather than merely focusing on the production systems. Thus, this production system can easily be related to factories, manufacturing and construction. Gao and Low (2013) expressed that the Lean Production philosophy is based on less human effort, less manufacturing, less time, less investment in tools, less inventory etc. Nowadays, Lean Production is usually considered as originating from the Toyota Production System (TPS). Under the leadership of Eiji Toyoda and Taiichi Ohno, Toyota led the way in developing what is now called the TPS. Toyota production system's aim is to reduce cost without increasing production volume (Gao and Low, 2013).

In the Lean Thinking methodology it is essential to build quality in order to identify what are the normal and abnormal conditions (Womack and Jones, 1997). In order to understand these differences, Lean Production exists at both a strategic and operational level. At the strategic level the concept of Lean Production supports the customer value to identify tools that are supported to eliminate the waste in order to reach the continued improvement within Lean Production. The first point of view (strategic level) is related to progress and guiding principles and the second point of view (operational level) consists of the set of management tools and techniques that can be directly affected to Lean Production (Womack and Jones, 1997).

According to Koskela et al. (2002) the success of Lean in manufacturing and the benefit of using the process of Lean Production is one of the main motivations for applying this process to the construction area. Lean Construction defines a management process based on a production approach to project delivery, which is particularly useful when there is complexity and uncertainty. As Koskela et al. (2002) stated, the definition of Lean Construction is following the same aim as Lean Production, both consider to eliminate waste in order to maximize the value.

In Lean Construction, the aim is to create a construction work-flow by improving the performance of the project team. This affects the organization in order to have a creative collaboration in different phases of the construction (Koskela et al. 2002). As Koskela expressed, Lean Construction is the process that involves site staff and planning to workers not waiting for work and work not waiting for workers which is affected by social disturbance.

It would not be possible to transfer management practices from manufacturing to the construction industry until the necessary efforts had been taken to modify management tools or the culture of the construction industry (Gao and Low, 2013). Therefore, it is important to analyse the differences between the manufacturing and the construction

industry. The complicated part is to design and analyse an appropriate model from manufacturing or production to construction. As Gao and Low (2013) stated, this model could be applicable in some areas such as:

- Large infrastructure work especially in civil engineering.
- Routine building projects that provide majority of new building such as a school and offices and so on.
- Housing.

All these categories are based on work sites and project oriented construction. The main differences between the construction and manufacturing industries regarding different phases are shown in the next table.

Phases	**Construction industry**	**Manufacturing industry**
Duration life cycle	Short	Long
Nature	Part of the nature	Cyclic and repetitive
Work station	Temporary	Stable
Enviroment	Productively influenced by the change in environment	Less influenced by the change in environment
Technology	Low level of Mechanization, prefer not to use	Better and advanced
Quality	Rework is common that is related to product conformance	Close to process control and rework is avoided
Culture	Site personnel not defined completely about the company's management philosophy	Clearly defined
Controlling involvement	Many work phases are depends on agreement and regularly abilities	Less subject to checks and approval

Table 1. Differences between manufacturing and construction industry. (Koskela, 2000; Riley and Clare-Brown, 2001; Winch, 2003)

2.1.4 Lean Construction principles

In accordance to table 1, all phases focus on the comparison on technical aspects of the construction and manufacturing industries. Through this comparison, opportunities arise

for firms to identify valuable aspects in order to formulate a strategy moving from site planning to organizational planning (Koskela, 2000).

According to Tapping et al. (2002) and in order to support these phases, companies that want to implement a Lean Construction methodology need to follows five principles:

- Customer focus
- Culture/Society
- Workplace standardization
- Waste elimination
- Continuous improvement / built-in quality

Through these five Lean Construction principles, organizations have an opportunity to compare their current activities from the perspective of what kind of policy they are following now and what sort of practices they are going to follow based on applying these principles (Tapping et al., 2002).

2.2 The concept of value and its relation to Lean Construction

2.2.1 The concept of value

The concept of value has been recognized as one of the most important and relevant concepts of social science (Salvatierra-Garrido, 2011). Many researchers and academics have developed theories or models where this concept plays a vital role. For instance, one of the three pillars of Koskela's theory of production is the concept of value generation (Koskela et al., 2002). In this model, the basic objective of the value generation concept is to reach the best possible value from the point of view of the customers. Another example can be identified in the Toyota Production System where the perspective of value perceived by the customers is the engine that moves all the production processes and contribute to improve these constantly (Liker, 2004).

It is widely recognized that it is not easy to define the concept of value (Maia et al., 2011; Salvatierra-Garrido and Pasquire, 2011; Salvatierra-Garrido and Pasquire, 2011b). Many diverse sectors such as sociology, business, marketing or engineering among others have tried to develop it with different results (Salvatierra-Garrido and Pasquire, 2011). Evidently, this concept is not adequately understood and for this reason it is necessary to specify it in a proper way.

According to Koskela (2004) the concept of value is considered as "something materialistic which is possible to understand and to specify". Koskela is not the only author who has tried to define this concept. Also Björnfot and Stehn (2007) describe value as a concept related to materials, parts or products. It can be seen that value has been addressed to a conceptual model where customers can see it through an empirical vision. Other example can be found in the book "Lean Thinking" where value is defined

as “a capability provided to a customer at the right time and at an appropriate price, as defined in each case by the customer” (Womack and Jones, 1996, p.311). In addition, and considering a more general view, it can be said that value is a relation established between subjects and objects (Maia et al. 2011). This supports the idea that value is not something precise. In fact, this is the result of a relationship between individuals (or groups) and objects and it does not make sense to use this concept if one of the previous parts is absent.

From the Lean Thinking perspective, the concept of value has been largely recognized as “…the most difficult to approach in the new way of managing construction projects.” (Salvatierra-Garrido and Pasquire, 2011; p. 9). These researchers also stated that value is mainly delivered in the production process on site which reinforces the materialistic view that this concept has received.

2.2.2 Characteristics of value

The concept of value presents many features depending on within which field it is used. Through a wide literature review, Salvatierra-Garrido and Pasquire (2011) highlight the most important characteristics of value from the point of view of the construction industry. They can be described as follows:

Firstly, a value can be seen as objective. Through this feature value is understood as a property of goods or services (Salvatierra-Garrido and Pasquire, 2011). This means that value is connected to measurable attributes or physical product features and maybe this is strongly associated to the concept to value today.

Secondly, subjectivity is another important feature of value. Not everyone is able to give the same value to a certain thing or action. Thus, each individual or society has his/her own scale of values and these normally differ from other individual values. According to Emmitt et al. (2004, p.3) “the perception of value is individual and personal, and is therefore subjective”.

Thirdly, a certain value depends on the context where it is measured or perceived (Salvatierra-Garrido and Pasquire, 2011). Therefore, the concept of value can be seen as context-dependent. For instance, in some layers of our society a luxury watch represents an important value but in other spheres the same watch has a minor importance because their scale of values differ totally.

Finally, the perception of value changes during the time. It means that this concept is not static and because of this, the understanding of value should be revised periodically. This dynamism makes that value can be seen as an oscillating concept (Salvatierra-Garrido and Pasquire, 2011). In the construction industry the oscillation can be identified when a value is delivered for a particular building project but its final result impacts on society. In this way Salvatierra-Garrido and Pasquire (2011) stated that

value becomes a phenomenon that moves constantly from a particular context (local context) to a global context (society).

2.2.3 Value from a Lean Construction perspective

Traditionally the concept of value from the Lean Construction perspective has been associated with the on-site production process (Salvatierra-Garrido and Pasquire, 2011). This is due to this concept was originally transferred from the Lean Thinking philosophy (associated with the Toyota Production System) and in this field the concept of value was addressed to "define value in terms of specific products with specific capabilities offered at a specific price through a specific dialogue with specific customers" (Womack and Jones, 1996, p.19).

Based on the difference between the construction and manufacturing sector, Koskela (2000) distinguished three main pillars in his theory of production called TFV (Transformation-Flow-Value) generation. Through this theory a value generation model arose based on five principles: requirement capture, requirement flow-down, comprehensiveness of requirements, capability of production subsystems and measuring of values.

- Requirement capture: Ensuring that all customer requirements have been captured
- Requirement flow-down: Ensuring that relevant customer requirements are available in all phases of production and that they are not lost when progressively transformed into design solutions, production plans and products.
- Comprehensiveness of requirements: Ensuring that customer have a bearing on all deliverables for all roles of customers.
- Capability of production: Ensuring the capability of the production system to produce products as required.
- Measuring of values: Ensuring by measuring that values are generated for the customers.

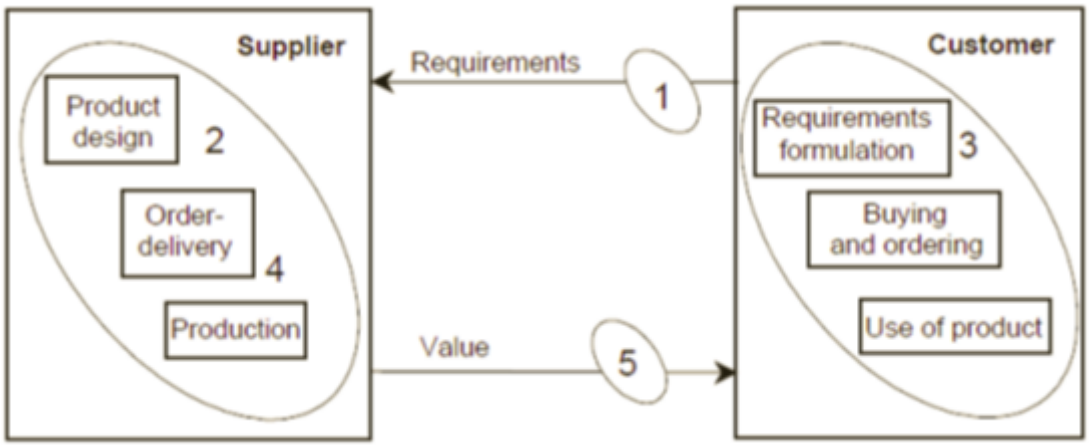


Figure 2. Value generation model (Koskela, 2000)

From Koskela's value generation model, values arise from the interaction of products, customers and suppliers (Salvatierra-Garrido, 2011). Also as the main principle of the Lean Thinking is to reduce value loss through the continuous improvement along the life cycle of the project, the adaptation of this model to the construction industry has been commonly oriented to reduce activities that do not add value for customer requirements, especially on-site activities within the production phase.

One critic of this adaptation to construction industry was made by Salvatierra-Garrido and Pasquire (2011) in their research about value theory in Lean Construction. They argued that through the adaptation of the Lean Thinking to the construction sector, the generation of values has focused on requirements from project customers and too little importance has been given to societal issues even though the customers are part of the society.

2.3 Social disturbances at construction sites

According to a study realized by the European Commission, 80% of EU's citizens live today in and around cities (European Commission, 2013). Also during the next 15-35 years it is expected to increase the transportation infrastructure network in almost the double across Europe (Pantura, 2011). These facts contribute to increase the risk for society of being affected by inconveniences produced by construction activities when construction projects are carried out in urban areas.

Construction and maintenance of urban infrastructures normally cause the major part of the disturbances for the urban population. This fact together with the data provided in the previous paragraph (during the next 15-35 years it is expected to increase the transportation infrastructure network in almost the double across Europe) makes that the pressure on administration and government authorities increase in order to find a solution which decreases the inconveniences of these activities for the population most exposed (Pantura, 2011).

The concept of disturbance has been described by many researchers in a general way. Andersson and Johansson (2012) use in their research a definition of disturbance which consists of "an event in time that disrupts the community or population, and change resources or the physical environment". However, the concept of disturbances for local population around the construction site has not been widely explored. The Swedish Law refers the disturbances for residents as disturbances that are harmful to the residents' health, according to current health protection regulations (SFS 1970:994). If this definition is applied to the topic within which this thesis is based, disturbances can be defined for our purpose as "a consequence derived of the construction works that affects negatively to those who are exposed".

Through a european research project (Pantura, 2011) focussing on "improving highly flexible off-site production processes, create resource-efficient construction sites, improve technologies and tools for bridge construction in densely populated areas and enhance communication between local authorities and construction companies", some social disturbances were identified. These were further investigated by Andersson and Johansson (2012). In order to better understand the area in which this thesis is focused, the inconveniences on the surrounding society produced by the construction site will be called "social disturbances" because they affect society negatively in respect to the daily activities around the construction sites. These disturbances are further explored in the next sections.

2.3.1 Different types of social disturbances

Mobility

According to Pantura (2011) mobility disturbances can be defined as the kind of problems for society where an increment of the travel time is produced between two points of a transport route because of the existence of construction works. These kind of disturbances cause social, environmental and economic impacts due to the increase in travel time, the increase of the distance if there is an alternative route, the increase of petrol consumption and the dissatisfaction that affect to people.

According to a research carried out by the Dutch Ministry of Transport, Public Works and Water Management (2008), mobility should be analysed in order to organize smarter opportunities to travel. This analysis should be focused on influencing behaviour in the society.

Noise

This disturbance can be defined as the site measurements of the areas within the construction works with noise levels exceed the permitted levels by regulations and laws (Pantura, 2011). In order to minimize the levels of noise produced by construction activities, it is important to try to reduce noise created by machines and other activities related with it at the construction site.

This inconvenience is especially relevant if it is produced during certain moments of the day. For instance, during the night this disturbance takes more importance because it interrupt basic human activities such as sleep.

Dust emissions

Andersson and Johansson (2012) defined dust emissions as "the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment". Thus, it is important to take this disturbance into account when a construction site is analysed.

It is clear that engineering works produce dust emissions during their production phase. For instance high levels of dust emissions are commonly produced within road construction and it affects to the air quality in the area. One factor that can contribute to vary the levels of dust emissions is the climate. Therefore, in wet climates the concentration of dust particles is smaller than in dry climates.

Safety of residents

According to a research carried out by Glass and Simmonds (2007) construction sites can have an adverse impact on the health and safety within the local population. In order to establish a fruitful relationship between the construction company and the local neighbourhood, the impacts regarding safety conditions should be considered. These authors also describe this disturbance as "accidents occurring outside the site boundary caused by falling materials, broken pavements, damaged footpaths and dark temporary access ramps". They also mention as an inconvenience for the safety of the residents the stress caused by the constant noise and disruptions.

Pantura (2011) mentions that this disturbance is vulnerable to a number of external effects outside of the control of the construction site such as weather conditions or the increase of the traffic jams due to external influences.

Vibrations

According to Andersson and Johansson (2012) vibrations consist of wave motions that propagate through the air and ground. Also Ungar and Zapfe (2011) stated that an inevitable inconvenience of new building construction is the generation of considerable ground vibrations that propagate from the construction site into neighbouring building and in consequence to the local population (Ungar and Zapfe, 2011). According to them in recent years there have had an increasingly concern about the potential adverse effects that vibrations can produce on the surrounding areas of the construction sites. These effects were expressed by Svinkin (2004) as a range from nuisance for the local population and disturbance of working conditions for sensitive devices, to diminution of structure serviceability and durability. The level of vibrations caused by construction activities depends on the construction method, soil medium, heterogeneity and uncertainty of soil deposits at a site and sensitivity of the local population to vibrations (Svinkin, 2004).

Accessibility

These kind of disturbances are related with the difficulties that pedestrians have to access to their destinations. Some examples could be problems for accessing to shops, schools or work places due to the existence of barriers or changes made by the construction projects. When accessibility problems are examined from the business point of view, these disturbances affect to both clients and owners because when clients perceive difficulties to reach a shop, they can change to other store that it is easier to access and owners can see as their incomes are reduced.

2.4 The Lean Construction perspective and its relationship with society

Humans learn to make a request when they are learning to speak but they do not always learn to observe. However, people can learn from each other by listening and people can teach each other to observe. In a more sophisticated view, value can be seen as a driving force for reaching customer satisfaction. This understanding guides construction industry to realize that the customer in an agreement situation is not the only one with concerns to be satisfied, and not the only one to receive value from a transaction but also human which is the part of society should be considered as well (Koskela, 2000). Connecting the society with Lean Construction is also in relation to whom it is defined as the customer. The end users or surroundings are also a type of customer that should be taken into account from a Lean perspective.

2.4.1 Creation of value in the Early Stage of projects

As it has been already discussed in different articles (Salvatierra-Garrido, 2011; Koskela, 1992), most of the problems in the buildings arise from poor management that include some activities such as the design planning stage. In addition, the problem of poor management also could affect the production phase. As Koskela (2000) expressed, design can be considered as a value generation activity that can help to add value in the early stage of the project. The main principle of this approach is to eliminate the gap between the achieved valued and the best possible value. The practical contribution is that it considers customer's requirements in order to meet the best possible process (Koskela, 2000).

2.4.2 The relationship between society and the Lean Construction experience

In TFV model from Koskela (2000), construction is considered as a production system activity where the value generation is considered as a process to meet the customer's requirements. Therefore, sometimes achieving the value is much more important than to reducing the waste. Thus, sustainability issues in this process should be paid more attention to in order to get more benefit from society and industry. Therefore, sustainable practices is a way to achieve traditional process to sustainable design in terms of focus on quality, cost and time. Thus, these facts are considered in order to minimize the social and environmental issues. (Salvatierra-Garrido, 2011).

Healthy economy

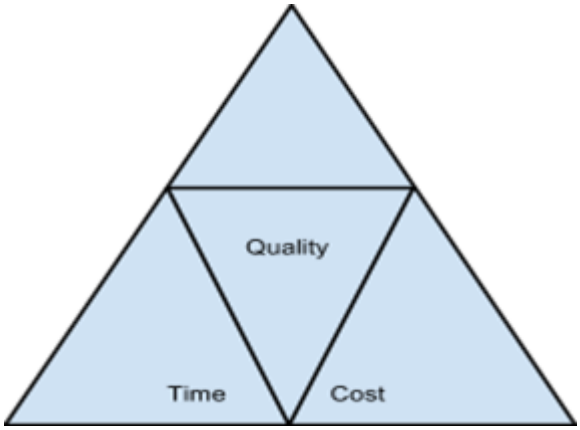


Figure 3. Aspects for sustainability in construction. Koskela (1992)

Based on the TFV theory of Koskela, environment and social aspects should be considered as important parts in order to reach customer satisfaction. Thus, Koskela expressed that Lean principles can contribute to achieve sustainable goals by:

- Eliminating waste: Minimisation of resources consumption and minimisation of pollution
- Adding value to the customer: Minimization of resources, Matching business and environmental business quality.

2.5 The relationship between Lean Construction and the challenges of sustainable development

According to a study carried out by the European Commission "the European construction sector is the largest European single activity (10% GDP) and the biggest industrial employer. Also since the buildings use 40% of total EU energy consumption and generate 36% of the greenhouse gases in Europe, the construction industry is today a critical issue to improve the environmental conditions in Europa" (Ec.europa.eu, 2013). These previous data can shed light to the importance for the construction sector to meet a sustainable development.

The most extended definition of sustainable development was stated by the World Commission on Environment and Development in 1987 and for this organization a sustainable development is a "development that meets the needs of the present without compromising that ability of future generations to meet their own needs" (WCED, 1987). Taking this definition into consideration and recognizing that traditional and design construction have focused on cost, performance and quality objectives (Huovila and Koskela, 1998), it is demonstrated that there are many challenges to implement sustainability in the construction industry.

Sustainability in Lean Construction has been mainly focused on some phases of the projects related with the design and the improvement of the activities carried out during the production phase. However, the production stage and the relation between this phase and the neighbourhood perspective have not been considered much from a sustainability view (Rosenbaum et al., 2012)**.** Current sustainable construction approaches show the disconnection between environmental, financial and social aspects in projects in order to reach the sustainability level (Rosenbaum et al., 2012). According to these authors, it is not clear if the application of Lean Thinking leads to better environmental performance in order to have an innovative manufacturing process.

The social, environmental and financial aspects are three important facts that are related to sustainability in construction projects. This has been concerned that improving environmental and social performance would compromise the economic sustainability of an organization and many companies cannot provide the cost of meeting their environmental and social responsibilities (Florida, 1996).

However, according to Found (2009), organizations with higher environmental achievements have higher stock market returns. This author also stated "*Minimising the amount of waste that is produced, reducing energy consumption and making more efficient use of resources can all lead to financial cost savings, in addition to helping to protect and enhance the environment and social*" (p. 3). This finding suggests that adopting the Lean approach for eliminating waste has the potential for environmental, financial and social benefits in terms of saving cost and reach sustainable practices in construction projects (Corbett and Klaasen, 2006). Rothunberg et al. (2001) expressed that the relationship between the construction industry and the environment is not achieved until the culture of company adopts the best practice of change. It can be said that it would be difficult to reach sustainable practices if the culture of the companies does not change.

Figure 4. Representation of the sustainability framework

Lean Construction can be one approach to implement a sustainable construction process by introducing the social, economic and environmental issues as new values to achieve instead of only focusing on the benefits applied to the production phase (Bae and Kim, 2007).

2.5.1 Sustainable construction implementation

Huovila and Koskela (1998) stated that sustainable construction is the response of the construction sector to the challenge of sustainable development. In their article they describe a schematic possible route for achieving an adequate implementation of a sustainable process within the construction industry. For the purpose of our thesis, this route can be slightly modified and its aspect looks like the follows.

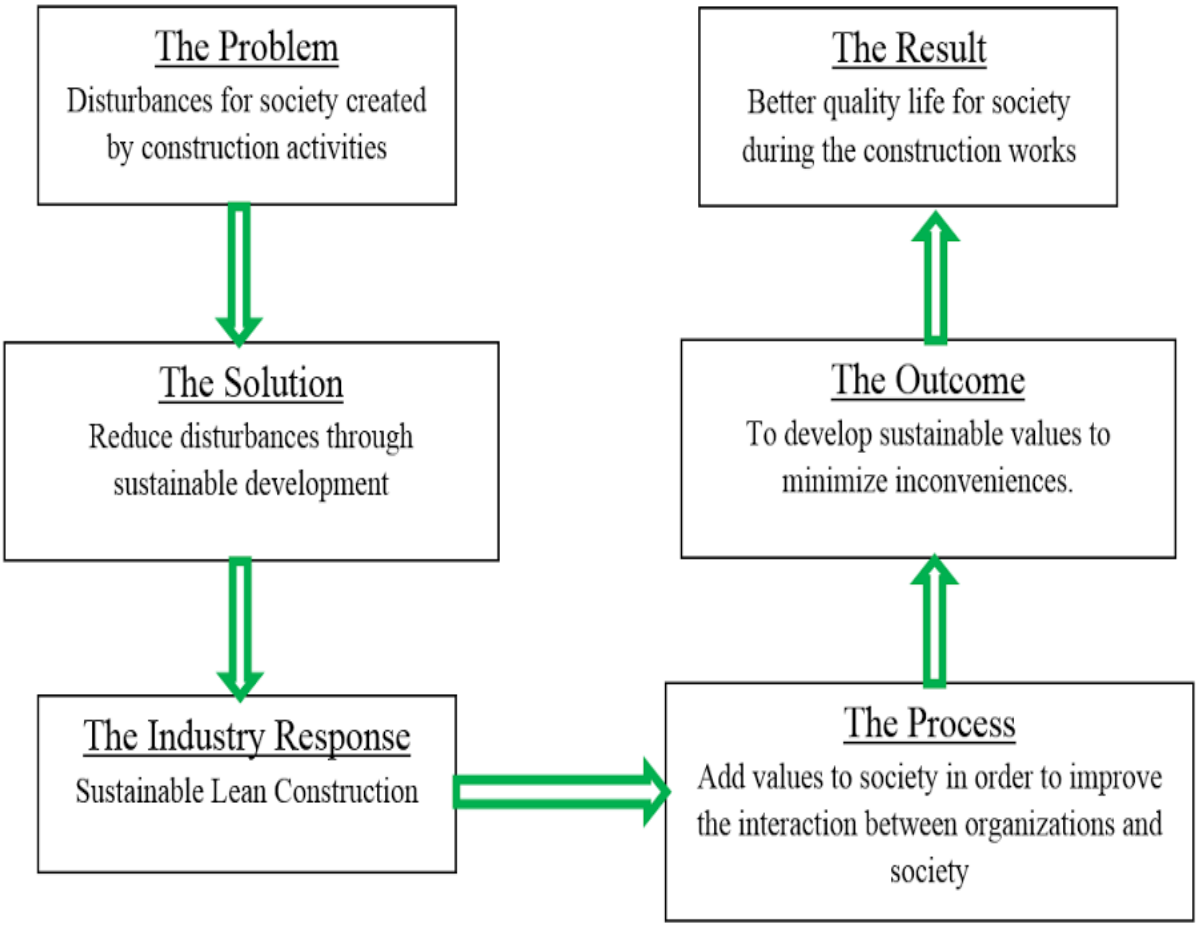


Figure 5. Simplified route for sustainable construction adjusted from the article written by Koskela (1998)

In a continually changeable business market in which construction companies develop their projects today, they need to adapt their practices into the issues concerning sustainable values at all level of the society, but especially at the local one because its members are those who suffer more directly the consequences of the inconveniences derived from the construction activities.

3. Methodology

3.1 Research design

Research design is one of the most important aspects of a research process and it involves several decisions which lead to improve the rigor of any research. Once this design is defined, the research will have an established way for carrying it out.

According to Salvatierra-Garrido (2011) the research design includes the interaction between human decisions, theory and practice.
Through a concise literature review about designing research, the research methodology followed in this master thesis can be explained describing the next aspects.

- The relation between findings and theory: inductive approach
- The purpose of the research: exploratory
- The data collection techniques used: qualitative interviews and observations

3.1.1 Inductive approach and exploratory research

An inductive theory represents the common view of the nature of the relation among theory and research findings. This means that the findings need to specify how data can be collected in relation to the concepts that makes the hypotheses (Bryman, 2008). This view supports the theory in relation to the finding or empirical study. In general, an inductive research starts with the empirical data and through analysing them, a theory is developed or extended. In this inductive approach, theory is the outcome of the research (Bryman, 2008).

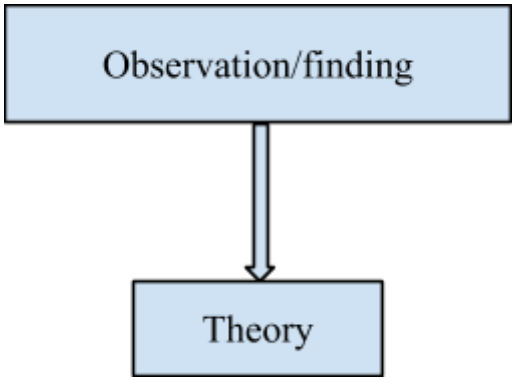


Figure 6. Schematic illustration of the relationship between theory and research in an inductive approach

With respect to inductive approach, it was chosen for this thesis because this study started with the observations of the difficulties that construction sites create for the society and based on the necessity of minimising them, the Lean Construction philosophy was studied in order to describe how this theory can contribute for achieving it. In other words the reason why an inductive approach was taken in this master thesis is because it began with the observations and analysis of a type of problem for society created by the construction projects during the production phase, and based on this empirical material, a theory is deeply analysed in order to explain how it can be used to diminish these social disturbances.
Based on the purpose, a research study can use an exploratory approach to achieve its objective. This kind of approach is utilized when an emergent subject is explored and there is information that should be included in order to achieve a more global understanding in the literature and practice (Salvatierra-Garrido, 2011). From this point

of view, this thesis can be categorized as exploratory. The reason why this method was chosen is because an emergent subject (social issues regarding disturbances generated by the construction projects) is explored and the intention is to get a better understanding of this phenomenon and how it together with the use of the Lean Construction can reduce neighbourhood disturbance generated from the construction sites.

3.1.2 Qualitative research method

It is also very important to consider the existing techniques for collecting data. There are several alternatives that can be highlighted regarding this fact but only two of them will be described in this section. One of them is a qualitative technique and the other one is observations. According to Kothari (2004), a qualitative approach is one in which the inquirer often makes knowledge claims based primarily on constructivist or participatory perspective. It also uses strategies of inquiry such as narratives, grounded theories studies. In other words, qualitative research is concerned with qualitative phenomenon. The other mentioned technique for collecting data is observations. Farenga et al. (2003) described this method as "*a basic skills that must be cultivated in order to conduct richer inquiry. It is central to the scientist's method of enquiry for generating hypotheses, formulating laws and confirming theories".*

Regarding the reason why these techniques were chosen for this master thesis, it should be said that the qualitative method was selected because this method permits to create a participatory interaction between different groups of actors involved in the study of Lean Construction and how it could be used for reducing the discomfort caused by the construction sites. Also by using semi-structured interviews, a conversation around the subject can be developed and it allows follow-up questions that are useful to answer the research questions.

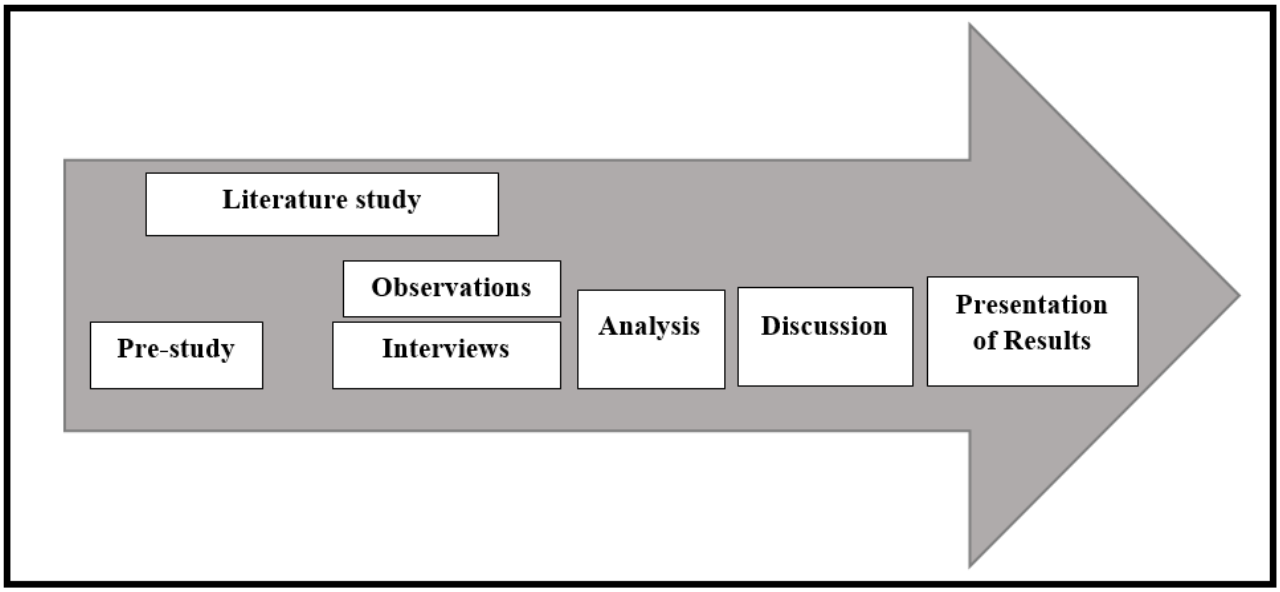
With respect to the observations, this method was used in this research because through observing different construction sites it is a good way of identifying the different disturbances created by the construction sites that have direct impact on the local neighbourhood. Also through these observations it is possible to identify actual patterns about how these inconveniences affect people and what the construction companies currently do to reduce them.

Figure 9 shows the schematic research process followed in this master thesis. First a pre-study was performed in order to gain a better understanding of the topic and also for narrowing down the research questions. In this phase, two pre-interviews were conducted and they were very useful for choosing what research approach was the most appropriate for this study. At the same time, a visit to two different construction sites situated in the city of Gothenburg was made in order to identify the most important disturbances produced. Parallel to this pre-study, an extensive literature review was

carried out in order to get a deeper understanding of the field and for validating the results obtained from the data collection process. These results were obtained by analysing the data collected in the interviews and by examining the observations realized in several construction sites around the city of Gothenburg. These two processes were used to develop the discussion chapter. Finally, conclusions were made and recommendations for future developments were presented.

Figure 7. Schematic research process carried out in this Master Thesis.

3.2 Pre-Study



This master thesis began with a pre-study where the aim was to narrow down the research area and to obtain a clearer picture of the main disturbances produced by the construction activities. This pre-study consisted of two interviews, two exhaustive visits to different construction sites situated in the city of Gothenburg and an initial literature review. For both interviews, the interviewee was proposed by the supervisor and they were relevant people with wide experience managing different construction projects and with numerous previous experiences handling inconveniences caused by the construction sites and that affect the local neighbourhood. Both interviews were conducted in Swedish, recorded and transcribed. The visits to the construction sites were carried out with the purpose of checking the disturbances on site. Moreover, the day chosen for these visits was carefully selected because these inconveniences are more noteworthy when weather conditions are bad. An initial literature review was also performed at this stage and some articles were read in order to obtain a basis about the Lean Philosophy and the main disturbances observed in the construction sites.

The result from the pre-study was useful for focusing the literature review and for obtaining a real picture about the inconveniences that the disturbances produce in the local neighbourhood. Also from this pre-study the decision about how to orient the research and obtain data was taken. On the one hand it was noticed that people with wide knowledge about Lean Philosophy should be interviewed in order to extend this methodology for considering social aspects. On the other hand it was also necessary to obtain data from people who develop their daily activities around a construction site. The approach to this second group should be different to the people with knowledge about Lean Construction.

3.3 Literature review

A literature review has been carried out in order to create a theoretical framework in this research, as presented in Chapter 2. The aim of this theoretical framework was to support the empirical findings obtained through the data collection process and to provide an adequate context for the study and for the data analysis. The literature review in this study was based on relevant scientific articles and books which have been found through the Chalmers University of Technology database and through the recommendations from the supervisor and examiner. All material and resources concerned the following research areas:

- Lean Construction and production principles.
- The concept of value from the Lean Construction perspective.
- Social disturbances created by the construction sites.
- Relation between society and the Lean Construction perspective.

The literature review was performed during the study, starting in the pre-study phase and continuing throughout the data collection. The main keywords for the search of the articles and books have been: Lean, Lean Construction, reduce disturbances, generation of value, construction sites and local neighbourhood.

3.4 Data collection techniques

3.4.1 Observations

Observing is an empirical process. It is based on direct experiences with the surrounding environment, and is influenced by prior knowledge (Farenga et al. 2003). This technique presents some advantages and disadvantages and it is very important to take them into consideration when a researcher decides to use this method for collecting data.

One noteworthy advantage is the fact that this method provides researchers with the opportunity to perceive and comprehend similarities and differences in the objects they are observing while building a knowledge base. By doing visits to different construction

sites it was possible to observe and understand how disturbances affected population and distinguish similarities and differences in that sense.
Another important benefit of observing is to create a starting point for critical analysis based on the gathering of baseline data. One application that can be developed from baseline data is "change" (Farenga et al. 2003). In this master thesis the change is related with the need of reducing disturbances for the population and by observing this need, the change was identified.

Regarding the disadvantages of the method, two should be emphasized. One of them is the fact that this method consumes a lot of time and resources and it can be a problem when these two factors are limited. The other disadvantage is that all observations are susceptible to observer bias, thus undermining the reliability and hence the validity of the data gathered. This is an important limitation that should be take into account when this technique is used.

Taking these advantages and disadvantages into consideration and parallel with the literature review and the interviews, several visits to different construction sites were carried out in order to observe how the disturbances created by these sites affect to the neighbours, and also what kind of actions the construction companies are currently taking in order to minimize these inconveniences. Before each visit a search for general information about the construction project was conducted in order to have a first idea about how the project was planned and what are the most important aspects to take into account. This search was performed by using the website of the client and once this information was collected, the day for the visit was also decided based on the weather forecast. This aspect was considered because with bad weather conditions the disturbances created by the construction sites are more pronounced.

During the observations of the place, several photographs were taken and annotations of the most important aspects were made. The locations of the selected places are as follow:

- Construction site 1: Chalmers platsen– Aschebergsgatan (Gothenburg). The area extends from the bus and tram stops of Aschebergsgatan to Chalmers University main entrance.
- Construction site 2: Sven Hultins gata (Gothenburg). This area is situated inside the Chalmers University Campus.
- Construction site 3: Hjalmar Brantingsgatan– Långängen Street (Gothenburg). These are two important streets of an important area of Gothenburg.
- Construction site 4: Järntorget Square (Gothenburg). This square is located in the city centre of Gothenburg.
- Construction site 5: Norra Hamngatan (Gothenburg). This street is also situated in the city centre of Gothenburg.

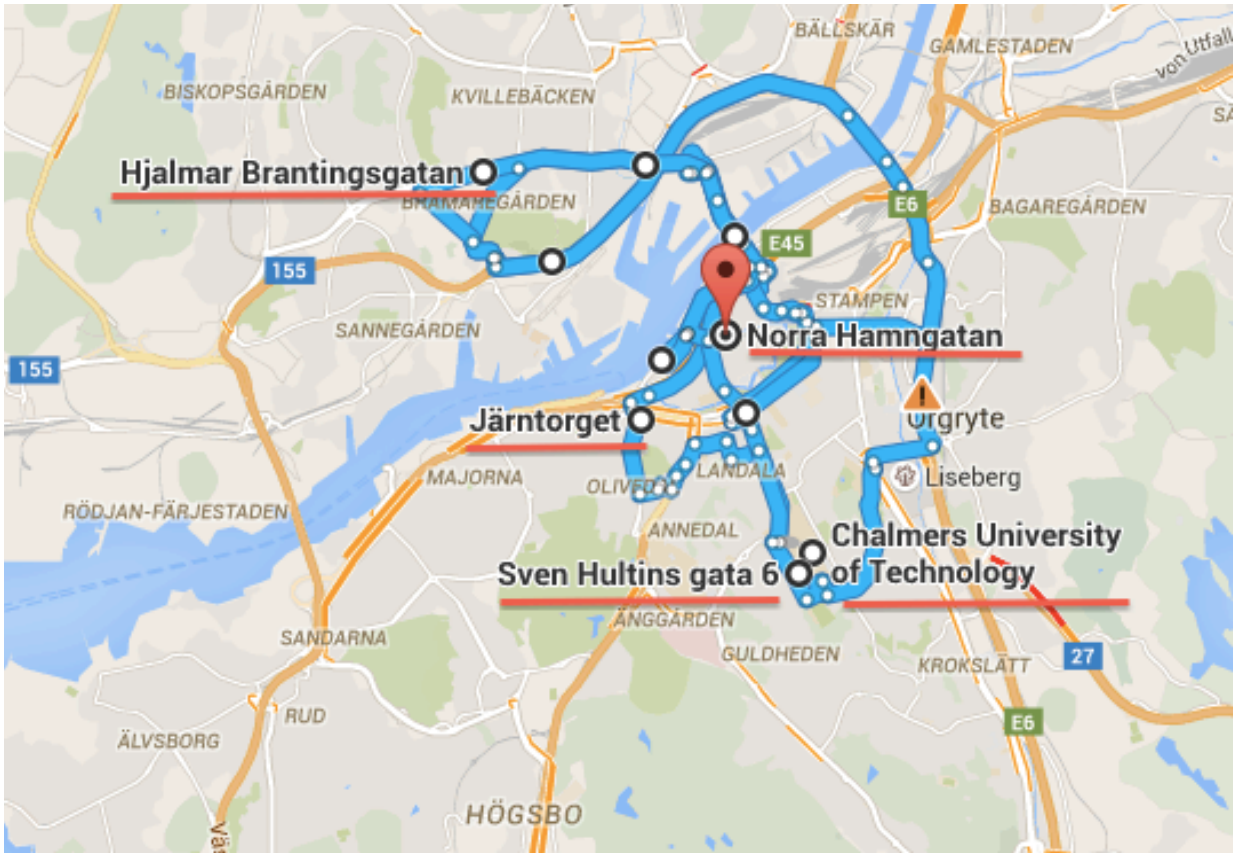


Figure 8. Image of Gothenburg city with the location of the selected construction sites

Through walking around the site and trying to analyse how the interaction between the local population and the construction sites was, the different disturbances were identified.

Other aspects observed were the distribution of resources within the site and the information provided by the construction company to the public. These two factors can also contribute to what extent the inconveniences affect the population.

The selection of the previous construction sites was proposed by the supervisor and also by the suggestions of the interviewees in the pre-study. As it can be seen in the figure 10, all these sites are located inside the city of Gothenburg and are civil engineering projects where the effects on the population were very visible.

3.4.2 Interview study

The aim of the qualitative data collection method was to obtain detailed data based on semi-structured interviews. Two pre-interviews were conducted in order to get pre-information about how disturbances are currently treated by the construction companies and also for other entities that take an important role in the project such as the client. Also three interviews were performed with relevant and expert people in the Lean

Construction area, three interviews were also carried out with professionals who have long experience managing projects where they have also met a large number of disturbances for society, and eleven interviews were conducted with neighbours and business owners who live or work around the construction sites. The major part of the interviews were performed in Swedish, recorded and translated to English during the transcription. Only one interview was conducted in English.

The reason for using semi-structured interviews was the possibility to create a conversation around the subject and allow for follow-up questions and reach the answers for research questions. Also by interviewing three different groups of actors, this research takes into account a wide variety of opinions from different entities that play an important role in the field in which this study is focused.

One of the benefits of having semi-structure interviews is that when there is a list of questions for researchers in interviews, interviewees' answers are based on the research area and his/her background and experiences. Therefore, in this case the interview process is flexible. The reason is that semi-structure interviews allow researchers to use interviewees' answers for adding more information or new interview questions. This means for each single interview there are possibilities for researchers to find out new or key information that would be useful for develop the research.

Another positive action in this sort of interview method is the fact of emphasising the interview frames and understand the research issues from the point of view of the interviewees. Thus, semi-structured interview is kind of open interview to collect the history of research. In this method of research recording the interviews and face to face with the interviewees are two methods that provide a better quality of the results.

However, not all aspects are positive. There are also limitations of this method. One of them depends on the people who answer interview questions. First of all researchers need to find people who are relevant to the area of questions, after that it is sometimes needed to motivate interviewees. This process of interviewing people always takes time and researchers have to wait a long time to get response from interviewees when they try to contact to arrange a meeting. Researchers have to have a clear idea about the subject and specify the area of research questions to find a correct and relevant interviewees.

Due to the fact that the interviewees had different knowledge, experience and positions regarding the construction project, the approach followed for the interviews was different. For those whose role was more oriented to develop Lean Construction within the company, the interview was mainly focused on the fact of considering social aspects and how this methodology could be expanded. The interview questions used in this interviews are shown in the appendix I.

For those whose job is more related with the project management area and have long experience managing construction projects and facing disturbances created by the construction sites, the interview was more oriented to investigate how they face these inconveniences and to what extent this social concern is relevant for their organizations. These interviews questions can be seen in the appendix II.
For neighbours and local business owners the interview was mainly focused on describing how they perceive the disturbances and what their suggestions are in order to minimize them. No technical question was asked.

3.4.2.1 Description of the interviews and the interviewees

All interviewees were chosen based on the supervisor's recommendations and other interviewees'. It means that through asking interviewees about relevant people related with the area that this study is focused on, they suggested somebody to interview (it is also called the Snowball effect). This kind of connection between interviewees supports this study and it permits to know different stakeholders´ opinion and their relation.
Three of the interviewees were professionals whose job is related with the Lean Construction field and were working in a construction company. The purpose of conducting these interviews was to get opinions about how Lean Construction can be extended to create values not only for clients but also for society. Two of these interviews were performed in Swedish and one of them in English. The duration was forty five minutes approximately each one of them and the interview questions were sent to the interviewees in advance.
Another three interviewees were project managers that were currently working on important projects in the city of Gothenburg. All of them had a long experience (more than 10 years) working in the project management area of their respective companies. Two of them work in the same company (a public company) and the other one in a private construction company. Also they had different roles in the projects they worked due to their companies represented different interests. The public company was the client and the construction company the contractor. The duration of these interviews was forty minutes on average and the interview questions were sent to the interviewees in advance. These interviews were conducted in order to acquire opinions or data about how these professionals and these companies act when they face claims from the local neighbourhood due to disturbances caused by the construction sites, and also whether they have already developed some strategy to reduce them.
Yet another type of qualitative interviews was carried out between local neighbours and business owners who have their businesses around the construction site. Two interviews were performed with business owners and nine with neighbours and all of them were conducted in Swedish and later translated and transcribed to English. The purpose of these interviews was to obtain reflexions about how the disturbances affect them and what their suggestions were to minimize these inconveniences.

As it has already stated above and in section 3.4.2, the next table represents the number and type of interviews carried out in this study.

Type of Interviews	Number of interviewees	Time spent in interviews
Lean Experts	3	45 minutes
Senior Project Managers	3	40 minutes
Local neighbourhood	9	15 minutes
Business owners	2	25 minutes

Table 9. Description of the interviews and interviewees

3.5 Data analysis

Data analysis refers to the examination and interpretation of data collected. Along this master thesis qualitative data was collected and analysed using qualitative techniques. Bryman (2008) described qualitative data analysis as an 'attractive nuisance', because of the attractiveness of its richness but the difficulty of finding analytic paths through that richness. It means that this is an important part of the research which should be carefully considered due to its difficulty.

In this study two different techniques have been used to collect data: interviews and observations. In this section the way of analysing these data is described and also how the data were combined is explained in order to shed light about the followed process for obtaining the empirical findings.

3.5.1 Analysis of data from interviews

In this study two different groups of interviewees can be described, one of them is the group composed by those who have long experience working with the Lean Construction methodology (Lean Experts) and the other one is the group of people who have long experience facing the problems arisen in the construction sites because they have been working on the project management department during a large number of years (Senior Project Managers).

The research questions can be considered as the starting point for this analysis. Based on them, the data were collected taking into consideration that probably those who are considered as Lean Experts can contribute in a higher extent to answer the first research question and, those who can be considered as senior project manager can be more useful to answer the second one.

Once the interviews were translated and transcribed, a number of categories were established through reviewing the research questions. These categories can be considered as the core aspects that should be described in order to get a valid response for these research questions. According to Bryman (2008) these categories may subsume two or more concepts. Therefore, each category was examined using a number of concepts that contribute to describe it.

After the establishment of categories and concepts, each interview was analysed in order to identify what the opinion of the interviewee was about each concept. This action permitted to compare several opinions from different interviewees and it was the starting point to generate hypotheses about possible findings. The followed process is shown in the next figure:

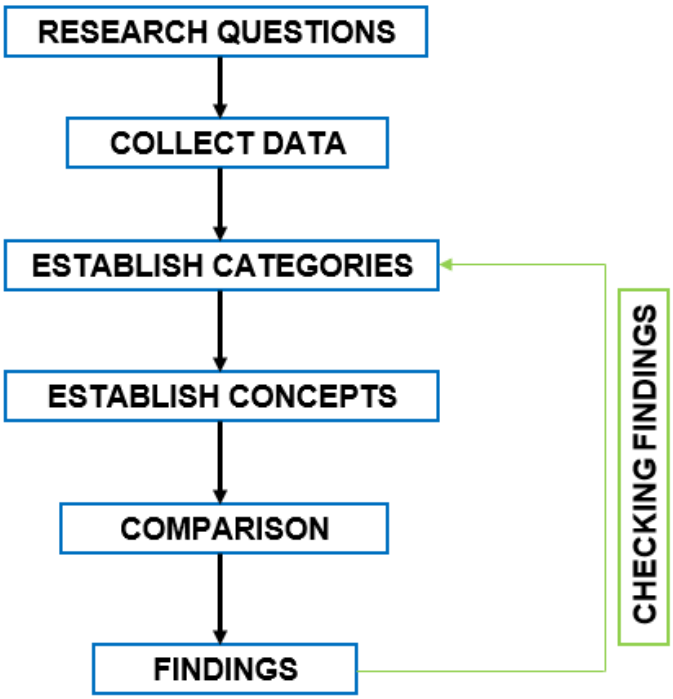


Figure 10. Process for analysing data from interviews

After the generation of findings, these were checked in order to be sure that the outcomes were reached. If these outcomes were not achieved the process was repeated again reconsidering the establishment of categories.

3.5.2 Analysis of data from observations

Observation is a process to provide researchers with the opportunities to follow what the similarities and differences are in the object researched in order to observe and understand how disturbances affect population in this case. Therefore, in order to

comprehend the concept of analysis of observation, the second research question was considered as a fact to be investigated through observations.

Observations concerning the following three categories areas:

- Disturbances
- Construction site
- Company procedures

The fact of categorising the observations allows this thesis to come up with comparisons between indicators and the concept of categories, which means observing different disturbances in construction sites let this research explore the relationship between the categories to emerging the hypotheses. Therefore, observing the disturbances in construction sites was the reason to find out the possible plan for managing disturbances in construction site. In addition observation analysis is the reason to understand what actually happens in construction sites and how people makes sense at what is happening surround them.

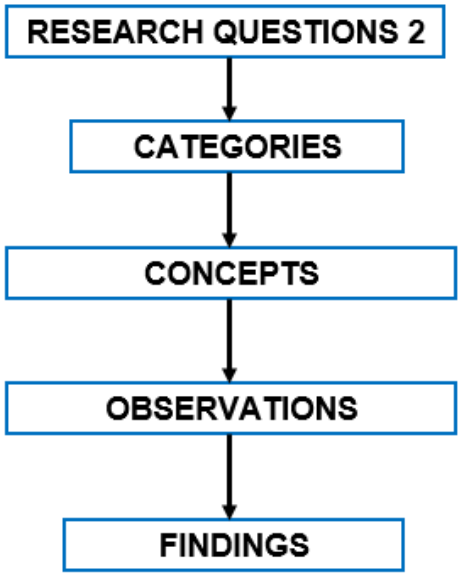


Figure 11. Process for analysing data from observations

When the findings from both interviews and observations were identified, all this information was combined in order to lead this research to get a wider spectrum of empirical data.

3.6 Validation of the study

Validity is referred whether "one is observing, identifying or measuring what one says one are" (Bryman, 2008). Validity is related with the fact that whether there is a good

match between researchers' observations and the theoretical ideas they develop. In this sense on the one hand it can be said that the disturbances for the local neighbourhood are present in almost every construction projects and they are normally created during the production phase. It means that these inconveniences are associated with the production activities. On the other hand the Lean Philosophy was conceived as a theory to be applied to the production system of a company. It means that the match between observations and theory is strong.

4. Empirical findings

4.1 Findings about Lean Construction

4.1.1 Knowledge about Lean Construction

After analysing all interviews performed for this research, it can be highlighted the great variability of knowledge about the Lean Construction philosophy that exists among different employees in a company. It is as can be expected that those who are to be considered as Lean Experts (LE) have a high level of knowledge of this philosophy as this is the field in which they are responsible. However, the lack of knowledge that exists among the other employees is noticeable. Based on the interviewees described in table 11 (3.4.2.1 Description of the interviews and interviewees) all Senior Project Managers (SPM) answered negatively to the questions about whether they knew the main aspects of the Lean Construction philosophy. Moreover, 75% of the SPM interviewed did not use Lean Construction and only one of these SPM recognized that this methodology was not currently used but it was expected to be implemented in future projects.

Another aspect that should be underlined is the fact that both LEs and SPMs considered Lean Construction as a tool with a great potential for being used in construction projects, even though the last category did not have a clear idea about what that actually meant. They did not see it as a theoretical model with a poor contribution to their projects. They considered it as a valuable method that could improve the projects in which they were working on. Even one of the LE commented "*from my point of view Lean Construction is a strategy for being implemented and not a philosophy"*.

With respect to the main basics of Lean Construction, the LE agreed on highlighting the necessity of creating a "flow" throughout a project. Through this flow, a process of continuous improvement can be created and this is the way of reducing not only waste but also the time for delivering the project to the client. Other important aspects that they underlined were the creation of values for customers and the fact of increasing respect of all company employees in order to achieve the best output from them. Only one of these LEs considered the social issues as one of the aim of the Lean Construction.

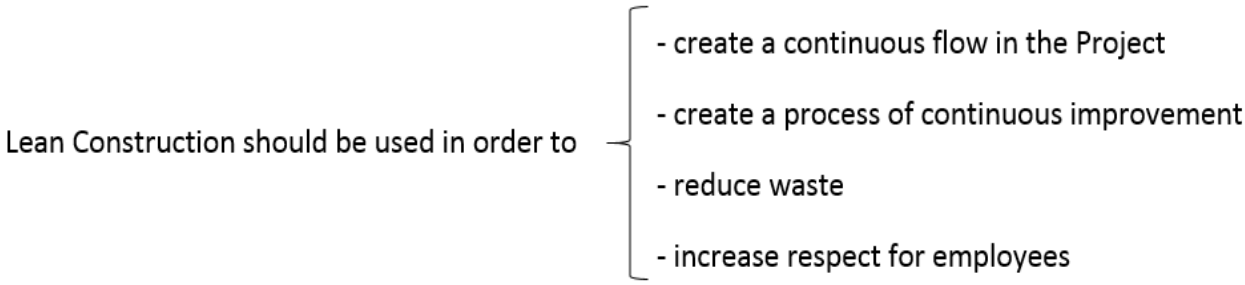


Figure 17. Main aspects of Lean Construction according to the interviewees

4.1.2 Implementation of Lean Construction.

According to all interviewees, one of the most important challenges in the implementations of the Lean Construction philosophy is related with the concern about the social issues within the whole organization. This means that all employees should be aware of why and how the organization can apply Lean Construction in order to minimize the social disturbances. In order to reach this level, they suggested that communication might be improved between the company and stakeholders. This can be a new way to improve the collaboration between those who are working in different companies and also those who develop different phases of the project. According to the interviewees the benefit of this collaboration could lead to better connections between individuals who are working in the early phase of the project and those who are working in the production phase, and thus making early planning to minimize future disturbances possible. Furthermore, this can be seen as an opportunity to interact adequately with other (external) actors related with the construction project in order to clarify what could be done to reduce social disturbances in the production phase.

One of the interviewees stated that some Lean methods can contribute to improve the collaboration among stakeholders and also to reduce disturbances. "5s" is one of these methods. Through this method there are possibilities to sort the disturbance situations during the production phase and it can contribute to reduce them. Kanban is another Lean method to reduce these disturbances. It is defined as an inventory control system and by using it, the material in the work site can be minimized and consequently some of the disturbances too. These two Lean tools can be used by all stakeholders and this can achieve an improvement in the collaboration between them. However, according to this interviewee it will not be possible to improve collaboration and reduce disturbance by using "5s" and Kanban if the respect for people is not a priority of request.

"Focusing on people is the way of changing the organizational culture". This sentence was stated by one of the SPMs when he was asked about how to implement Lean Construction in a company. This strategy allows to integrate the Lean Construction

philosophy because until now the existing culture in this industry has been based on blaming others when failures take place. According to this interviewee, without this change the implementation of Lean Construction would be more difficult.

In addition, LEs suggested during the interviews that though training courses and organizing a professional team who are responsible for implementing Lean in the firms are necessary items in order to minimize the social inconvenience that happen around construction sites.

4.1.3 Social aspects of Lean Construction.

Regarding the contribution of the Lean Construction philosophy to the improvement of the social issues that construction companies have to face in a construction site, all interviewees agreed that Lean Construction can contribute to minimize them. One of the LEs stated that *"...actually many principles of Lean such as respecting people, establishing a standardized process and continuous improvements help to reduce social disturbances..."*. In addition all of them expressed that social contribution of LC has not been well developed. Therefore, from the interviewees' answers it can be said that Lean Construction can be extended not only for improving internal aspects such as productivity or quality of the products, but also for contributing to reduce disturbances for society derived of the activity of the company.

Another important point to highlight is the fact that some public and private organizations have developed policies regarding disturbances caused by the construction sites. With respect to these, all interviewees recognised that their organizations have prepared policies and tools to manage disturbances generated by the construction sites. Some organizations have even developed different tools in order to analyse to what extent disturbances are relevant for individuals and organizations. One example, further described in Appendix III, shows a table to support in prioritizing the impact of the disturbances on different parts of the society.

Regarding the way of including the contribution of LC in order to diminish the inconveniences for the local neighbourhood, caused by the construction activities, two aspects can be highlighted from the interviewees' answers. On one hand, all interviewees stated that in order to include this contribution in practice, it would be necessary to change the main motivational aspects that in this moment take an essential role in the construction industry. In other words, they stated that in order to take advantage of the contribution of LC, the construction industry should not only focus on economic factors. This tendency should be avoided. On the other hand, two LEs pointed out that the culture of the construction industry should be changed. For instance one of them stated that *"...the actual existing blaming culture in the construction industry should be changed and a new one must be created if we want to implement the benefits that LC offers for society…"*.

Another interesting point, with respect to the benefits of considering the contribution of LC from the social perspective, is the improvement of the team's performance. The majority of the interviewees coincided in the fact that the teamwork is nowadays essential in the construction industry. As one of the Lean principles consists of "developing exceptional people and teams who follow the company's philosophy", they stated that through applying this social perspective of LC the teamwork performance will be reinforced.

Many suggestions for applying the social aspects of LC can be considered by analysing the interviews. One of the most remarkable suggestions was stated by a LE who expressed, as indispensable, to include the central factors of the social perspective of LC in the core values of the company. It was important because according to her, this could permit spreading this view across the whole organization through a fast and effective way. Another aspect to take it into account is collaboration with different stakeholders through sharing information and analysing what disturbances will be crucial to consider before starting the production phase. One of the interviewees underlined the importance of considering disturbances for the public at the early stage of the project with the collaboration of all stakeholders involved in order to avoid these disturbances during the future phases. All interviewees agreed on the importance of collaboration between stakeholders.

4.2 Empirical findings from observations and interviews

As it has been mentioned in the methodology part, five different construction sites were considered for determining the most common disturbances generated by them. Furthermore in order to identify the sources for these difficulties, observations were conducted in these construction sites in parallel with interviews. As it has already stated, these construction sites were situated within the city of Gothenburg, where the effects on the population can easily be perceived. The selection of these sites was based on the recommendations from the supervisor and some interviewees. The aim of observation is to understand how these difficulties affect people who are living or working close to the construction site, how these disturbances affect people walking and passing around the construction site, and last but not least, how construction companies currently handle the subject.

Taking photos was one of the most important parts of the observation phase in order to record different disturbance situations. Another important part was to interview people nearby the site and asking them their opinions about the situation caused by the construction site. These activities were carried out to understand the people's perspective on disturbances in the actual situation.

By visiting different construction sites and interviewing people in the surroundings allows this thesis to identify disturbances caused by the construction work. In these pictures the most common difficulties that can be observed around a typical urban construction site are illustrated.

Image 12. In the left side image of Långängensgatan (Gothenburg). In the right side picture of Hjalmar Brantingsgatan (Gothenburg).

In the figure 14 several disturbances can be identified. One of them is the lack of sidewalks and this causes people having to walk closer to the roadway or sometimes even on it. This inconvenience increases the risk of accidents for cyclists, car drivers and pedestrians. Another disturbance identified in these pictures is related to cyclists because it can be seen how the cycle path is closed and there is no possibility to go in a straight way. Therefore, they have to choose a different and more dangerous way. In the picture on the left side some businesses can be found, such as restaurants and beauty salons, which are affected by the construction activities.

In the figure 14, safety for resident and economic losses are generally the main concerns. Therefore, some brief information regarding the safety problem is located in the site. However, there was no warning sign before entering this area for pedestrians and cyclists. Moreover, in the right picture it can be seen that all parking places were removed or disturbed and no parking place for the neighbourhood's cars were made available.

Image 13. In the left side perspective of Gamla Tuvevägen (Gothenburg). In the right side picture of Hjalmar Brantingsgatan (Gothenburg).

In the image 15 two different construction sites are shown where different disturbances for the local neighbourhood can be observed. On the left side it can be seen how the position of the fences makes it impossible to use the parking spaces. This means that people who live in the buildings situated in front of the site have to look for other spaces for parking and, as a consequence, the distance they have to walk from their cars to their homes or workplace is increased. Another important observation that can be identified in the left picture is that by placing the concrete fences as have been done in this two-way street, the width of the street is drastically reduced and this creates mobility problems within the neighbourhood, especially during the peak hours.
On the right side, it can be observed how one of the streets has been closed, not only for traffic but also for pedestrians. This means that local residents who live in these buildings and business owners cannot access to their properties through this street. Another consequence of this action could be the increase of the traffic in the adjacent streets due to all cars, public transport and bicycles which must use other ways to circulate through this area.
In both pictures it can be seen how the construction companies use fences for separating the construction site from its surroundings and by doing so that they increase the safety for residents, visitors and construction workers. However, while in one of the pictures there are brief indications for pedestrians and cars, in the picture of the left side there is an apparent lack of such information. Also, in both images no alternative route or possibility is indicated.

Image 14. In the left side perspective of Sven Hultins Gata (Gothenburg). In the right side picture of Chalmers Square (Gothenburg).

In the left side of the figure 16, a construction worker using a compactor that produces vibrations, can be seen. This is one of the disturbances observed in this site and due to the place's characteristics (this area belongs to Johanneberg campus, Chalmers University), this inconvenience should be limited. There existed no warning sign for vibrations or noise posted the day this disturbance took place. These social disturbances disturb the silent environment for those who need to have a quiet working place and can even generate some harmful physical reaction for those who cannot stand with these difficulties. Students, teachers and other personnel that work at the university showed irritation.

In addition to the noisy situation that vibrations produce, there are also inconveniences for cars with reduced lane widths, closed roads, meeting construction traffic and removed parking possibilities. In the right picture, a tricky situation for bicyclists is illustrated by closed bicycle lanes and obstacles on the lanes. Moreover, these difficulties become even more pronounced during the winter time with cold weather conditions. These photos clearly illustrate construction sites that do not consider the effects on society and the negative consequences the construction site generate on the surrounding neighbourhood.

Image 15. Perspective of Sven Hultins Gata (Gothenburg).

In the figure 17 it can be appreciated how bad weather conditions can increase the negative effect by the disturbances on the population created by the construction sites during the production phase. In this picture it can be seen how there is no sidewalk around the construction site, not even a provisional one. This causes the pedestrians to walk on the roadway and the safety for them decreases. Furthermore, the lack of sidewalks makes people walk closer to the cars, and, with these weather conditions, it is more likely that they can be splashed with water, especially when cars pass with high speed. It can thus be concluded that this specific site exhibit problems with mobility, accessibility, safety of the residents and emissions from cars; and with noise and vibrations as discussed above.

During the visit to this construction site, and as it can be observed in the picture, the construction company does not provide an alternative safer route for pedestrians and neither information nor indications for car drivers about risks of driving through this area.

Image 16. In the left side picture of Järntorget Square (Gothenburg). In the right side picture of Norra Allegatan (Gothenburg).

In the figure 18 two pictures from two different construction sites are shown. In the left side it can be seen how the construction works not only affect private transportation (cars and bicycles) but also the public transportation. By asking local neighbours in this area about what problems have arisen after the beginning of the works, they said that the time of travelling from their homes to their works has notably increased because the tram route had changed. Also a lot of delays in the trams have arisen. Another disturbance emerged as consequence of the construction activities namely the increase of noise. This is perhaps not obvious from studying the photos but by asking people and staying there motionless during a couple of minutes, it is easy to feel it. This inconvenience makes people irritated and also makes businesses loose customers.
In the right side it is shown both a bicycle and a pedestrian path that have been closed. This forces the bicyclists and pedestrians to change their routes and cross the street to continue their journey. Therefore, safety for these groups is reduced and the risk of an accident is increased.
In the right side of figure 18, the construction company uses small boards for showing to the general public what they had to do but they did not give clear information about other aspects such as the estimated time of the works.
Another important aspect is the distribution of the materials. In the picture of the right the pipeline is placed on the bicycle and pedestrian path, even though the excavation works have not started yet.

As it has been described in the methodology chapter, several interviews were conducted with professionals who work in different companies exploring their opinions about Lean Construction, the integration of the social issues as an important part of this methodology and how using the previous extension of the Lean Construction, the disturbances caused by the construction sites can be minimized.

Two different groups of professionals can be distinguished in these interviews. One group is composed of those who have experience working with Lean Construction (they can be called Lean Experts (LE)) and the other one is composed of those who have large

experience managing different construction projects (they can be called Senior Project Managers (SPM))

The findings described in this section are divided into two categories. The first category, which is called "*findings about Lean Construction*", shows important aspects about this methodology from the perspective of this study. In this category three concepts are described in order to clarify the content of the category adequately. These three concepts are: the actual knowledge of Lean Construction among professionals, the level of implementation of Lean Construction in organizations and the social contribution of this philosophy.

The second category, which is called "*findings about disturbances*", shows the disturbances created by the construction sites in order to understand what their causes are and, by doing that, how the Lean Construction can contribute to reduce them. In this category two concepts are also distinguished: the management of the disturbances by organizations that create them and the importance of considering this social concern among the actors involved in a construction project.
In this section, based on the interviewees' answers, different ways of managing inconveniences created by the construction projects are described. It can be said that these are ways of managing disturbances that the construction companies are currently carrying out with the purpose of controlling the consequences of these inconveniences.

According to the one of the interviewees, using JIT (Just In Time) at the early stage of the project is one of the methods that they are using for managing disturbances for the local neighbourhood. In this method they try to prioritise different risks such as wasting material and time at construction site in different projects. This strategy can support project managers to manage some disturbances before starting to work. Therefore this way of working supports organization to start thinking and considering social disturbances at the early stage of the project and, it can also support in prioritizing disturbances risks that could arise during the production phase.

According to one of the SPMs, in her company there is an internal group which is called "Mobility Management Team" who is responsible for capturing and sharing information among the local residents and commercial actors related to the disturbances that could arise due to the construction site. This is another way to inform the local neighbourhood about how the disturbances can affect them and it can be also considered as a way of managing disturbances. She mentioned that the benefit of having this group is related to the possibility of sharing as much information as possible from the construction site to the citizens. She even stated that there is a handbook created in her company as a work experience database related with the management of disturbances. Her organization uses this tool to gather previous work experience to avoid repeating the same mistakes in current and future projects.

Two of the LEs stressed that in order to obtain a continuous improvement process in Lean implementation, senior project managers and Lean experts need to think more about the planning phase. The rational research behind this is that already in planning phase data and information is collected, thus before the design phase, therefore, it would be a good idea to think about disturbances and find a management way in the planning phase in order to better control disturbances from the construction site.

As two of the SPMs mentioned, their organizations have always been a leader in managing disturbances. Therefore these organizations already have a strategy for managing these disturbances when they take place. The strategy is based on recommending alternatives to persons who are affected by disturbances created by the construction sites. One example was described by them and it is related with the level of noise. For instance when the level of noise produced by a construction site exceeds 70 decibels, which is the maximum level permitted by the regulation for avoiding to disturb people, the strategy is to relocate those who are affected by this disturbance in other available apartments within the city or to offer the monthly payment until that the work activity is finished in order to compensate them.

When the interviewees were asked to state the most important problems occurring in their projects, none of the answers contemplated the inconveniences caused by the construction projects for the society. All interviewees stressed problems related with technical and economic aspects. This indicates that the social concern must be further reinforced in order to avoid these inconveniences. Taking this need into account, it can be observed that there exist important benefits if this concern is incorporated. Two of the interviewees coincided in the fact that the project plan could be considerably improved if the social problems are considered and analysed from the early stages of the project.

Based on our understanding, another benefit of this extension of the social concern could be the improvement in the communication between stakeholders. By giving importance to the extension of the social inconveniences and trying to prolong this concern among all stakeholders involved in the project, the communication between the construction company and these stakeholders could be improved. This includes communication between the contractor and different subcontractors or between the construction company and the client for instance. In fact, this could be applied to all stakeholders.

Furthermore, all SPMs highlighted the risks that their organizations will meet if the disturbances for the neighbourhood's stakeholders created by the construction sites are not considered. One of these SPMs stated that *"if the construction companies do not take inconveniences for the public into account, the image of the company will be deteriorated"*. Another interviewee commented that *"if these disturbances are not considered, the continuous improvement process will be negatively affected"*. Also,

another risk pointed out by the interviewees was the fact that the construction plan will not satisfy the client's expectations and this is not desirable.

All these benefits and risks can be considered as evidence that a change should be contemplated and the social inconveniences created by the construction sites should be considered by the construction companies. According to two of the SPMs, the extension of the social concern should not only be carried out internally but also externally. They proposed to provide special training to all employees related with the production plan along the project and also, they described that it could be needed to arrange periodical meetings where previous mistakes were analysed in order to avoid them. In addition, they stated that it could be positive to create a network where all companies related with the construction industry have the opportunity to share information, experiences and advices regarding how to minimize disturbances for population. Furthermore, it can be said that training, collaboration and sharing information between stakeholders is very important for spreading social concern.

Another interesting finding that can be generated from the interviewees' answers is the fact that all of them, LEs and SPMs, agreed on highlighting the contribution of the Lean Construction philosophy whether the social concern is considered in a better way in order to make the construction industry more sustainable. One of them stated that *"...through considering social concern of the Lean Construction philosophy in a better way among the construction industry, not only the social issues are improved but also the environmental ones because it could lead to use the materials more efficiently..."*. The reason behind this sentence was explained by the interviewee stating that if a company gets to apply LC within the whole organization including the social concern, it probably leads to increase the concern for the environmental issues as an factor that impact negatively to the society. According to him, one consequence of that could be the rationalization of the material used in the construction sites. This is very important because it indicates a relation between sustainability and the benefits of considering the inclusion of the social values from the Lean Construction perspective.

5. Discussion

The main findings underlined in the previous section are the basis for establishing a discussion where these aspects are analysed and evaluated. Furthermore the theoretical framework that is developed in this study is also used for supporting or criticising these findings and this permits to generate the foundations for giving answers to the research questions.

5.1 Lean Construction Knowledge

Perhaps one of the main reasons why the Lean Construction philosophy has principally focused until now on creating values for customers has been because it was developed at the beginning of the 90s and, at that time social and environmental issues were not as seriously considered as they are today. Moreover, the fact that it originates from the Lean Production philosophy makes it is a methodology oriented to improve the production process in a company, and as consequence it is more oriented to generate values for customers. One example of this orientation is the data given by Luoma and Junnila (2011) where they stated that the top three research areas during 2000-2010 in Lean Construction have been project management, design management and cost, performance measurement and implementation.

One important aspect in this research is that Lean Construction is a methodology for improving the production system and create continuous improvements by reducing waste. Even one of the early adopters and developers of this methodology pointed out that “the definition of Lean Construction is following the same aim as Lean Production,

both consider to eliminate waste in order to maximize the value" (Koskela et al., 2002). Again, no reference to the creation of values for society is mentioned.

However, the dependency relationship between society and the construction industry should not be forgotten. This is a reason to move the attention of this sector to create value not only for customer, but also for the benefit of the society and in this context, the Lean Construction philosophy is a possible tool to achieve it. Therefore, it is necessary to extend the Lean Construction perspective in order to take social issues into account. According to Koskela (2000), construction is considered as a production system activity where the value generation is considered as a process to meet the customer's requirements. Based on this Koskela's input, the value generation can be considered as a process to extend Lean Construction and take advantage of its contribution to minimizing social disturbances.

One of the aspects that a company should take into consideration, if it wants to implement adequately the Lean Construction methodology, is the culture of the organization (Tapping et al., 2002). Furthermore, one of the principles of the Lean Philosophy is to build a culture in the organization that foster the achievement of the company's' goals (Liker, 2004). This means that an organizational culture, that contributes to implement and maintain the benefits of the Lean Construction methodology, is needed.

It can be considered the actual prevailing culture in the construction industry as a negative aspect or a barrier for applying the Lean Construction principles. They perceive it as a culture based on blaming others when mistakes take place and by this, the responsibility of the people who is in charge of taking decisions is not well understood. Efforts must be made to developing values for the company in line with two of the principles of the Lean Methodology namely "grow leaders who thoroughly understand the work, live the philosophy, and teach it to others" and "develop exceptional people and team who follow your company's philosophy" (Liker, 2004).

Respect for people is one of the main factors of the Lean Construction philosophy. However, it is not perceived it throughout the construction industry and a change in the culture is needed in order to obtain all the benefits of this philosophy. It can be said that this cultural change is needed and without it, the implementation of the Lean Construction methodology is not possible. For instance, if an error takes place in a construction phase and people responsible of planning this phase attribute it to the workers instead of analysing their own responsibility, the principle of "growing leaders who teach to others" is really difficult to fulfil and by experiencing this, it is equally difficult for the workers to identified themselves with the company's values.

Another interesting aspect about the knowledge of Lean Construction is the noticeable difference that exists in this field among the professionals who work in the construction

industry. As it has been stated in the "empirical findings" section, specifically "4.1 Lean Construction knowledge", only one of the SPMs was able to mention briefly something about what Lean Construction consists of and the others did not have knowledge about this philosophy. They had just heard about Lean Construction but they did not know too much about it. However, and as expected, all LEs had extended knowledge about this topic. This big difference illustrates that until now, organizations have tried to implement Lean Construction philosophy by applying it to a reduced group of people who are exclusively dedicated to investigate how this methodology can help the company to reach its goals. Organizations have not given importance to spreading Lean Construction to all layers of the company.

The previous circumstance, together with the previously described fact about the lack of including social concern in the Lean Construction methodology, contributes to highlight a strange paradox. On the one hand Lean Construction is a valuable tool that can be used to improve the production system and, by considering social issues in this philosophy, the disturbances caused by the construction sites can be diminished. However on the other hand, organizations have not extended this concern throughout the whole company. Only a reduced number of employees have knowledge about that.
According to Koskela et al. (2002), Lean can be used as a methodology or a theory tool for analysing, designing and controlling different activities and applying them in an organization in order to give direction and to get better results in processes. By concentrating the Lean Construction knowledge to a few employees, it is difficult for the rest of employees to understand the direction the company takes to follow and most importantly, the employees cannot identify with this direction.

5.2 Values from the Lean Construction perspective

Until now, construction companies have mostly considered the fulfilment of customer requirements and little consideration has been given to social issues (Salvatierra-Garrido and Pasquire, 2011). Therefore, construction companies need to think not only about the customer value but also to start thinking about social perspective. In fact, in order to implement Lean in a proper way in organizations, firms need to consider the Lean perspective at the early stages of the projects. This allows organization to begin the process that could fulfil not only the customer values but also consider society's requirements. The aim of considering Lean at the early stage of the project is to improve interaction between organizations and society.

One way of increasing the process of value generation to reach the social requirements about disturbances created by the construction sites could be to consider them at the early stage of the project. Therefore, disturbances for the local neighbourhood are one of the challenges that the construction industry seriously needs to deal with. Perhaps one of the reasons why construction companies could not deal with these societal issues

until now is because they did not consider them before starting the production phase. The organizations need to take this subject into consideration in a different way. One possibility could be to accept the knowledge of Lean as a method that permits construction companies to minimize disturbances for society created by the construction sites. This method provides a framework to generate values in order to consider unpleasant situations for society.

During different interviews many suggestions were expressed regarding values from the Lean Construction perspective at the early stage of the project. The major part of these suggestions were oriented to improve collaboration between stakeholders through Lean Construction. This means that if organizations consider the social perspective as a core factor of LC, on one hand the construction industry will have a better understanding about how to limit disturbances and, on the other hand, it is an opportunity for organizations to increase collaboration between stakeholders through sharing the information and analysing disturbances in projects. The rational point of stakeholder collaboration is to create a process of continuous improvement from the beginning of the project until the end-product with respect to social satisfaction. In order to create this process, trust and respect should be two crucial aspects to increase the quality of collaboration between organization and stakeholders throughout a construction project.

By using Lean Construction to develop projects, has considerable benefits compared to projects developed using other methods and processes. Therefore, Lean Construction can be extended not only to improve internal aspects such as productivity but also to contributing to increase social concern. The important fact is that there is still a gap between organization and social aspects from Lean Construction perspective. To eliminate this gap and extending the social perspective, organizations need to establish a culture that promotes the understanding of social values from Lean Construction (Salvatierra-Garrido and Pasquire, 2011). Communication is one of the most important aspects for organization to understand what the society needs, therefore sharing information proves to be important aspect for this.

5.3 Management of disturbances

Construction and maintenance of urban infrastructures normally cause the major part of the disturbances on the urban population (Pantura, 2011). In order to consider these difficulties, organizations need to establish a strategy to manage the disturbances created by the construction project. The aim of this strategy should be oriented to improve interaction between organization and society who are developing their activities around the area of working. Therefore, Lean Construction methodology should be part of this strategy in order to minimize inconvenience situations generated by construction projects during the production phase. In addition, this strategy can support organization to analyse what kind of problems could happen if construction

companies do not take these inconvenient situations into account. This is one way to think about the social concept of construction companies. This strategy can also contribute to save time and material at the site and establish a better continuous improvement process.

It can be said that Lean Construction can create values oriented to improve the perception of the social concern in construction companies. By creating this kind of values, disturbances can be considered by leaders in organizations in order to implement a solution. This is one way for transmitting the social concern to the whole organization.

As it has already been stated in empirical findings (4.2.2.1 Management of disturbances), "JIT" and "5S" are two of the Lean tools that allow organizations to reduce waste from different perspectives such as time, material and cost. By reducing waste, the management of disturbances will be easier from the organizational point of view because when waste is reduced, organization can dedicate more resources for managing disturbances. This has not been demonstrated but it could be a possibility for increasing the resources dedicated for managing disturbances and as consequence, these inconveniences could be better managed.

One of the current strategies to manage disturbances is the creation of "Mobility Management Team" (MMT). This is a group of people which are responsible to manage interaction between the organization and society in order to minimise inconvenient situations. The aim of this strategy is to face disturbances through a proactive approach. This means to create a plan for the company before some inconveniences take place in order to minimize them and also, to be the link between the company and society for communicating and analysing negative situations.

Other possibilities to manage disturbances can be based on making recommendations to local neighbours, for example regarding free parking space or other the temporarily people re-location. To distribute information in daily and local newspapers is another possibilities to minimise disturbances. The benefit of the previous strategies is that all stakeholders follow a plan which has been already decided and there is a consensus behind that.

5.4 Contribution of Lean Construction to sustainable development

According to Bae and Kim (2007), Lean Construction can be considered as one approach to implement a sustainable construction process by introducing the social, economic and environmental issues. They stated that, by using Lean Construction methods, the impacts for the purpose of sustainability should be analysed by three perspectives: economic, social and environmental. Therefore, in order to generate sustainable values these three perspectives should be considered together. In this study,

by extending the Lean Construction philosophy and including the social perspective, these impacts can contribute to reduce disturbances for society. Hence, it can be said that only by generating values oriented to improve the social, economic and environmental issues, the construction industry can reach a sustainable development. Therefore, as the fact of minimizing disturbances created by the construction sites can be seen as a social improvement, especially for the local neighbourhood, the implementation of Lean Construction, including the extension of the social issues in a better way, can lead to a sustainable development for organizations.

As it has been stated in the theoretical framework (2.5 The relationship between Lean Construction and the challenges of sustainable development) the construction activity generates 36% of the greenhouse gases in Europe and buildings consume 40% of the total energy generated (Ec.europa.eu, 2013). This means that this industry should take environmental issues into consideration as an essential part to improve in the construction projects. According to Epa.gov (2015) Lean can hold more environmental improvements when the cultural environment is highly conducive to waste minimization and pollution prevention. When waste resources in production phase are reduced, the social and financial facts are increased. This aspect coincides with the opinion of two of the interviewed LEs. They pointed out that the Lean Construction philosophy can contribute to manage more efficiently the materials in the construction site and this can lead to reduce disturbances for the society. One of these LEs used an example to clarify this issue and stated that by using Lean Construction tools, the material can be organized in a more proper way within the site and this can contribute in two ways: reducing waste material and probably needing less space for storing it which means that the size of the construction site could be minimized and as consequence, disturbances for neighbours reduced.

Another interesting aspect was highlighted by Rothunberg et al. (2001). They expressed that financial, environmental and social consequences should be taken into account in order to reach sustainability but this would be very difficult to achieve unless the organizational culture changes within construction. As it has also been described in one of the empirical findings section (4.2.1.3 Social aspects of Lean Construction), the culture of the construction industry should change in order to take advantage of the benefits that Lean Construction can offer when the social issues are developed in a better way within this philosophy. From these two facts it seems that the organizational culture is an important aspect that should be changed in order to make this industry more sustainable.

6. Conclusion

The objective of this thesis is to analyse how Lean Construction philosophy could be extended and interpreted in order to create not only sustainable values for the client but also for society, and specially the immediate neighbourhood around an urban construction site. In addition, the study aims to indicate how a construction company could apply this new perspective in order to reduce societal disturbances during the production phase while still benefitting from the traditional advantages of Lean Construction. To reach this objective, a research method was developed based on qualitative interviews with relevant professionals in this field and observations of different construction sites. The data obtained from these interviews and observations was analysed and discussed and the results form the basis for the followings conclusions.

6.1 Research questions

How can Lean Construction be extended to create sustainable values not only for client but also for society?

Up to now Lean Construction has been mainly focused on the internal processes and on fulfilling the customer requirements. In order to widen the perspective change this tendency and creating sustainable values, construction companies should not only consider financial aspects but also they must think about the social and environmental factors. Lean Construction is one approach to implement a sustainable construction process by introducing the social, economic and environmental issues as new values to achieve instead of only focusing on the benefits applied to the production phase. Lean Construction can be considered as a strategy to support the creation of sustainable values only if organization's goals take social, environmental and financial perspectives into consideration together.

The concern about creating sustainable values has become an important goal for the construction companies. However, in order to reach this aim, firms need to make a balance between customer and society requests. Therefore, Lean Construction philosophy, as a methodology, is the reason to reach this level of balance between client and society. In order to extend Lean Construction, there are some aspects that companies need to take into consideration. First, customer and society requirements should be both considered in order to reach sustainability in different projects. This means that in construction projects, companies need to identify what the difficulties in construction sites are if they have not considered society as a stakeholder. Second, as it has been already mentioned, social disturbances are created by the construction sites. Therefore it is important to take them into account and by doing that, benefits for both (construction industry and society) are achieved.

Another way to extend Lean Construction is through trying to increase the knowledge of Lean Construction within the whole organization. The construction is a production system activity where the value generation is considered as a process. This value generation process will be developed easier if the knowledge of Lean Construction is shared within the organization. This way of developing values in the construction industry supports companies to focus not only on the customer expectation but also in society.

How could a construction company apply this new scope in order to reduce societal disturbances during the production phase while still benefiting from the traditional advantage of Lean Construction?

It can be said that most of the construction industry is still anchored in a traditional way of managing projects, which is mainly focused on blaming others when a mistake takes place instead of guiding them. It would be very difficult to reach sustainability in the construction industry unless the organizational culture changes within this sector. According to one interviewee, in order to apply new methodologies as Lean Construction, a cultural change is needed. One important action that a construction

company must carry out in order to include the benefits of creating social values through Lean Construction philosophy is to gradually change the organizational culture.

A relevant fact in this thesis is the way to extend Lean Construction to not only include creating values for customer but also for the society. In this sense, this concern should be expanded to the whole organization and all employees should be aware and embrace it. One way of achieving this expansion is through incorporating the core aspects of Lean Construction (including the social issues) into the core values of the company. Nowadays, construction companies have developed values that they want to transmit to their employees, stakeholders and the society as an essential part of the company to reach its objectives. By applying the core principles (2.1.2 Lean principles) of Lean into the values of the company it can spread this philosophy within the whole organization and benefiting of its wide advantages in terms of generating values not only for customers but also for the society.

Two other aspects that should be highlighted are collaboration and communication. These two aspects contribute to facilitate including social values within the Lean Construction philosophy and they can also help construction companies to improve the interaction between them and the local neighbourhood around an urban construction site. On one hand, an appropriate way of collaboration should follow one of the Lean principle: "respect your extended network of partners and suppliers by challenging them and helping them to improve" (2.1.2 Lean principles). Collaboration between the construction company and all stakeholders involved in a project should be improved in order to make them aware about the necessity of including social concern and considering disturbances created by the construction sites as an important aspect to be minimized. As a long term effect this may lead to less complaints and a smoother construction process.

On the other hand, an improvement in the way of communicating is needed related to the way in which the construction companies share information about disturbances created by the construction sites with society and especially with the local neighbourhood. This improvement can generate a better interaction between the company and the neighbours and it can lead to improve the social image of the company.

6.2 Recommendations

Based on the results obtained in this study some challenges can be highlighted and in this section recommendations are suggested to meet these challenges. The following recommendation are proposed:

- To improve the information given to the citizens about disturbances caused by a construction site in a city, construction companies must inform people through different ways and at different locations. For instance, when a public transport line

is re-routed because of construction works, organizations should not only install information boards around the construction site but also in other public places in order to limit this inconvenience as much as possible.

- To minimize the nuisances created by the construction sites for the local neighbourhood, organizations could offer an alternative to these citizens. For instance, if the parking places are occupied by the construction site, the construction project should look for other parking possibilities for those who have been affected by this action. This kind of measure should be included in the company strategy to manage disturbances in collaboration with the client.

- To organize a team for the company to be in charge of analysing and communicating with stakeholders. This team is responsible for capturing and sharing information among the local residents and commercial actors that is related to the disturbances that could arise due to the construction site. This is one way to inform the local neighbourhood and it can be also considered as a way of managing inconvenience situations. The benefits of having this team could be oriented toward two aspects. One aspect would be the improvement of collaboration between the construction company and the stakeholder. The other aspect is to use this team to support project managers when disturbances take place in the site.

- To offer different workshops and trainee courses about Lean Construction in order to encourage employees on how they can use Lean Methodology to extend social issues in construction and trying to extend this concern among all stakeholders that involved in the project.

- To improve the interaction between construction companies and local neighbours, organizations could establish different channels of communication. The reason behind this is that not everybody use the same platform for getting information. For instance old people normally use a different way of communication that young people. By using different communication channels, information can reach all people affected by disturbances.

- To extend the Lean Construction philosophy to include societal values, construction companies could find competitive advantages when bidding for projects in urban sites.

6.3 Practical contribution of this research

The contribution of this Master Thesis is to improve the interaction between construction companies and society by reducing those disturbances created by the construction sites that generate negative impacts on the population during the production phase. With our recommendations construction companies increase their

concern about social issues and the image that society has about this industry is improved. This is one of the most important facts that the construction industry needs to take into consideration.

In addition, this master thesis contribute to expand Lean Construction philosophy to consider social issues and by doing that, it is possible to take advantage of all its benefits in a better way. In fact, making value for society is the reason to reach sustainability in construction activities when society is considered at the same time as customers, environment and financial aspects. This thesis also contributes to make construction sites safer and more environmental friendly by developing sustainable values that help companies to increase its concern about social issues such as disturbances created by these construction sites.

6.4 Further research

This thesis underlines the potential of developing Lean Construction philosophy to including the social perspective as an important aspect of this methodology. In addition, this study aims to indicate how a construction company can apply this perspective in order to minimize disturbances for society created by the construction sites. Therefore, this research opens the opportunity to further discuss and investigate different aspects related with the application of this new scope. Thus, this section provides some proposals for further researchers.

- As a way to analyse the application of the recommendations suggested in the previous section, a real project should be chosen and all these proposals should be applied in this project. By doing that, two aspects could be studied. On one hand it could be examined to what extent disturbances for the local neighbourhood are diminished and, on the other hand, an analysis about the social and economic benefits for the company could be developed.

- A further understanding of the factors generating disturbance to the neighbourhood could lead to develop technology as well as process development.

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Appendix I -- Interview questions for Lean Experts

INTRODUCTION

1. Within the organization, in which department are you working and what is your role?

2. What kind of projects you are managing now?

3. What is your responsibility in the projects you currently carry out?

4. Can you briefly describe the main activities you carry out during the period you manage a project (time schedule, control budget, quality, etc)?

THE LEAN CONSTRUCTION PHILOSOPHY

1. According to you, what are the main aspects of the Lean Construction philosophy?

2. Until now, little consideration has been given to the social and environmental issues from the Lean Construction perspective and maybe it has mainly focused on delivering values only for costumers. Do you think that this perspective (focused mainly on delivering values for customers) of the Lean Construction can be extended and provide values also for society?

3. How can Lean Construction be extended to create sustainable values not only for client but also for society?

4. For our Thesis, disturbances mean those consequences derived of the construction works that affects negatively to those who are exposed (for instance traffic jams, vibrations, noise, dust, etc). Do you think that the Lean Construction philosophy can help to reduce disturbances in the construction sites during the production phase? Why?

5. How could a construction company apply this new scope in order to reduce societal disturbances during the production phase while still benefiting from advantage of Lean Construction?

6. Has your organization developed any policy regarding the contribution of Lean Construction to reduce disturbances in the construction sites? If so, can you describe the most important aspects of this policy?

DISTURBANCES IN THE CONSTRUCTION SITES

1. What do social disturbances mean for you?

2. From your point of view, what are the most important disturbances that a construction company should consider in order to improve the quality of life of the local population during the production phase?

3. Which effects of the disturbances do you think are the most important/hazardous for local neighbourhood?

4. Has your organization developed any policy regarding social disturbances? If so, what kind of strategy follows these policies?

5. Do you think that your company should change the way of managing social disturbances along its projects?

STAKEHOLDERS RELATIONSHIPS

1. How would you describe the cooperation between your company and different stakeholders for reducing disturbances in the construction sites?

2. What sort of collaboration is already working well for you?

3. Do you consider that collaboration between your company and stakeholders contribute to reduce disturbances for local population? If so, what are the main benefits?

4. What are the major problems / challenges in the collaboration for reducing disturbances between different stakeholders?

5. Do you get support from your organization in order to reduce disturbances at the construction sites during the production phase? If so, how is this support?

6. Is there any specific department responsible for managing relationships between your company and stakeholders in order to analyse disturbances for local neighbourhood in the construction sites?

Appendix II -- Interview questions for Senior Project Managers

INTRODUCTION

1. Within the organization, in which department are you working and what is your role?

2. What kind of projects you are managing now?

3. What is your responsibility in the projects you currently carry out?

4. Can you briefly describe the main activities you carry out during the period you manage a project (time schedule, control budget, quality, etc)?

IDENTIFICATION AND MANAGEMENT OF DISTURBANCES

1. Along the projects you have lead, have you ever faced disturbances produced by construction works and that affect negatively local population?

2. If so, can you describe these disturbances you met?

3. From your point of view, what is the most important disturbance that your company should consider in order to improve the life quality of the local population during the production phase? Why?

4. Which effect of the disturbances do you think is the most important/hazardous for local neighbourhood?

5. Has your organization developed any policy regarding social disturbances?

6. If so, what kind of strategy follows these policies?

7. When your organization meets disturbances for people created by the construction sites, what kind of collaboration do you think it is necessary in order to minimize these disturbances?

8. What are the benefits of this collaboration for your organization?

9. What kind of risks will your organization meet whether social disturbances are not considered?

10. Do you think that social concerns are sufficiently extended within your organization? and within other stakeholders? If not, how would you extend it?

11. Do you think that the concern about social disturbances should be one of the main motivational aspects for your organization? If so, how could you achieve it?

12. What are the major challenges for your organization in order to implement suggestions to minimize these disturbances?

THE LEAN CONSTRUCTION PHILOSOPHY

1. What does Lean mean for you?

2. Do you use the Lean Construction philosophy/tools in your organization? If so, how do you use this methodology?

3. Do you think that the Lean Construction philosophy can help to reduce disturbances for local neighbourhood in the construction sites during the production phase? If so, how?

4. According to you, how can a construction company use this philosophy to reduce these kind of disturbances in its projects?

5. Would you recommend this methodology (Lean Construction) as a valuable tool for implementing it in a construction company in order to minimize the social inconveniences produced by the construction projects? If so, how would you recommend to implement it (actions to be taken)?

STAKEHOLDERS RELATIONSHIPS

1. How does your organization interact with the different stakeholders in order to share information?

2. What sort of collaboration is already working well for you?

3. Do you consider that collaboration between your company and stakeholders contribute to reduce disturbances for local population? If so, what are the main benefits?

4. Do all stakeholders take into consideration disturbances for society in the surroundings of the construction sites?

5. What are the major problems / challenges in the collaboration for reducing disturbances between different stakeholders?

6. Do you get support from your organization in order to reduce disturbances at the construction sites during the production phase? If so, how is this support?

7. Is there any specific department responsible for managing relationships between your company and stakeholders in order to analyse disturbances for local neighbourhood in the construction sites?

Appendix III -- Analysis of needs and impact of the disturbances

Projekt:	xx		
Datum:	xxxx-xx-xx	Datum senaste revidering:	xxxx-xx-xx
Ansvarig för upprättande av dokumentet:	xx	Ansvarig revidering:	xx

	Trafikförslag		Projektering			
	Antal	Särskild hänsyn ja/nej	Störningens omfattning (X)	Typ av trafik (Y)	Störnings-nivå (X*Y)	Anmärkning /information
Viktiga verksamheter/målpunkter i omr.						
Boende					0	
Skolor					0	
Förskolor					0	
Arbetsplatser					0	
Handel					0	
Café/Restaurang					0	
Hotell					0	
Vårdinrättning					0	
Kunder hemtjänst/hemsjukvård					0	
Evenemangsplatser					0	
Styr & Ställ-cykelställ					0	
Byggprojekt/ etableringsprojekt					0	
Cykelparkeringar					0	
Parkeringsanläggningar för bilar					0	
Övriga viktiga målpunkter:					0	
					0	
					0	
					0	

Instruktion för poängsättning av störning:

Störningens omfattning - värde X	Värde
Ingen störning	1
Liten störning	2
Stor störning	3
Mycket stor störning	4
Typ av trafik - värde Y	**Värde**
Helg	1
Vardagar lågtrafik	2
Eventtrafik	3
Vardagar högtrafik	4

Instructions for scoring the level of the disturbances

	Trafikförslag		Projektering			
	Antal	Särskild hänsyn ja/nej	Störningens omfattning (X)	Typ av trafik (Y)	Störnings-nivå (X*Y)	Anmärkning /information
Typresor genom området					0	
Pendlingsresor (arbetet, skola)					0	
Affärsresor					0	
Fritids/sällanresor					0	
Trafikslag					0	
Gång					0	
Cykel - pendlingscykelnät					0	
Cykel - övergripande cykelnät					0	
Cykel - lokalt cykelnät					0	
Kollektivtrafik - buss					0	
Kollektivtrafik - spår					0	
Kollektivtrafik - taxi					0	
Personbilar					0	
Räddningstjänst					0	
Lätt yrkestrafik					0	
Godstrafik					0	
Byggtrafik					0	
Övrigt att ta hänsyn till (exempelvis trafikater med särskilda behov så som barn, funktionsnedsatta och äldre):						
					0	
					0	
					0	
					0	
					0	

Instruktion för poängsättning av störning:

Störningens omfattning - värde X	Värde
Ingen störning	1
Liten störning	2
Stor störning	3
Mycket stor störning	4
Typ av trafik - värde Y	**Värde**
Helg	1
Vardagar lågtrafik	2
Eventtrafik	3
Vardagar högtrafik	4

Instructions for scoring the level of the disturbances