BARRIERS AND SUCCESS FACTORS FOR DEVELOPING A LEAN CULTURE

A case study at a Romanian contractor

Master's thesis in the Master's Program
Design & Construction Project Management

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ABSTRACT

After proving its benefits in the manufacturing industry, Lean management has been introduced into the construction industry as a response to its problems regarding low efficiency, productivity and overall performance. However, many construction companies have struggled to implement Lean, considering it a very complex and confusing philosophy. Applying Lean tools and techniques without proper consideration of the human dimension is destined to failure, as 'people' are one of the key success factors when undertaking a Lean journey.

Therefore, the aim of this thesis was to study the barriers and success factors which would allow to develop and implement the Lean culture necessary to enable Lean management tools. The work environment at a Romanian construction company was studied in the light of Lean management tools and cultural prerequisites, in order to assess the company's capacity to adapt to Lean management.

The results showed that the Romanian company in the study partially satisfied some of the requirements necessary for a Lean culture, the most important being its focus on its employees' development, which has also created a good work environment based on trust and respect. The employees showed good theoretical knowledge and a high level of skills and expertise, but a lack of rules, procedures and long-term vision were among the most important problems which the company would have to be overcome. Another identified barrier for developing a Lean culture was the absence of a culture for safety, organisation or standardised processes, which could be overcome by implementing clear rules, procedures and work standardisation, with a close follow up of their application. In this way the company could succeed in developing a Lean culture which would adhere to Lean management tools and principles.

Key words: Lean, Construction, Culture, Romania, Barriers and Success factors

Contents

Preface

The subject for the dissertation was chosen only after I have completed all the selected courses from the course program. It was hard to choose as I was interested in many areas such as Financial Management, Logistics, BIM and Stakeholders management.

Early in the second part of the first year of the master program, I became very interested to extend my research regarding BIM impact on production efficiency in construction sites, research which potentially could be conducted through a potential master thesis subject. I have found this subject very interesting and enlightening, especially after undertaken the BIM management course.

Nevertheless, as I have followed the courses of the master's program, my interest area has broadened, especially given the opportunity to select my own courses in the second year and tailor my own area of study. Some special courses, and I call them special at least because they were special to me, drew my particular attention, even if at first glance they did not seem anything like that. The 'Lean management', the 'Construction, processes and management', the 'Leadership' and the 'Urban metabolism' courses have in fact helped me to redefine and reshape my own goals and beliefs both in professional and in personal life.

The current environmental situation, Lean philosophy and servant leadership are new targets in my own life, and how better to extend my knowledge and contribute to the academic field if not through a master thesis dissertation! At this point the subject for the master thesis became easy to select, as my interest, curiosity and motivation were very high. Moreover, I have chosen to conduct the study in my own native country, as I wanted to contribute to the academic literature since these concepts have not been much explored.

Göteborg, May 2018

Bogdan Bahnariu

1 INTRODUCTION

The thesis's purpose is to study the barriers and success factors for implementing and developing a Lean culture. A Romanian construction company is studied through Lean management cultural prerequisite lenses, to assess and understand the current situation. This chapter describes the background, the research motives, the aim and purpose of the paper. Also, the research questions are defined, and the study limitations are stated.

1.1 Background

It is a well-established fact that the construction industry faces many problems in terms of efficiency, productivity and performance, (Lajevardi et al., 2011, Winch, 1998), waste, and underdevelopment (Josephson and Saukkoriipi, 2007) and is frequently failing to deliver the initial established objectives, with negative consequences on customer satisfaction due to increased projects costs, additional execution time, disputes and litigation (Sambasivan and Soon, 2007).

One reason which explains these problems, is that the construction industry, even though building projects involve a high degree of problem solving skills and innovative technical solutions, is failing to learn from its projects, or to codify and transmit innovation information to other projects, making the whole industry resistant to cost reductions or quality improvements (Winch, 1998), with numerous individual trades and professions forming dominating subcultures that do not support closer and indeed lessen working relationships (Jørgensen et al., 2004).

Another reason is that construction processes contain many activities which actually do not generate any kind of value to the final product and therefore to the final client (Lajevardi et al., 2011). Waste can take many different forms, depending on the type of industry and working processes, with the cost of waste in the construction industry reaching 30% to 35% of project activities (Josephson and Saukkoriipi, 2007). For example, in Australia, up to 35% of the total cost of the project is represented by waste on reworks, while in UK, Scandinavian countries and US the proportion is up to 30% and labour efficiency is approximative 40% to 60% (Li et al., 2015, Lajevardi et al., 2011).

Therefore, there is a need for change in the construction industry especially as low profitability conditions have led to high demand for reducing costs, increased quality, and longer guarantee periods for construction projects (Höök et al., 2008). Josephson and Saukkoriipi (2007) claim that with developing technology, purchasing processes and industrialisation, the construction industry is tending to adapt to new management systems which are successful in other industries, especially in identifying and reducing waste from construction sites.

1.2 Research motives

Nowadays the consumption of the natural resources is conducted in an unsustainable and concerning manner regarding the future of humanity itself on planet Earth (Li et al., 2015). Global warming, ecosystem degradation and raw materials depletion are some of the impacts of our current lifestyle (Daly, 2005). It is irrational to think that in the current context of everyday personal and business life, it is possible to have infinite growth, whilst the planet's resources are finite, under precise natural laws and generation cycles, (Hawken et al., 1999). Moreover, the material regeneration cycles do not sustain the current consumption rate and cannot renew them as quickly as they are consumed (Barles, 2010).

The construction industry has one of the highest rates of raw material consumption, almost 50% more than any other industry (Elgizawy et al., 2016), constituting about 24% of global material extraction (Wu and Wang, 2016). As regards waste generation, the construction industry has the biggest waste share (Katz and Baum, 2011), in Australia reaching around 40% of total generated waste, or 19 million tonnes per year (Tam and Lu, 2016) and this is expected to increase to 65% by 2025 (Elgizawy et al., 2016). The industry's waste consists of numerous materials like concrete, wood, bricks, glass, gypsum, metals, plastic, solvents, asbestos and excavated soil (Commission, 2016). Current recycling rates are very low, and it is expected that by 2025, waste generation to increase by 70%, to an average of 3.5 million tons per day worldwide (Elgizawy et al., 2016).

In Hong Kong the construction sector accounts for 25% of the total generated waste, around 1.25 million tonnes per year. In China the figures are approximatively 30% to 40% of the total generated waste, around 800 million tonnes per year, in the USA around 170 million tonnes per year and in the UK about 80 million tonnes per year (Tam and Lu, 2016). In European countries, construction and demolition waste have a share of approximatively 25% to 35% from the total municipal waste (Iacoboaea and Aldea, 2016), accounting for around 800 million tonnes per year (Commission, 2016).

In Romania, the data are difficult to quantify and, moreover, the existing data are not reliable, as the National Management Integrated System (NMIS) does not function within required parameters and construction contractors usually do not declare their waste so therefore, only 10% of the total waste is represented as the construction waste, which is significant lower than the European average (Iacoboaea and Aldea, 2016). Because of these practices, construction waste is disposed of in regular or old landfills and even sometimes in illegal ways, causing multiple pollution incidents to air, land and water (Iacoboaea et al., 2010). Romania is failing to reach the environmental targets imposed by European Union, especially in regards to waste generation and recycling, Whilst in European countries the recycling rate is on average more than 50%, with the Scandinavian ones reaching more than 80%, Romania has a recycling rate which has varied from less than 5% between 2003-2008 to 47,7% in 2011, with the proviso that these data reflect only collected waste and not the real generated ones (Iacoboaea and Aldea, 2016).

Furthermore, against this background of low recycling rates, Romanian culture plays an important role in waste management, with Romanian people having contradictory behaviours. On one side people need more education in recycling concepts, processes and options, whilst on the other side, even where they show good comprehension in this area, and admit its importance, still they often do not recycle for various unknown reasons. Lack of environmental education in school and teaching of good practices from childhood seem to be the main problems in starting to recycle (Kolbe, 2014).

1.3 Aim

In this context of the construction industry's inefficiency and environmental impact, land deterioration and depletion, consumption of energy and non-renewable natural resources, and emissions due to dust and gases (Li et al., 2015), and as a result of the learnt knowledge through the master program courses, there is an intrinsic motivation to find new solutions how to improve working practices, to develop awareness and responsibility among the people and companies, and to understand how to develop and achieve sustainable development in the Romanian construction industry.

Lean management could be one solution to these problems, the general focus in this management style being on the waste reduction and elimination of non-value adding activities. According to Josephson and Saukkoriipi (2007), there is a high need to increase cooperation between all factors involved in construction projects in order to reduce waste and non-value adding activities, regardless of the prices and costs of the projects. Even if waste from a green perspective is not the same as waste from a Lean one (Verrier et al., 2016), by optimising the production processes, by producing only when the demand exists, by increasing supply chain efficiency (and decreasing transportation values), and by training and educating employees, it can be stated that Lean management helps by reducing energy, materials and water consumption, and by reducing material waste (Wu and Wang, 2016). Moreover, Lean management, adopted in the construction industry as Lean construction, is seen as a management method which has the capability to improve quality and flexibility and to reduce costs, therefore increasing both competitiveness between organisations and, ultimately, clients' satisfaction (Valente et al., 2012).

Therefore, this thesis will study the barriers and success factors for implementing and developing a Lean culture necessary to enable Lean management tools. The current situation at a Romanian construction company and its adaptability to implement Lean management cultural prerequisites will be analysed, according to these barriers and success factors.

As a result of this analysis, the intended outcome will be to assess, through Lean management tools and cultural prerequisites, how this Romanian construction company might improve its work environment and employees' satisfaction, so as to reach an improved position where work efficiency can be increased, and waste reduced, no matter what its form.

1.4 Research questions

Through this paper, the author will try to formulate an answer to the following questions:

1. *Why is it important to understand and develop a Lean culture when implementing Lean management tools?*
2. *What are the barriers and success factors for implementing and developing a Lean culture?*
3. *What is the company's current situation as regards these barriers and success factors?*
4. *What are the possibilities for this Romanian construction company to implement Lean management tools?*

1.5 Research outline

The thesis content is detailed in 6 different chapters, being formulated and established in such a way to give the reader a clear understanding of the thesis development. The chapters are summarised below:

Chapter 1 – *Introduction*, presents the background and research motives of the thesis, being formulated a clear aim and purpose through the research questions.

Chapter 2 – *Literature framework*, defines and elaborates the main theoretical concepts, which are going to be used in this paper. Within the theoretical framework, it will be framed and described construction industry, project management, Lean philosophy and Romanian construction context.

Chapter 3 – *Method,* explores the methodology and the procedures used to conduct the research and data analysis, which were performed during this thesis elaboration, needed to answer the research questions. Ethical consideration, reliability and validity and research limitations are also identified here.

Chapter 4 – E*mpirical findings,* presents the empirical data obtained from the interviews and the case study, being described the observations and data gathered regarding the work environment and procedures, and employees' work relations.

Chapter 5 – *Analysis,* performs the analysis of the empirical data, by bridging the interviews and case study data with the theoretical framework.

Chapter 6 – *Conclusions,* presents the final conclusions which are formulated according to the research questions, empirical findings and theoretical framework. Moreover, some future recommendations and studies are suggested.

2 LITERATURE FRAMEWORK

In this chapter, the theoretical framework will be assessed and the main concepts, which are going to be used in this paper, will be defined and elaborated. The theoretical framework is aimed to frame and describe the construction industry, project management, Lean philosophy and Romanian construction context.

2.1 Lean way and philosophy

2.1.1 History and context

In the 1950s, in the post-World War era in Japan, local companies were confronted with many problems such as scarcity of natural resources, low cash flow, fragmented and limited markets, slow infrastructure development, low levels of demand for different products, and increased competition from foreign companies (Liker et al., 2008).

To survive this harsh environment, there was a high need to increase flexibility, to shorten lead times and to coordinate supply chains. Taiichi Ohno together with Shigeo Shingo, from the Toyota Motor Company, pioneered a new management system, a new deep business philosophy, which was called the 'Toyota Production System' (TPS) (Liker et al., 2004, Bertelsen, 2002). It is an ongoing fundamental process, with Toyota spending decades to reach their current state, and still they are learning and perfecting it (Liker et al., 2011b). To develop this system, Ohno took inspiration from Japanese culture, from the Toyota culture (which was initiated and cultivated by its company founder, Kiichiro Toyoda), and even from existing manufacturing ideas developed by Henry Ford and Taylor, which were focused on mass production (Liker et al., 2004).

The first time when the Toyota Production System drew the attention of the Western world was in 1980s, when after the oil crisis, the Toyota Motor Company recovered very quickly as in comparison with its competitors (Lander and Liker, 2007). From 1950 until 2008, Toyota was one of the single companies in the world which was profitable every year, managing to deal in a successful way with different crisis like Great Recession, the recall crisis and the Japan earthquake. Only in the year 2007, faced with global recession and an oil price spike, was Toyota's record broken, and after 2008 Toyota become once again profitable (Liker et al., 2011a).

2.1.2 Toyota Production System

The Toyota Production System is a management system which focuses on customer satisfaction, on elimination of all types of waste and inventories, on producing in small batches and on a 'just-in-time' (JIT) delivery system, and on reaching perfection (Daeyoung, 2002). Production is seen as a flow, where a series of activities and processes are conducted, with some of them adding value to the final product and some not. To optimise these processes, an ongoing process takes place to identify and eliminate waste from non-value-adding activities and to improve the value-adding ones (Bertelsen, 2002).

To reach these goals, TPS is based on understanding people's motivation, on a management style committed to people, investing in them and promoting a culture of continuous improvement and high quality, and on long-term thinking. (Liker et al., 2008). Moreover, according to Liker et al. (2004) this production system is designed to provide the necessary tools for employees not only to conduct their work but, more, to continuously improve it. The system's efficiency is dependent on the workers' ability to perform to their best to reduce inventories, and to identify and fix problems.

According to Taiichi Ohno, the former Toyota CEO and father of the Toyota Production System (TPS), one of the explanations for the Toyota Production System was that "*all we are doing is looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value-added wastes*" (Liker et al., 2004, p. 7).

The success factors for the TPS were based on two major concepts, the first one being to achieve the cost reduction by waste elimination, by utilising 'just-in-time' production systems (such as pull system, one-piece flow and levelling) and by the concept of 'jidoka' (autonomation). The second concept was full utilisation of the workers' capabilities which required a system based on respect for people, ensuring safety in the work environment and assigning greater responsibility to the workers by allowing them to participate in events where they could improve their jobs (Lander and Liker, 2007).

2.1.3 Lean management

In 1983, Womack named the Toyota Production System "lean" and, for the first time, conceptualised the system's concepts and evolution from a western point of view, presenting it to the western world through the book "The Machine that changed the World" (Womack et al., 1990).

Lean management is described in the book in the following terms: *"It uses less of everything compared with mass production – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever-growing variety of products." (Womack et al., 1990, p. 13)*

Lander and Liker (2007) define Lean management as a management system which can reduce overall cost, especially indirect costs and manufacturing cycles, by eliminating the waste from the value streams, and at the same time increasing quality standards

Therefore, through Lean management it can be reduced the lead time (the time between the customer order and shipment of the product), whilst the costs are decreased and the quality improved, by identifying and eliminating waste from the value stream (Bakås et al., 2011).

Höök et al. (2008) argued that there is a debate in academic world regarding the definition of 'lean', as Lean is compared to other management methods.

1. Some researchers see Lean as an improvement "*tool based*" methodology, containing concepts and characteristics from Just-In-Time (JIT), Total Preventive Management (TPM), Total Quality Management (TQM) and Human Resource Management (HRM). Thus, Lean is a set of tools that allows to identify and therefore eliminate the waste, to improve to quality, the production time and to reduce the lead time.
2. Other researchers define Lean as a management method, a "*flow-based*" approach, which is focused on continuous improvement of work, and it is influenced by the market demand. At the same time, it involves a strong cultural identity, a climate which foster collaboration between the workforce, concepts which are totally different from Fordism and Taylorism.

Considering the second statement of Höök et al. (2008), by following a continuous improvement practice, problems will be exposed repeatedly, and, for example, waste reduction will be just a natural consequence of this way of thinking and not the aim itself. The tools are used only as a solving mechanism, necessary and put in to practice only when the problems arise (Liker et al., 2004).

Therefore, the Lean methodology is not about the tools, it is about exposing problems in inadequate working environments and then using the tools to achieve the ideal (Liker et al., 2008). The goal itself is not important, but more important it is how the organisation achieves that goal (Höök et al., 2008). Nevertheless, for the employees to own the processes which bring value, they must understand, embrace and integrate the Lean tools, concepts and techniques, and master them to become – after years of practice by the student – the master (sensei). In this context, the culture which sustains this environment is even more important than the tools and Lean concepts themselves (Liker et al., 2008).

2.1.3.1 Lean principles

Lean principles were developed as the guiding structure for Lean management and they are summarised in a pyramid shape, the 4P model, comprising philosophy, process, people and problem solving, see *figure 2.1*:

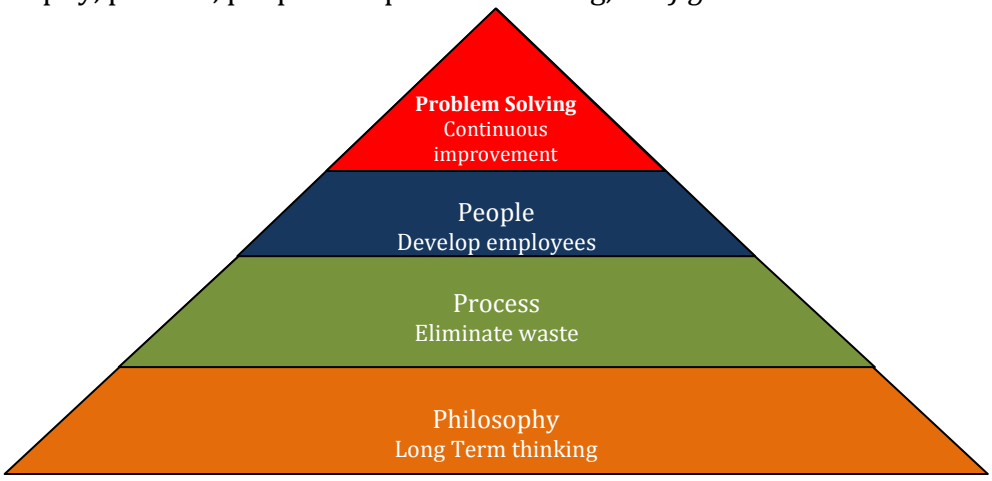

Figure 2.1 Lean 4P model (Liker et al., 2004, p. 26)

The foundation of the pyramid is represented by the long-term thinking which was adopted by Toyota regarding its strategies, policies and behaviours, the '*philosophy'* towards its employees, customers and even society. This first layer is the Toyota's intrinsic purpose – '*why*' the company exists. The second layer consists in tools and strategies to shorten lead times by identifying and removing all kinds of waste.

The next building block of the pyramid represents the people and culture inside the organisation – the people will drive the company forward by using and applying the tools and problem-solving thinking needed to identify and remove waste, the culture will determine how people will act, think and work together towards successful realisation of the common goals. People are encouraged and helped to develop so that a continuous improvement environment can be formed, which is represented through the last layer of the pyramid (Liker et al., 2004).

The pyramid concepts are further elaborated in the Lean fourteen principles, underpinned in four sections, as the 4P model, *table 2.1*.

Section I		**Long-term Philosophy**
	Principle 1	*Base your management decisions on long-term decisions on long-term philosophy, even the expense of short-term financial goals*
Section II		**The right process will produce the right results**
	Principle 2	*Create a continuous process "flow" to bring problems to surface*
	Principle 3	*Use "pull" systems to avoid overproduction.*
	Principle 4	*Level out the workload (heijunka) – work like the Tortoise, not the Hare*
	Principle 5	*Build a culture of stopping to fix problems, to get quality right the first time*
	Principle 6	*Standardised task and processes are the foundation for continuous improvement and employee empowerment.*
	Principle 7	*Use visual controls so no problems are hidden.*
	Principle 8	*Use only reliable, thoroughly tested technology that serve your people and processes*
Section III		**Develop and challenge your people and partners through long-term relationships**
	Principle 9	*Grow leaders who thoroughly understand the work, live the philosophy and teach it to others*
	Principle 10	*Develop exceptional people and teams who follow your company's philosophy*
	Principle 11	*Respect your extended network of partners and suppliers by challenging them and helping them improve*
Section IV		**Problem solving, and continuous improvement drive organisational learning**
	Principle 12	*Go and See for yourself to thoroughly understand the situation (Genchi Genbutsu)*
	Principle 13	*Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly (nemawashi)*
	Principle 14	*Become a learning organization through relentless reflection and continuous improvement (Kaizen)*

Table 2.1 Lean principles (Liker et al., 2004, p. 51)

2.1.3.2 Toyota model

Toyota has summarised its principles through an internal document, called '*The Toyota Way 2001*', which was elaborated especially for training employees about Toyota culture and core values (Liker et al., 2011b). It was used a graphical illustration, a house which has a strong foundation and two central pillars to sustain the *Toyota Way*, see *Figure 2.2*. Those two pillars are '*Continuous Improvement*' (often called '*Kaizen*') and '*Respect for People*', and the foundation has five elements '*Challenge*', '*Kaizen*', *'Genchi Genbutsu*' (go and see), *'Respect'*, and *'Teamwork'*.

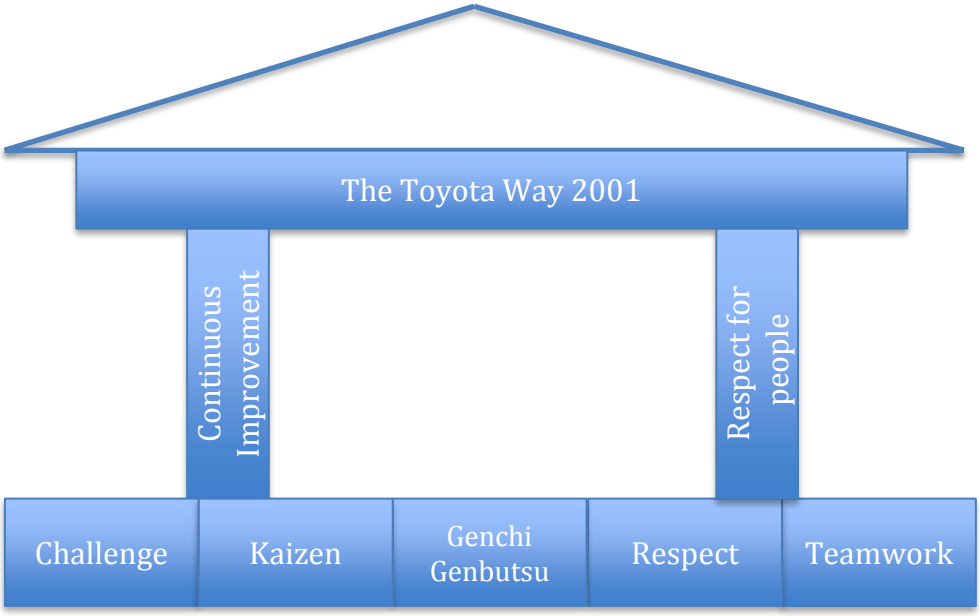

Figure 2.2 Lean house of the Toyota Way 2001 (Liker et al., 2008, p. 779)

The '*Continuous Improvement*' pillar which has its foundation on *'Challenge'*, *'Kaizen'*, and *'Genchi Gembutsu'*, defines the basic approach about how to conduct the business itself, to challenge everything and to constantly improve oneself (Liker et al., 2008) .

- *Challenge*: means to form a long-term vision both for the company and for the employees, and to meet the challenges with courage and creativity
- *Kaizen* (change for better): means to improve business operations in a continuous manner, striving always for innovation and evolution.
- *Genchi Genbutsu* (go and see): means go to the source, to the shop floor, where the things are happening, and it is commonly implemented through the Gemba Walk. This is done with the scope to observe and to find facts to be able to make the most correct decisions, to build consensus among the employees and peers, and achieve the desired goals at best speed.

The '*Respect for People'* pillar is further categorised as *'Respect'* and '*Team Work'*, and it defines the relationship with the employees and the work environment (Liker et al., 2008).

- *Respect*: means to respect others, to make every effort necessary to understand each other, to take responsibility and ownership of the work performed, to prevent flaws from the production line, and to create mutual trust among every employee.

- *Team Work*: means to stimulate personal and professional growth, to share and give development opportunities to maximise each individual and consequently team performance.

2.1.4 Lean "heart and soul"

To successfully implement non-traditional methodologies, it becomes clear that the emphasis is upon successfully creating a highly motivated workforce, upon effectively managing people, and on considering them an **asset** for the company (Daeyoung, 2002). In the *Toyota Way* people are considered the most valued asset of the organisation, its human resources strategies and philosophies, with people being TPS's "*heart and soul*" (Liker et al., 2008). Three out of the fourteen principles of the *Toyota Way* are addressed especially to people, while among the other principles can be found bullet points related again to people. Moreover, in the Lean house, one of the pillars is represented by respect for people.

Eiji Toyoda, one of the former presidents of Toyota Motor Corporation, expressed the following regarding the workforce: "*people are the most important asset of Toyota and the determinant of the rising and fall of Toyota*" (Liker et al., 2008). Toyota believes that its success relies on its highly motivated and skilled workers, who make thousands of improvements every year from which Toyota benefits by reducing overall costs and cycle times, and increasing quality and so one, which gives the firm therefore a substantial advantage over its competitors (Veech, 2004).

Any organisation which wants to apply Lean tools or even more to become Lean, must understand that applying those tools and techniques does not guarantee success. The human dimension must also be taken into consideration, where respect for people is the central key. People must be trusted, empowered, motivated, encouraged to express themselves freely, trained and allowed to grow and learn (Hines et al., 2004).

While technology and capital can be acquired and duplicated from one organisation to another, human capital, its qualifications and motivation cannot be, which makes Lean so hard to translate from Toyota Motor Corporation to any other organisation. People will make the real difference between two organisations and give the competitive advantage in the business environment (Daeyoung, 2002), and this strategy of focusing on people seems to be strangely disregarded by companies which desire to become Lean (Green, 1999).

Veech (2004) has stated that Lean represents a system of tools meant to improve people: "*Focus on the people and the results will follow. Focus on the results, and you'll have the same troubles as everyone else – poor follow-up, lack of interest, no ownership of improvements, diminishing productivity.*"

2.1.5 Critiques

The *table 2.2* incorporates, according to Liker et al. (2004), the main positive and negative aspects of Lean philosophy.

Strengths	Weakness
Very efficient	Very hard to implement – requires a cultural change in the organisation
Resilient in crisis situations	Very sensitive to faults and disturbances
Short lead times	Long time to implement
Applicability to every industry/business	False sensation of acquiring Lean stage
Good tools and techniques	Lean journey never ends – it is a continuous, never ending process

Table 2.2 Lean strengths and weakness

2.1 Construction industry

2.1.1 Context

The construction industry, unlike many other industries, is characterised by a specific *engineer-to-order* project type, and its social, cultural and technical environments of construction processes and delivering products, are influenced by some major peculiarities, i.e. site production, temporary organisation, one-of-a-kind delivered product (Vrijhoef and Koskela, 2005) and governmental control (Höök, 2006).

Construction projects are described as being unique and complex, usually of considerable proportions, with extensive hierarchy (Jørgensen et al., 2004), and being operated under the constrains of time, budget and quality in highly uncertain environments (Daeyoung, 2002). The process of production, according to the traditional way of conducting business in the construction industry, is seen as several separate and individual steps, each of them adding value to the final product (Koskela, 2000).

In this context the construction industry faces many problems in terms of low efficiency, productivity and performance, (Lajevardi et al., 2011, Winch, 1998, Vrijhoef and Koskela, 2005), being underdeveloped (Josephson and Saukkoriipi, 2007), and frequently is failing to deliver its initial established objectives, with negative consequences on customer satisfaction due to increased projects costs, additional execution time, disputes and litigation (Sambasivan and Soon, 2007). Even the structure and organisation of the construction projects are considered a barrier towards efficient project management, as they are temporary and composed for a particular project, involving different subcultures with many individuals and different actors and companies, with specific and different tasks, subtasks, roles and responsibilities, whereby fragmentation between parties is increased, leading to poor levels of communication, trust and cooperation (Jørgensen et al., 2004).

One reason which might explain these problems, is that the construction industry, even though building projects involve a high degree of problem solving skills and innovative technical solutions, fails to learn from its projects, to codify and transmit innovation information to other projects, which makes the whole industry resistant to any cost reductions or quality improvements (Winch, 1998). Another reason is that the construction processes contain many activities which actually do not generate any kind of value to the final product and therefore to the final client (Lajevardi et al., 2011), with the cost of waste reaching up to 30% from the project activities and the labour efficiency up to 40% to 60% (Li et al., 2015).

Josephson and Saukkoriipi (2007) argue that there are four major obstacles to development in the construction industry: its uniqueness and conservative approach, poor insights into value adding and non-value adding activities, the paradox that work improvement leads to greater waste, and the industry's organisation which is structured to resist change.

Therefore, to change how business is conducted in the construction industry, one proposed solution would be to shift the management style to focus the project processes on the client's needs, to train and motivate the employees, using leadership as a motor, and to eliminate all non-value adding activities which generate waste (Josephson and Saukkoriipi, 2007). By optimising each of production processes, the construction industry could bring its projects towards an optimised state and the entire costs of the project could be lowered (Bertelsen, 2002).

2.1.2 Project definition

According to Wysocki (2006, p. 6) a project can be defined as "*a sequence of unique, complex, and connected activities that have one goal or purpose and that must be completed by a specific time, within budget, and according to specification*".

Projects are characterised as being unique organizations operating within a temporary framework, being established with the purpose of creating a specific change which is needed to generate benefits and increase the business value to the base permanent organisation, through the project itself (Wysocki, 2006, Eskerod et al., 2013). The project has a predictable time span, with clear and explicit start and end points, and by using different project management methods and actions such leadership styles, teamwork concepts, communication techniques and other tools, the project will deliver its desired product (Kliem et al., 1997).

2.1.3 Project management

Project management is defined by Wysocki (2006, p. 27) as "*an organized common-sense approach that utilizes the appropriate client involvement in order to deliver client requirements that meet expected incremental business value*".

According to Kerzner and Ebrary (2013) in order to declare the project management method, as successful, the project has to deliver its imposed objectives in the agreed schedule, budget and at the required technical quality, utilising efficiently all the human and natural resources, culminating with the client's approval.

However, Atkinson (1999) argues that the assessment success criteria for a project, the *Iron Triangle* (time-cost-quality), is limited and does not reflect the real situation, as many project fail, despite the management style. Atkinson (1999) suggests that a new assessment criterion should be implemented, namely *Square Route*, which beside the *Iron Triangle*, should include factors which will assess all the stakeholders (e.g. workers, environment, community, authorities, users, etc) and therefore will reflect the project's efficiency and effectiveness, waste reduction, organisational learning, strategic goals, satisfaction among workers and users, environmental impact, etc.

To find the most suitable management method for a project, Wysocki (2006) claims that the project's characteristics must be taken into consideration, its uniqueness and the surrounding environment, and also the business profile. Kerzner and Ebrary (2013, p. 87) define the project management method as "*a series of processes, activities, and tools that are part of a specific discipline, and are designed to accomplish a specific objective*".

Therefore, the management methods represent the sum of all the necessary actions used to conduct a project, such as project scheduling, resource and control, project estimating, etc. (Joslin and Müller, 2016) and by repeating them, without significant adjustments, they can be used for every project, bringing benefits such as reduce the project time schedule, reduce costs, prevent undesired changes in the scope of works, improve the execution strategy, help to predict the results, provide a better general picture of the project for senior management, reduce project risks, standardize execution, summarize and use the best practices, improve the relationship with the client, and increase customer satisfaction (Kerzner and Ebrary, 2013).

In the construction projects, Jørgensen et al. (2004), through their study, have identified five "*de facto sub organisations"*:

a. *A system of operations* – which is represented by the formal project management needed to execute the project according to the project instructions; the project managers are the representatives of the main contractor, designers and investors (clients);

b. *A system of resource controllers* – comprising the subtractors' own management system, by which they organise production resources and manage labour and materials;

c. *A system of formal control (directive functions)* – encompassing the hierarchical structure system used to direct and divide tasks and operations between teams and gangs, coordinated typically by foremen and clerk of work;

d. *A system of informal control (adaptive functions)* – this system covers the practices and work habits which are negotiated and dealt daily outside the formal procedures systems;

e. *A system of social and personal relations* – comprising the interpersonal relations, crucial for the developing interaction, cooperation and communication among people;

2.1.3.1 Traditional project management methodologies

Traditional project management methodologies (TPMM) have been used since the middle of the 19th century and it is considered that TPMM are rigid, highly rational, bureaucratic, plan driven, structured and process heavy with no flexibility to adapt to the new challenges of the present days (Kliem et al., 1997). In other words, TPMM characteristics comprise a set of rules, practices, reports, plans, documentations, checkpoints and schedules, all under Iron Triangle constraints and emerging from the need to control and foreseen every aspect of the project (Kerzner and Ebrary, 2013).

TPMM have been particularly implemented in the construction industry, as it fosters a predictable and repeatable environment, whereas in other industries with a more dynamic and ever changing environment, TPMM characteristics were not the best answer and new solutions had to be found and implemented (Kliem et al., 1997). Although TPMM can work and have positive results in the construction industry, eventually they will collapse when they are challenged by new practices and technological complexities, resulting in loss of project control especially when the resistance to change is high (Kerzner and Ebrary, 2013).

As represented in *figure 2.3* , the Linear Project Management Life Cycle (PMLC) is one of the simplest and most intuitive models of TPMM, where the goals and solutions for the project are known and deviations (changes) cannot be easily adapted (Wysocki, 2006).

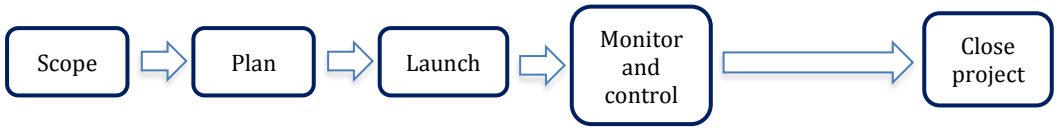

Figure 2.3 The Linear PMLC model (Wysocki, 2006, p. 341)

This model can be seen in the construction industry in the *Waterfall model*, *figure 2.4*, which has a sequential flowing process passing through the following phases: conception, initiation, analysis, design, tendering, construction, operation and maintenance (Vuurmans, 2015).

Figure 2.4 Project phases in the waterfall model (Vuurmans, 2015, p. 28)

Critical path method, critical chain project management, work breakdown structure and earned value are other TPMM which can be used when conducting/managing a project.

2.1.3.2 Non-traditional/practical project management methodologies

The non-traditional/practical project management methodologies (NTPMM) are described by Kliem et al. (1997, p. 16) as being more than a set of tools, principles and techniques, and as a " "*philosophy as well as a methodology for completing projects that deliver a product that satisfies the customer*".

Some important characteristics of this type of project management are that these methods are flexible, transparent and adaptive and have emerged as a response to uncertainty environment in projects which could not be resolved by traditional methods (Canty, 2015). Among the non-traditional project management methodologies, the followings have been suggested: Agile, Scrum, Kanban, Adaptive Project Framework, Lean, Six Sigma, Lean Six Sigma.

2.1.3.3 TPMM vs NTPMM

The previous subchapters have presented two major, but different methodology-groups used in project management; the traditional ones (TPMM), which are rigid, very structured and hierarchical, with distinctive phases and focused on planning, and the non-traditional ones (NTPMM), which allow for more flexibility, emphasis communication and are customer focused.

In *table 2.1*, Canty (2015) has summarised principal differences between Agile project management and traditional project management taking into consideration different aspects of an organisation, including the Iron Triangle.

	Agile Project Management	**Traditional Project Management**
Focus is on	People	Processes
Documentation Level	Low, only as required	High
Process Style	Iterative and incremental	Linear
Initial Planning	Low	High
Requirements Prioritization	Based upon business value and regularly updated	Fixed within the project plan
Quality	Customer focused	Process focused
Organization Style	Self- organized	Managed
Management Style	Decentralized	Centralized
Changes	Backlog updated	Formal change management in place
Leadership Style	Collaborative; servant leadership	Command and control
Performance Measurement	Business value	Conformity to the project plan
Return on Investment (ROI)	Early and throughout the project life	End of the project life
Customer Involvement level	High and throughout the project	Involvement level is varied and depends upon the project life cycle

Table 2.3 Differences between Agile and TPMM (Canty, 2015, p. 79)

Another, non-traditional management method, Lean management, focuses also on increasing customer satisfaction, and was developed by Toyota Motor Corporation. Womack et al. (1990) have identified that in comparison with its competitors, Toyota, through this management method, needs fewer human resources and less investment to deliver its final product to the costumer, while quality has been increased and cooperation with suppliers has been improved. By shortening lead times and diminishing its stock levels, Toyota has become more cost efficient and, at the same time, has been able to produce in low volumes, with more variants, stable prices and increased market share (Womack et al., 1990).

2.2 Lean construction

Following recorded successes in the automotive industry, Lean construction was adopted as a new way of conducting construction projects, with the aim being to better satisfy customer needs, to increase productivity and reduce waste, whilst using the minimum resources (Lajevardi et al., 2011).

Many construction companies started to implement Lean construction as they wished to achieve better results in comparison with other methods, but there was a struggle when it came to implementation, as the process is not straightforward, and many of them failed during this journey since most of the practitioners consider Lean construction as being one of the most complex and confusing philosophies (Daeyoung, 2002). Moreover, it has been argued that there are many differences, including cultural ones, between the automotive manufacturing industry and the construction one, as Lean construction tried to adapt Lean philosophy to the construction project culture (Hirota et al., 1999).

Nevertheless, Lean construction is seen as a management method which could improve quality, flexibility and reduce the costs, increasing therefore competitiveness between organisations and clients' satisfaction (Valente et al., 2012).

2.2.1 History and context

Lean Construction theory, methods and concepts were introduced into the construction industry in 1993, firstly with the work of Lauri Koskela, who claimed that efficiency in the construction industry would be increased by applying flow production concepts from Lean management (Bertelsen, 2002). Therefore, this author introduced the concept of a new unified production theory, the Transformation-Flow-Value (TFV) (Koskela, 2000). His research was followed by the work of Glenn Ballard and Greg Howell who introduced a new method for production control in the construction industry called Last Planner (Bertelsen, 2002).

Today there are many articles, books, master and doctoral theses which investigate the concepts of Lean construction and its applicability in the construction industry. The International Group of Lean Construction (IGLC), founded in 1993, and Lean Construction Institute (LCI), founded in 1997, are two major institutes which are focusing on studying and developing Lean Construction.

2.2.2 Objective

Lean construction has been focused on understanding the application and implementation of the Lean production system in the construction industry (Bertelsen, 2002). Lean construction is defined, according to the Lean Construction Institute, as "*a new way to design and build capital facilities. Lean theory, principles and techniques, taken together, provide the foundation for a new form of project management*" (Daeyoung, 2002, p. 11).

The objective of Lean construction is to generate value to the customer by eliminating all the factors which do not add value and are considered as waste (Lajevardi et al., 2011) and by searching for continuous production flow (Koskela, 2000). It aims by using a Lean construction management system it is desired to improve performance by managing the interactions, dependencies and variations between all the activities in an everyday project (Lajevardi et al., 2011).

Even if the Lean management derives from the automotive industry, Hirota et al. (1999) claim that there are similarities between this industry and the construction industry, and that implementing Lean in construction projects is just a problem of the "learning process" – changing the established thinking patterns and managerial methods. The old habits of doing things and the strong implemented culture from the construction industry must be changed or even abandoned in order to implement successfully the Lean tools and more the Lean philosophy (Hirota et al., 1999).

2.2.3 Tools

In their assessment criteria for Lean implementation in a construction organisation, Valente et al. (2012) mention both qualitative and quantitative aspects of planning and production management, such as Kanban system for inventory and material flow, 5S, supermarket concept for the warehouses, supply scheduling, A3 tool for problem solving situations, waste removal tools. Furthermore, there are customised tools for the construction industry, adapted from the Lean, such as Last Planner (Bertelsen, 2002).

Gemba Walk together with Value Stream Mapping (VSM), Work Standardisation, 5S and Visual Management are together the most powerful tools used to eliminate waste from the production processes. These tools allow the user to visualise the flow of production, to identify opportunities for improvement and therefore to highlight the waste (Verrier et al., 2016). The downside of Standard Work and VSM tools is that they require the organisation to be mature enough in the Lean transformation process (Verrier et al., 2016).

2.2.3.1 5S

The '5S' tool is a simple and effective system, which was implemented with the scope to create a clean and well-ordered workplace by eliminating different kinds of waste. This tool represents a building block in teaching the Lean culture towards greater standardisation and problem solving thinking (Liker et al., 2004).

This tool has a direct purpose to organise and clean the workplace. However, the indirect purpose is to standardize the work and increase the employees' involvement and commitment to a better workplace both for themselves and their co-workers. Because of this strategy satisfaction at the work place will increase, the mind will be free from unnecessary activities, which will stimulate creativity and thinking, and the end-result will be an increased value for the products and therefore for the customer (Höök et al., 2008).

There are five concepts in this tool which are formulated by Liker et al. (2004) as follows:

1. SEIRI - Sense of Use (eliminate from the work place everything not required to perform the work)
2. SEITON - Sense of Ordinance (efficient placement and arrangement of equipment and materials)
3. SEISON - Sense of Cleanness (tidiness and cleanliness)
4. SEIKETSU - Sense of Health (ongoing, standardized, continually improving „seiri", „seiton", „seison")
5. SHITSUKE - Sense of self-discipline (discipline with leadership)

The first three concepts of 'S' help to create a normal state which will allow the deployment of the production activities, while the last two points help to maintain and improve the acquired state. Moreover, the '5S' tool can reduce repetitive strain injuries (RSI), therefore increasing health and safety during the production processes (Verrier et al., 2016) and can create the necessary environment for continuous improvement (Grigore and Cioana, 2013).

2.2.3.2 5 Why

The '5 why' tool is a technique which is used to identify the root cause of a problem, going repeatedly through questions of 'why' to find the initial cause that generated the final problem. In the *table 2.4* a model is presented of how to apply this tool and find the root cause of a problem, together with the corresponding countermeasures which were taken.

	Problem	**Corresponding level of countermeasure**
	There is a puddle of oil on the shop floor	Clean up the oil
Why?	Because the machine is leaking oil	Fix the machine
Why?	Because the gasket deteriorated	Replace the gasket
Why?	Because we bought gasket made of inferior material	Change gasket specification
Why?	Because we got a good deal (price) on those gaskets	Change purchasing policies
Why?	Because the purchasing agent gest evaluated on short term cost savings	Change the evaluation policy for purchasing agents

Table 2.4 '5 why' tool technique

2.2.4 Waste

2.2.4.1 Lean waste

Among the objectives of the Lean philosophy, a major one is product value maximization for the costumer (Denzer et al., 2015). This objective is achieved by removing waste from the production system through identification and elimination of the non-value-added activities from the production processes, known in broad term as waste or *muda* (Verrier et al., 2016). "*Muda refers to waste of unnecessary activities. This type of waste is characterized by using time, money and resources, while not adding any value to the customer*" (Denzer et al., 2015).

Ohno defines waste as "*everything that only raises costs without adding any value*" (Denzer et al., 2015) and divides waste into seven categories, which can lead to loss of company efficiency and profitability, and human motivation (Womack et al., 1990). To these seven categories is added an eighth one, about the workers knowledge (Liker et al., 2004):

1. *Overproduction*
    - this category is represented as producing something too soon or in too much quantity or faster than it is needed; this practice can hide several other elements of waste, such as product damage resulted from extensive transportation and stocking, undetected quality defects, due to the high-speed processes and human interaction with the machines;
    - it is a common form of waste and it can be caused by poor planning and control or by incentives which can unintentionally reward overproduction;
    - this waste can be handled in Lean management by:
        - observing and understanding the *Takt Time* (the amount of time needed to complete consecutive units to meet the demand) to pace the production rhythm and to align it with the customer request;
        - implementing a pull system using the Kanban method to control the manufacturing process;
        - improving the efficiency of production to produce in smaller batches.

2. *Waiting*
    - this waste involves delays which occur in the stages of production, different processes being out of synchronisation, causing some other processes to stand idle and have to wait the input from the previous ones. They can be caused by inefficient communication and changeovers, large batch processing, and uneven workstation loads;
    - it can lead to capacity and efficiency loss and increase the lead time;
    - this waste can be handled in Lean management by:
        - implementing *Standard Work* so each activity uses a consistent method; when the activities are standardised, it is easy to observe any deviations from the base and to observe the potential improvements which can be made;
        - designing the processes to have a *Continuous Flow*, with the goal of minimising and eliminating the buffers between the process activities.

3. *Transportation*
    - includes unnecessary movements of raw materials, work-in-progress (WIP) or finished products. It can be argued that from the customer point of view transportation does not add value to the product, and sometimes can even reduce the value. Although some transportation is usually necessary, it is important to reduce the times and costs associated with it;
    - the chances of damaging or mishandling a product increase in direct proportional to the transportation duration and times;
    - this waste can be handled in Lean management by:
        - implementing the *Value Stream Mapping* method, to visualise the materials flow, from the raw material state to the product delivered to the costumer state, which includes also the transportation times, duration and distances;
        - solving other wastes, such as overproduction or inventory, as transportation is directly linked to them.

4. *Extra processing*
    - is represented by extra steps made in the product process, which are not necessary or do not provide additional value to the product itself, such as unnecessary customisation and inefficient routings;
    - this waste can be handled in Lean management by:
        - reviewing the product specifications to ensure that they meet the customer's requirements and aligning the production processes accordingly;
        - identifying opportunities to simply the production process.

5. *Inventory*
    - this category of waste occurs when the supply of raw materials, WIP or finished products exceed the immediate demand;
    - usually it results in overproduction;
    - even if at first glance the inventory of finished products does not appear to have a negative effect, it carries some risks, which the organisation must assume, such as:
        - the products from the inventory may not correspond after a while to the market demands, and it be not what the customer really wants;
        - the products may go bad or deteriorate after a period;
        - the inventory may contain products with poor quality;
        - holding inventory involves financial costs, reaching up to 30% from the purchasing costs;
        - the tied-up money from inventory can limit organisation's opportunities to invest the funds elsewhere.
    - this waste can be handled in Lean management by:
        - implementing the *just-in-time* (JIT) method in the purchasing of the raw materials;
        - focusing on designing a *Continuous Flow* to align the production processes;
        - eliminating the overproduction waste.

6. *Excessive motion*
    - it involves the unnecessary people movement, as the unwanted non-value-adding motion can lead to injuries, with important consequences on employees' health, and loss of time and disability costs to the company;
    - this waste can be handled in Lean management by:
        - implementing the *5S* tool to organise and clean the workplace;
        - using the *Value Stream Mapping* method, to visualise the movement of materials, equipment and employees;
        - doing *Gemba walk* to directly visualise the movement of people and arrangement of equipment and to identify potentially more efficient processes.

7. *Defects*
    - is represented by scrap materials or the materials which are thrown out or which need reworking;
    - this waste can be handled in Lean management by:
        - implementing *Root Cause Analysis* using the *5 Why* method to uncover the direct source of and reason for the problems and defects, and to solve them in the most efficient way;
        - using *Visual Management* to identify immediately the substandard products or processes;
        - applying *Standardised Work* for all the processes to establish the base needed for controlling and observing deviations.

8. Underutilised personnel
    - this category is represented by waste of talent, problem solving thinking and creativity on the organisation's part, as it fails to make the best use of its employees;
    - the employees' knowledge might be an important asset since they are close to their processes and can often recognise problems and improvement opportunities and it would be waste for the companies not to use this potential input;
    - additionally, employees might have some other unexplored talents, which are not part of their assigned jobs, and could be of use to the organisation;
    - utilising to its best potential the loyalty, involvement and knowledge of the employees, could make the difference in a highly competitive business environment
    - causes of this type of waste:
        - an organisation culture type which does not provide the opportunities and time to enable employees to achieve a continuous improvement mentality;
        - increased bureaucracy;
        - a stiff hierarchical organisation, in which employees must follow clear instructions and perform their jobs accordingly;
    - this waste can be handled in Lean management by:
        - teamworking and adequate training;
        - servant leadership which will help employees develop by fostering an environment of trust, commitment and respect, free from punishment;
        - empowering people and creating a sense of pride, involvement and ownership of the conducted work.

2.2.4.2 Construction waste

Construction waste focuses on non-value adding activities which take time, resources and space (Denzer et al., 2015). Identifying and reducing waste is one of the major challenges of the construction industry, in its journey of improvement and development, and it can be defined as "*the activity which absorbs resources but creates no value*" (Josephson and Saukkoriipi, 2007, p. 15). According to Bølviken et al. (2014, p. 3) waste is related both to unnecessary activities and the product itself, defining waste as "*the use of more than needed, or an unwanted output, while value is a wanted output*". Therefore, waste's principal attribute is to consume more resources, equipments, energy, work and time, than is necessary, over and above the wanted value which the customer is willing to pay (Denzer et al., 2015).

To optimise the construction processes, Bertelsen (2002) argues that the waste from non-value adding activities must be identified and eliminated, since there are more non-value adding activities than value adding actives, see *figure 2.5*. Moreover, the construction industry has already been focused on improving the value adding activities, and there is less to be done in this area. The work which is carried out on value adding activies is less than half of that on non value adding activities (Josephson and Saukkoriipi, 2007).

Denzer et al. (2015) found through their research that work activities can be categorised into value adding activities (direct work) and non-value adding activities (indirect work), which can be required (Muda 1) or not required (Muda2). The value adding activities comprise all the necessary activities to transform material according to the customer requirements. The non-value adding activities, Muda, are divided in Muda 1 and Muda 2, since it is argued that there are non-value adding activities (Muda1) which are necessary to perform the value adding ones and without them the works could not be executed. The second category of Muda is represented by activities which are not necessary to enable the value adding ones. The Muda 2 activities can be identified and removed from the process activities.

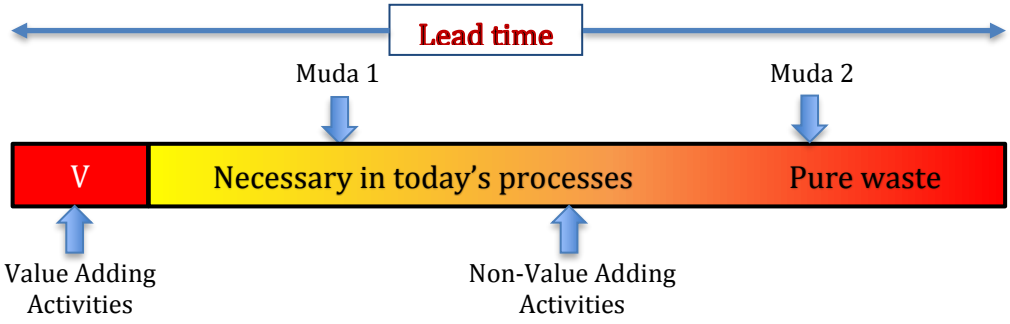

Figure 2.5 Process activities (Wänström, 2017)

Josephson and Saukkoriipi (2007) have grouped construction industry waste into four major sets:

1. *Defects and checks* – is represented by the waste related to hidden or visible defects, resulting in high costs for checks, inspections, insurance. It also included the costs for theft and destruction. This group is estimated to be responsible for about 10% of the production costs;
2. *Use of resources* – includes waste associated with waiting time, machinery not in use and material waste, and it is valued to be around 10% of the production costs;
3. *Health and safety* – comprise the waste which is related with the work-related injuries and illnesses, and the costs which are involved for rehabilitation and early retirement, which can also rich about 10% of the projects' production costs;
4. *Systems and structures* – is un underrated group and consists of waste for long land uses planning processes, extensive purchasing process and high amount of documentation. This waste is responsible for about 5% of the production costs.

The seven (plus one) waste categories identified by Ohno in the TPS production system have been further developed and customised for the construction industry into several more detailed (and not limited to the ones) below, (Josephson and Saukkoriipi, 2007):

- Defects in products
- Storing materials and products that wait to be treated
- Waiting among the personnel
- Activities and sub activities that are not necessary
- Personnel walking around without a clear purpose
- Products and services that do not meet the customer's demands
- Over work – carrying out more work than the customer demands
- Unnecessary movement when personnel carry out their jobs
- Over production – manufacturing or producing more than is necessary or than has previously been needed
- Rework
- Transports of material
- Materials waste
- Work carried out in the wrong order
- Too large work force

These categories of waste production from the construction projects are arranged by Bølviken et al. (2014), according to the Transformation – Flow – Value theory, in the following way, *table 2.5*:

	Transformation	***Flow***	***Value***
Production resource	Materials, machinery, energy and labour	Time	
Type of waste	Material loss	Time loss	Value loss
Wastes	1. Material waste 2. Non-optimal use of material 3. Non-optimal use of machinery, energy or labour	***In the work flow*** 1. Unnecessary movement (of people) 2. Unnecessary work 3. Inefficient work 4. Waiting ***In the product flow*** 5. Space not being worked in 6. Materials not being processed 7. Unnecessary transportation (of material)	***Main product*** 1. Lack of quality 2. Lack of intended use ***By-product*** 3. Harmful emissions 4. Injuries and work-related sickness

Table 2.5 Classification of construction waste from production (Bølviken et al., 2014, p. 820)

According to Denzer et al. (2015) some of these categories, like materials handling, work planning, coordination, health and safety, unloading and packing and rigging, are considered Muda 1, while activities such as reworking, unutilised time, waiting and interruptions, necessary personal time, observable waste, inspections, and others are considered Muda 2 type of waste. In the construction projects direct activities can hold 9.3% to 49.6% from the process activity, while Muda 1 from 13.7% to 45.5% and Muda 2 from 21.6% to 70.4% (Denzer et al., 2015).

Nevertheless, to successfully identify and reduce waste, the first step is to create a broader insight and the ability to judge what are the non-value and value adding activities, to correctly identify the waste, and to make it transparent to all the parties involved in the production process. To create this environment, the organisation will have to invest in the employees' education and training, putting a strong focus on the main processes of the project (Josephson and Saukkoriipi, 2007). Elimination of waste is an outstanding practical tool designed to make sense of effective practices, but it needs an elimination of resistance and a vision to foresee how the best practices should work (Bølviken et al., 2014).

2.2.4.3 Green Lean

Beside the negative implication in company functionality, waste can have also a negative environmental impact and generate greenhouse gases, eutrophication, excessive resource usage, excessive power usage, excessive water usage, pollution, rubbish and poor health and safety, all of which are categorised as the green wastes (Verrier et al., 2016).

Verrier et al. (2016) have identified the following links between Lean wastes and Green ones, see *table 2.6*:

	Lean wastes	**Associated green impacts**
1	*Overproduction*	- Unnecessary use of energy and raw materials, further safety troubles in case hazardous substances are involved, potential increase of direct output emissions
2	*Unnecessary inventory*	- Excessive power usage for heating/cooling/lighting… - Potential extra material used and rubbish production due to added packaging and possible products deterioration
3	*Transport*	- Energy usage in transports - Generated emissions in the air - Special risks in case of hazardous freight (spills…)
4	*Unnecessary motion*	- Potential more space (energy) and packaging (materials) required for unnecessary motions
5	*Defects*	- Waste of raw materials and energy - Management of re-treatments (energy, disposal…)
6	*Inappropriate processing*	- Unnecessary energy and raw materials needed, more rubbish and emissions created, potentially hazardous processes
7	*Waiting*	- Spoiled energy and resources, potential material damages
8	*Lost people potential*	- Lost potential for improvement

Table 2.6 Lean wastes and their associated green impacts (Verrier et al., 2016, p. 153)

2.2.5 Lean construction vs traditional construction

According to the seminar from 2002 held by the Lean Construction Institute, traditional construction is characterised by a series of measures and steps, which consist of: determining client requirements, designing them under Iron Triangle constraints (cost, time and quality); breaking down the project into pieces to estimate the duration and the required resources, bidding and assigning the contracts; starting the project, monitoring and coordinating it under Iron Triangle constraints and safety regulations by holding weekly meetings and a master schedule; and taking action to solve any deviation from the established standards and to seek potential cost reductions by productivity improvements (Daeyoung, 2002).

Therefore, traditional construction projects consist of several separate and individual adding value activities, in pursuit of optimising a specific activity to enhance project productivity and to decrease the costs (Bertelsen, 2002), while Lean treats the entire project as a production system, optimising the entire project, especially by identifying and eliminating waste from the non-value-adding activities (Howell, 1999).

In the *table 2.7*, Daeyoung (2002) summarises the differences between Lean construction and Traditional construction, in terms of control, optimisation, scheduling, production system and processes, performance measurements, customer satisfaction, planning, uncertainty, coordination and goal supervision, following the discussions from the Lean Construction Seminar held in 2002.

	Lean Construction	**Traditional Construction**
Control	Causing events to conform to plan – Steering	Monitoring against schedule and budget projections – Tracking
Optimization	The entire project	A specific activity
Scheduling	· "PULL" work schedule · Based on when its completion is required by a successor activity	· "PUSH" work schedule · Based on emphasizing required start dates for activities
Production System	Flow production system	Conversion production system
Production Process	Effectiveness	Efficiency
Performance measurement	Percent Plan Complete (PPC)	WBS, CPM, Earned Value
Customer satisfaction	Successor process satisfaction	Owner or final consumer satisfaction
Planning	Learning	Knowing
Uncertainty	Internal	External
Coordination	Keeping a promise	Following orders
Goal of Supervision	Reduce variation & Manage flow	Point speed & Productivity

Table 2.7 Differences between Lean and Traditional (Daeyoung, 2002, p. 15)

In traditional construction, to reduce costs or to avoid and mitigate the delays it is required to increase productivity, but this will not bring big changes and can even reduce the overall project performance (Daeyoung, 2002). The absolute process time of an activity, which is the value adding activity, is about 25 % of the activity total task time, and the remaining 75% represents waste time which results from activities which do not create any value to the final product (Lajevardi et al., 2011).

Figure 2.6 highlights the lead time savings by comparing traditional construction with the Lean construction. By focusing on improving the value adding activities, the gain to the lead time is quite small, whereas by identifying and eliminating waste from the non-value-adding activities the lead time gain is quite significant.

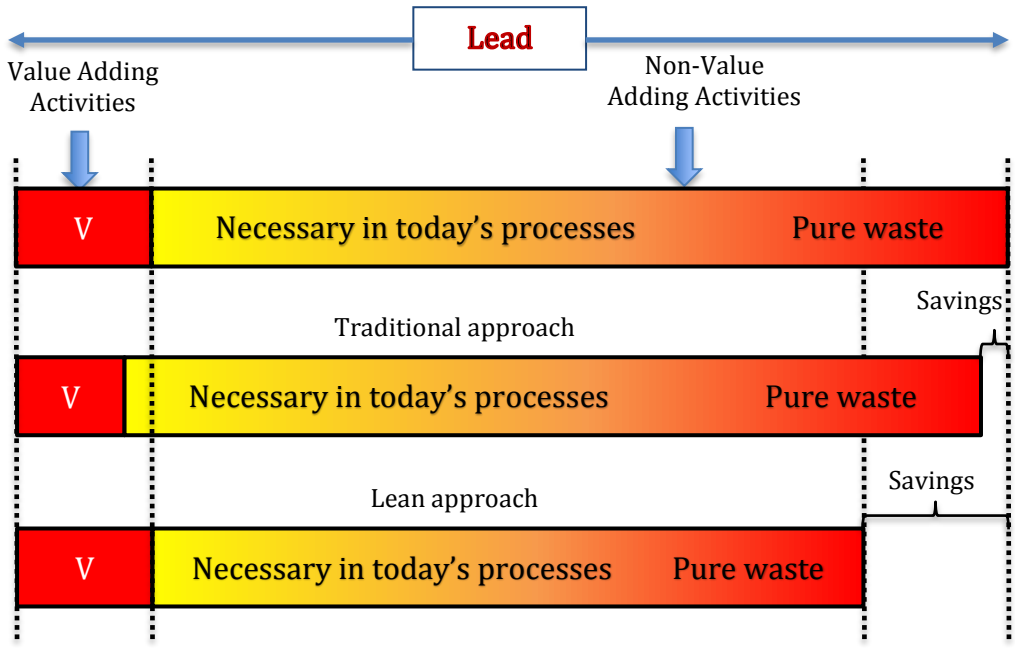

Figure 2.6 Differences between Lean and traditional construction with the focus on eliminating waste activities (Wänström, 2017)

2.3 General considerations when developing Lean

Regardless of industry or country the companies operate in, many of them have failed to implement *Lean Philosophy* and really become Lean organisations, as usually Lean was seen as a set of tools used to improve different processes or to remove waste (Lander and Liker, 2007) and all human aspects and their implications for productivity and work performance were neglected (Hines et al., 2004). Companies have seemed to disregard the TPS "blood flow" which is represented by the philosophies and strategies that create "*the buy in and engagement of the people*" to run smoothly an elaborate system such as Lean philosophy (Liker et al., 2008).

Applying Lean tools mindlessly – without taking into consideration the local culture and without building a new one, strong enough to integrate the new way of Lean thinking – is doomed to failure (Krafcik, 1988). The process must be sustained by a long-term strategy of investing in people and building a culture, to truly have a respect-for-people philosophy, to develop them in order to foster a continuous improvement environment (Liker et al., 2008).

In most cases it will take years, even decades, until the corporation will succeed in fully integrating the Lean philosophy, as it is a slow, hard and time-consuming process to change how people think and act on an everyday basis, in one word called *culture* (Liker et al., 2008). Even at Toyota, a newly founded plant is protected and helped to grow just like a "*baby*", and in the beginning there are no financial pressures, the focus being mainly on building the desired culture which will support the Lean tools (Liker et al., 2008).

It is observed that organisations tend to go Lean or at least try especially in condition of crisis, when the current managerial styles do not perform anymore (Höök et al., 2008). By implementing Lean philosophy into an organisation, the process speed is doubled or even tripled, costs are decreased by reducing waste , employees are transformed into quality inspectors by empowering them and by creating a high level of quality culture (Liker et al., 2004), which can even have a positive environmental impact (Verrier et al., 2016).

The key for Lean philosophy success is to use the right combination of process foci, to have long term and problem solving thinking, and above all to implement a respect-for-people strategy (Liker et al., 2004).

2.3.1 Strategies

According to Zanotti et al. (2017) there are two main strategies for implementing Lean, a top-down strategy and a bottom up one. The top-down method is pushed by the senior management into the organisation and it cannot be successful if it has not obtained the engagement of all stakeholders in the organisation to pursue through the entire Lean transformation. Another mistake in carrying out this approach is the lack of deep involvement from the top managers side, as they avoid doing *Gemba walks* and *Genchi Genbutsu* (go and see) on the actual projects, among the workers who perform the construction activities (Valente et al., 2012). These two values are an essential part of the Lean philosophy, which contributes to establish the required Lean culture (Liker et al., 2008).

Fujio Cho, one of the presidents of the Toyota Motor Corporation, has clearly stated that one cannot take some tools apart from the Lean philosophy and expect to become Lean, "*the key to the Toyota Way and what makes Toyota stand out is not any of the individual elements.... But what is important is having all the elements together as a system. It must be practiced every day in a very consistent manner not in spurts*", (Liker et al., 2004, p. 12).

The second approach proposed by Zanotti et al. (2017) is the bottom up strategy, which implies that the workers, by performing specific work routines, will create a work culture which can foster the Lean tools.

However, both methods have their importance, as the top-down approach allows management to develop and implement a long-term and efficient strategy, while the bottom-up one sends the right signals to the top management to follow (Verrier et al., 2016).

2.3.2 Barriers and success factors

In 2007, the Lean Enterprise Institute performed a study which identified the main barriers to the Lean implementation. These are represented by middle management, supervisors and shop floor workers, see *figure 2.7*, as there are many cultural and human difficulties and differences, which must be considered during transformation (Zanotti et al., 2017). The lack of top management commitment and general misunderstanding of Lean philosophy contributes as well to an unsuccessful implementation. According to (Valente et al., 2012), top managers do not have time to walk through the site periodically, to assess the existing situation, to identify problems and to create an organisational culture which will sustain the Lean tools.

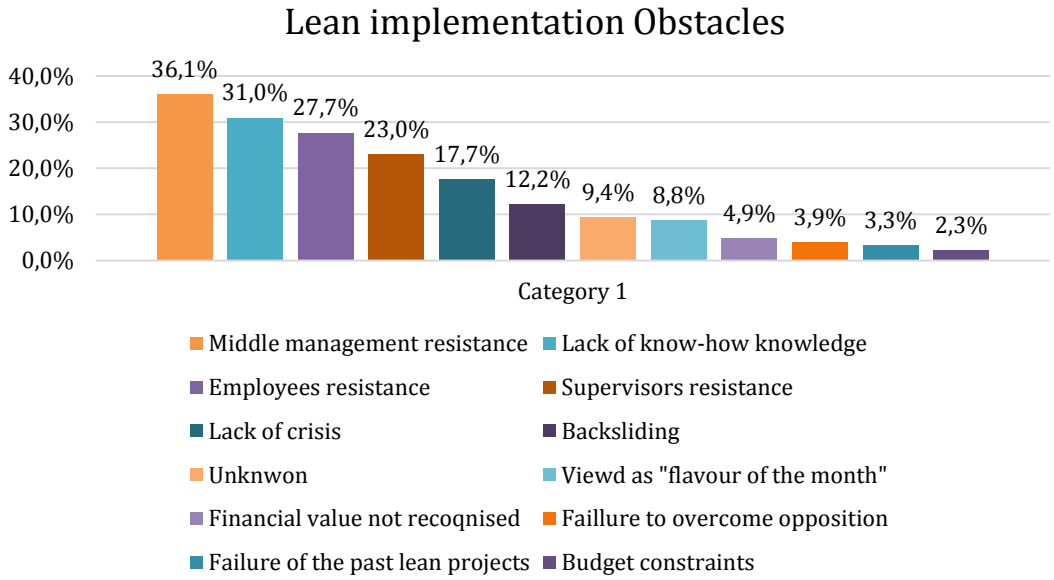

Figure 2.7 Obstacles to lean implementation (Zanotti et al., 2017)

Moreover, even the basic understand of Lean tools, like waste elimination is hard to be understood and assimilated by the construction industry, as the general culture is to focus on optimising the value-adding activities, instead of identifying and eliminating waste from the non-value adding activities, which represent more than two thirds of the workers' working time (Bertelsen, 2002).

Cano et al. (2015), through their study of the existing literature, have identified 110 barriers and 51 critical success factors in the implementation of Lean in the construction industry, which they grouped into six master groups: people, organisational culture, external and internal value chain, supply chain and externalities. Once again, the findings revealed that people and organisational structure are the first two main categories which influence the Lean journey in an organisation.

Table 2.8 shows, according to Cano et al. (2015) research, the critical and success factors extracted from the literature review and also from studies conducted in construction organisations.

<table>
<tr><th colspan="8">I. Findings from the literature review</th></tr>
<tr><th>Barriers</th><th colspan="4">People</th><th colspan="3">Organisational culture</th></tr>
<tr><th>Categories</th><th>Education and training</th><th>Top management</th><th>Operation</th><th>Attitude and culture</th><th>Philosophy</th><th>Resources</th><th>Structure</th></tr>
<tr><td>Success actions</td><td colspan="7">- adequate training and education
- deep understanding of the Lean Way
- support and commitment from the top management
- effective leadership
- elimination of waste culture
- clear definition of roles, responsibilities, functions and levels of authority
- selection and development of the right people
- collaboration, transparency, honesty and trust
- people motivation to change and embrace Lean,
- discipline
- respect for authority
- closer relationship between academia and industry
- setting process goal for the short and long term
- full implementation of the selected Lean tools,
- incorporation of pilots testing,
- more focus and attention to customer needs,
- solution to the root of the problems.
- management to provide adequate resources to support for the cultural transformation
- active involvement of all stakeholders
- constitution of an improvement committee responsible for the implementation,
- incorporation and sharing of knowledge learned,
- reduction of hierarchical levels</td></tr>
<tr><th colspan="8">II. Finding from the site studies</th></tr>
<tr><td>Barriers</td><td colspan="7">- difficult to identify the right people for Lean implementation
- difficult to identify and control of waste
- the results are not fast, and often only partially visible
- social problems and poverty
- the informality culture of the local industry.
- individuals lack initiative and self-esteem</td></tr>
<tr><td>Success actions</td><td colspan="7">- taking decisions collectively in teams
- labour reduction turnover at all hierarchical levels
- continuity of workforce in projects.
- improvement of workers life's quality
- establishment of a continuous process to measure losses
- facilitate socialization among individuals
- plan and think ahead
- generate confidence in Lean principles
- persistence in cleaning and maintaining order.</td></tr>
</table>

Table 2.8 Obstacles to lean implementation (Cano et al., 2015)

For example, when Toyota Motor Corporation is considering expanding its business around the world, it takes into consideration, besides the logistics and financial advantages, the existing cultural background of the considered area, the local people typology and their openness to learn and follow Toyota's values and principles, the *Toyota Way*. This process can be different from place to place as even local cultures can vary, and it is desired to develop a new culture, based on the already existing one, which can embrace and foster the Lean tools (Liker et al., 2008).

Furthermore, for an organisation to become Lean, it will need to achieve a higher degree of contingency, the main focus being on facilitating learning inside the organisation and achieving the ability to "*learn how to learn*" (Hines et al., 2004). To achieve organisational change, therefore to transform and to adapt into a Lean organisation, the goal is to develop a *Learning Organisation, "to facilitate the learning of all its members and continuous transform itself"* (Hirota et al., 1999).

Therefore, besides finding the right solution and fixing the revealed problems, by using the right Lean tools, Toyota gives a high importance to the process of finding the problems, to create the right and supporting environment and culture, and more to learn in a continuous manner from all mistakes. This process involves not only the employees, but also the customers, suppliers and even competitors, and Toyota often takes part in joint ventures like NUMMI (New United Motor Manufacturing Inc.) with one of its biggest opponents General Motors (Liker et al., 2011a).

According to Cano et al. (2015), it can be summarised that the main barriers, which are encountered when Lean philosophy is implemented in the construction industry, are:

- cultural problems;
- lack of stakeholders' involvement;
- lack of training, knowledge and understanding of Lean philosophy;
- resistance to change of the both managers and workers;
- traditional organisation and way to conduct work;
- lack of commitment to continuous work and of a proper attitude toward Lean;
- insufficient and inadequate planning.

To successfully implement Lean, a series of success factors are proposed, such as:

- achieve the stakeholders' involvement;
- increase cooperation, motivation, coordination, honesty and trust among the employees;
- overcome resistance to cultural change and change the mind set;
- teamwork, effective leadership and selection and development of the right people;
- adequate training and education.

During implementation endeavour of Lean management principles and tools, small and medium size companies can follow a set of guidelines proposed by Bakås et al. (2011) in their study:

- *Ensure a strong management involvement*, as without management support continuous improvement projects cannot succeed. Moreover, management support has a high impact:
    - on the time allocation - to free up time for workers to undertake continuous improvement work;
    - on the employees' motivation - in small and medium size companies, management has a more closer relationship with the employees, having a direct impact on their motivation or demotivation;
    - on small investments - small and medium size companies do not usually have allocated a budget for big investments, and financial support must be offered to provide the necessary materials, equipment, tools, services for the continuous improvement projects;
- *Obtain employee's involvement*, as without employees strong believe in continuous improvement work the change cannot take place. It is important that in the implementation process the right amount of people to be involved and then the knowledge to be spread all around the company;
- *Ensure sufficient time for deployment*, as most often small and medium size companies prioritize their work according to their urgency. It is important to allocate time, week after week, for continuous improvement projects, since they represent a constant priority in the implementation journey. Moreover, by optimising activity processes, time will be freed up, and the additional time can be used in future improvement initiatives;
- *Keep motivation for implementation on a high level*, as the culture of "firefighting" (solving problems only when they become serious) initiate an improvement project only when it becomes urgent. To overcome this problem, "external eyes", such as knowledgeable partners or peer companies, should be used to impose an external pressure of following up the improvement projects.
- *Keep an open mind towards new changes,* as the overall aim is to create a true mind-shift of the employees' attitude towards a culture of continuous improving, solving problems and find and eliminating various forms of waste from the work activities.
- *Implement, in parallel, performance evaluation systems*, such as visual indicators and KPIs, to help the employees to assess continuously their work performance, efficiency and quality, and to be able assess the positive or negative impact of their improvements.

In order to simplify the process of Lean implementation into an organisation, Mather (1988) proposed a basic model, a set of six steps, which the organisation can undertake in order to prepare itself to adopt Lean:

i. Reduce complexity by simplifying the working environment;
ii. Introduce more simple and effective institute control systems;
iii. Develop a long-term thinking;
iv. Train the right personnel with the right skills;
v. Reshape organisational structure to take smarter decisions with faster results;
vi. Assign responsibility and accountability.

2.3.3 Culture

While the tools are considered to be the "*easy part*" of conducting a business, the intrinsic values, how people think, act and interrelate on an everyday basis is the challenging and "*hard part*", as there are many and different interpretations of the culture concept (Liker et al., 2008).

The research about culture is complex, approaching diverse dimensions, as it can refer to the appreciation and understanding of music, literature, food, art etc., or can comprise the full range of learned patterns of human behaviour (Hofstede et al., 2010), or can have a national dimension as the one described by Hofstede, or an industry one and an organisational one (Schein, 2017). Through culture human beings give meaning and relate to their work and, in fact, to any kind of social processes (Jørgensen et al., 2004).

2.3.3.1 Definition

Every person during their personal life develops patterns of thinking, feeling and acting, which are learned from early childhood within their social environment and life experiences. Schein (2017, p. 6) gives the following definition of culture as being "*the accumulated shared learning of that group as it solves its problems of external adaptation and internal integration; which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, feel, and behave in relationship to those problems. This accumulated learning is a pattern or system of beliefs, values, and behavioural norms that come to be taken for granted as basic assumptions and eventually drop out of awareness*".

This culture is deeply imbedded in how group members act, think, perceive and make sense about things and situations around them, according to their biases, basic assumptions and beliefs. Culture is not easy to identify, as it is not displayed on the surface, but on a hidden and often unconscious level (Schein, 2017). It is more likely that someone will know when they are breaking the cultural norms, than to know when they are using and practise those norms (Clegg et al., 2011). Culture can only *exist between persons* (Alvesson), and must be studied only connected to the context in which occurs (Jørgensen et al., 2004).

2.3.3.2 Organisation culture

Organisation culture consists of all deep and basic assumptions, beliefs and shared values, that shape the decision making process, organisational membership, and translating finally in the presentation of form to other organisations (Clegg et al., 2011). It represents the organisation's *personality*, the basic assumptions, practices and values which are imbedded and practiced by the organisation members and transmitted to new members as the ground rules to follow (Schein, 2017). The organisational culture can be defined as "*the shared rules governing cognitive and effective aspects of membership in an organisation, and the means whereby they are expressed*" (Jørgensen et al., 2004).

According to Schein (2017) there are three levels of culture, illustrated by a circle representation, *figure 2.8*:

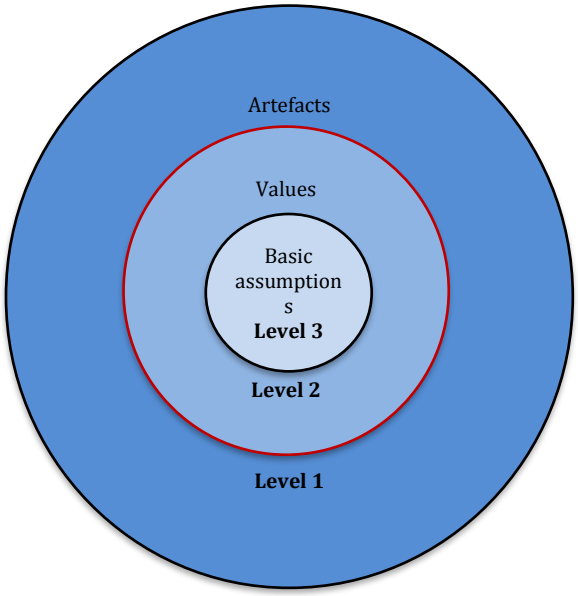

Figure 2.8 Levels of culture (Schein, 2017)

Level 1 consists of **artefacts**, which are seen at the surface level i.e. physical structure of the workplace, the architecture of a building, written documents, uniforms, interior and exterior design, etc. These are easy to observe but they are difficult to decipher as they do not communicate the entire information about the organisation's culture.

Level 2 consists of **beliefs and values**, the espoused values, which are at the second, much deeper level and represent a non-visible part of the norms and beliefs which employees express i.e. ideals, goals, values, aspirations, ideologies, statements, rationalisations, etc. They embody the basic rules of behaviour, generally accepted, and usually they are not written down or have an explicit form. They give information about what is or what is not acceptable to say, to behave, to dress, to be late and so on.

Level 3 consists of **basic underlying assumptions**, which is the deepest, most important and influential level, beneath artefacts and expressed values, and includes the basic assumptions that shape the people's beliefs, worldviews and norms. These are not explicitly articulated, in general people being unware of their existence, and they manifest at a subconscious level. These beliefs and values are taken for granted and they determine in a surreptitious way people's behaviours, perceptions, thoughts or feelings.

2.3.3.3 Japanese culture vs Western culture

One might argue that the Toyota Way cannot be replicated in other cultures, especially in western ones, due to the cultural differences between the Japan and western countries. Certainly, cultural values shared by the *Toyota Way* and the Japanese nation, like long term thinking and collectivism, are in contrast with western world values based on individualism and short term thinking (Liker et al., 2008). In western culture the focus is on the role of the individual and especially, in the construction industry, there are highly appreciated personal qualities and power traits (Jørgensen et al., 2004).

Additionally, from a geographical point of view, the Toyota way was established and developed right in the "heart" of the Japanese nation, in the Aichi prefecture, by Japanese people, like Toyota's founder, Kiichiro Toyoda, and Eiji Toyoda, his cousin and successor or Taiichi Ohno, the father of TPS (Liker et al., 2004). Kiichiro Toyoda set the core values of the Toyota principles even from the company's foundation, one of his remarkable statements being "*everyone should tackle some great project at least once in his life… You should make effort to complete something that will benefit society*". He was himself a very creative and innovative person, hardworking and never afraid of getting his hands dirty, desiring to contribute to the whole society, inspiring therefore his successors and employees (Liker et al., 2008).

Nevertheless, there are examples of western organisations which have been successful in applying Lean and becoming Lean organisations, while some Japanese companies have failed in applying Lean thinking (Krafcik, 1988). The *Toyota Way* core values are a "*unique combination*" between the Japanese cultural values and the vision and mind set of the company's founder and of all the other people who succeed him in the organisation (Liker et al., 2008). Therefore, it can be concluded that the Japanese culture can, due the cultural background, nurture the Lean Philosophy much easier compared to Western countries, where a great deal of adaptation is needed (Liker et al., 2004).

2.4 Romanian context

2.4.1 Construction industry

The construction industry plays an important part in the economic development and growth of any European country, as it is the major industrial employer from Europe, with the largest economic activity, representing more than 10% from the European gross domestic product (GDP), and in Romania it varies from 8% in 2011 to 6% in 2014 (Rabontu, 2016). In the year 2010 official records indicate that 705,000 people were employed in the construction sector, representing 8% from the total employed personnel (Meekel et al., 2011).

The maximum values of construction sector from Romania were registered in 2008, and from the third quarter of 2008 until 2012, the construction sector recorded a collapse of the market due to the global recession, the upward trend being recorded again only in 2012 (Rabontu, 2016, Simion-Melinte et al., 2015).

An interesting characteristic of the Romanian construction industry is that the construction business is carried out, in a high percentage, by numerous small to medium size companies with a relatively small number of employees, and with small financial power, 40% of them declaring negative financial results between the period 1994 and 2014 (Rabontu, 2016). However, the small and middle size business represents the foundation of a well-functioning economy, and even larger companies rely on small and medium companies to ensure their good functionality (Bakås et al., 2011).

2.4.1.1 High skilled workers migration

One of the major problems which the construction sector from Romania is facing nowadays is the migration of the experienced workers to other European countries, problem which affects the quality of the works as inexperienced workers are employed, without any training (Simion-Melinte et al., 2015). To overcome this problem Simion-Melinte et al. (2015) propose several solutions for the construction companies to use and train the employees, such as:

- Specific trade courses organised by the employer or training providers;
- Traineeships to find the right job vocation;
- Apprenticeship organised directly on the work place.

2.4.1.2 Health and safety culture

Another important problem, which exists in Romanian construction industry, is the culture towards health and safety, most of accidents being attributed to unsafe work practices of the construction workers, as they have their own perception about risks and safety rules and procedures (Meekel et al., 2011). In 2011 the accident rate was of 1.82 injured persons at 1,000 employees, which is the second highest in the accident statistics, the first one being from the mining industry (Meekel et al., 2011). Moreover, the fatal accidents rate in 2011 in the construction sector was nearly 12 workers per 100,000 employees (Meekel et al., 2011).

To improve health and safety in the construction sector, Meekel et al. (2011) suggest that rules and regulations must be enforced on sites, managers to play an active role, to introduce safe working systems, to increase awareness between the workers and to train them.

2.4.1.3 Work environment

Due the limited information found in the academic papers, through the used research sources, about the work environment and culture from the Romanian construction sites, a framework for the thesis Romanian construction context will be established by the thesis's author using his own work experience.

Therefore, the construction sites from Romania, might be characterised by a powerful masculine culture, where women are encountered especially in administrative or HR positions. Another characteristic of the Romanian site culture might be the fire-fighting culture, where problems are solved only when they become serious, affecting work progress and flow.

However, workers show a high level of problem solving skills when problem arise on sites, being able to find adequate technical solution to solve them. Despite these skills, workers show in general a high level of careless and interest when conducting works, being lazy and sometimes showing a lack of responsibility for their own work. There is almost no culture of getting the quality right, workers preferring to hide their errors and quality problems in front of their superiors and even of their co-workers.

Moreover, the construction industry, and even other industries, face a major problem of alcoholism during the work schedule, even if it is forbidden according to Romanian laws. A rough estimation will be that around 20% to 30% of the workers from the construction sites will drink during the working hours. This represents a major problem as accidents and injuries can occur due to this behaviour. Depending on Site Engineers and project management interest and way of conducting works, this problem is considered and treated in a more or less serious way.

Often, the construction sites might show a poor site organisation, without proper changing and food areas. On site, waste and constructions materials are stored all over the place, without following any rules or principles. Another negative trait of the construction sites might be the lack of cleaning and order on sites, workers failing frequently to clean after their own work and collect the resulted waste materials. Site Engineers and foremen usually might address to their workers by yelling and using trash talking, showing now consideration or respect to them. Sometimes, workers might be punished for their actions with pecuniary measures.

Nevertheless, the construction workers show a high acceptance to rules when are implemented on sites, even if they dislike them or they tend to resist the change. Some of them even prefers to work in such environments with strict rules and instructions, as they know clearly from beginning what they are allowed or not allowed to do.

2.4.2 Lean in the Romanian industries

Through the thesis research methods, there were found only a few examples of Lean management implementation in the Romanian companies from manufacturing industry. There have not been found, through the mentioned sources, any study regarding Lean management implementation in a construction company from Romania.

Nevertheless, even if Lean management is implemented on a small scale and only in manufacturing companies, all the studies promoted the advantages and benefits of Lean, being a good option for long term growth and competitiveness, and it could be extended also to other industries (Marinescu and Toma, 2008, Grigore and Cioana, 2013, Vais et al., 2006).

Therefore, by implementing Lean management in a manufacturing company, Marinescu and Toma (2008) have found that the work productivity was increased with 30%, the lead time was decreased by 40% and the production time was decreased by 20%. In the same time the work area was decreased and waste from non-adding value activities was reduced in a significant manner. Moreover, Marinescu and Toma (2008) concluded that employees' involvement increased considerably, the leadership style changed in one of consultation and participation, and the organisational culture was characterised now by a strong team work and discipline.

Furthermore, Vais et al. (2006) showed in their article the benefits on the environment by apply Lean management, as the company succeeded to reduce their amount of waste water with 83%. The main tools applied in this company from Lean management were Kaizen (creating a continuous improvement environment), 5S (cleaning and maintain order), total productive maintenance (ensuring the machineries capabilities to produce without interruptions), just-in-time (producing what is need when is needed) and total quality management (focusing on processes which will lead to an increased quality, a better environment and health and safety practices).

Iuga and Kifor (2014) argued that no matter of the industry where Lean management is applied, considerable improvements can be obtained, depending on the activity specific and cultural differences.

3 METHOD

The following chapter explores the methodology and procedures used to conduct the research and data analysis, needed to answer the research questions. Ethical consideration and research limitations are also identified here.

3.1 Research approach

Since the problem of studying and identifying the barriers and success factors for implementing and developing a Lean culture, which will enable the Lean management tools, was unknown to the author when research for this paper started, a qualitative abductive approach was used to conduct the study. This abductive process allows for a simultaneous development of the theory framework and empirical data collection, with the theoretical framework being developed, adapted and changed to complement the empirical findings (Dubois and Gadde, 2002).

To meet the aim of the paper, to assess how a Romanian construction company might adapt and implement the Lean management cultural prerequisites, this research was conducted following three steps:

The first step in conducting this research was to study and review the academic literature to build a theoretical framework of the chosen topic. The focus was to study Lean management concepts and principles, the construction industry's traditional state, the barriers and success factors for Lean implementation in the construction industry, the cultural aspects required to sustain Lean management in the Toyota Motor Corporation and finally their applicability, adaptability and implementation within the construction industry. In this context, the interview questions were designed, considering the theoretical findings and the cultural context of the Romanian construction market.

The theoretical information was gathered and accessed through online web sites and search engines such as Chalmers Library, Google Scholars, International Group for Lean Construction (IGLC) and the Lean Construction Institute, using keywords such as 'culture', 'lean', 'construction', 'change', 'barriers', 'waste', 'green', and 'Romania'. Moreover, the literature recommended in the courses 'Lean management', 'Construction, processes and management', 'Leadership' and 'Urban metabolism' also contributed to the theoretical framework. Detailed research was conducted on the concepts and principles of Lean management, waste, culture and traditional construction, with around 97 articles, 11 books, 8 master theses and 4 PhD theses, from a quantity of more than 700 downloaded documents, being selected for study.

The second step was the collection of the empirical data, through semi-structured interviews, discussions and direct observations. The research focused both on a bottom-up and top-down approaches, the data being collected from one middle size construction company from the Romanian market. The data was used to investigate the current state of collaboration, cooperation and working between the employees, their degree of satisfaction, and their likelihood to change and adapt to the Lean culture prerequisites.

The third step was to analyse the empirical data through the theoretical data lenses and to answer the research questions. Solutions were proposed after reaching the conclusion and the discussion made.

These steps where not necessary clearly delimitated, sometimes they overlapped and even reiterations were made to one step or another according either to the theoretical or empirical findings. Furthermore, even though the main purpose of the thesis remained unchanged, the research questions and the title of the thesis were changed three times in the elaboration period, and not until the end of April, were they finally defined after all the interviews were conducted and most of the theory had been studied.

Moreover, adjustments and corrections have been also made as a result of the supervision meetings and reiterations. Guidance was sought on a periodical basis from the supervising teacher from Chalmers University, in the peer review and opposition meetings, and in the master thesis seminars which were held by the Construction Management department.

3.2 Qualitative research

For conducting this master thesis, a qualitative research method, with interviews and observations, was chosen. This method is appropriate for investigating "*people's meaning and understanding in the construction of their social world* " (Bryman et al., 2011, p. 68), and for understanding "*qualities, or essential nature, of a phenomenon with a particular context*" (Brantlinger et al., 2005), while the researcher must remain objective through the entire process (Taylor et al., 2016).

Therefore, the qualitative research focused on colleting and gathering empirical data from the words and points of view of the participants, from visual data and, from the active involvement of the researcher (Bryman et al., 2011), to understand the interviewees' perspectives of the chosen topic, how the participants made sense of their working environment, giving therefore meaning, interpretation and description (Hanson et al., 2011).

3.2.1 Establishing the research questions

To frame the research questions, the desired topic of the thesis and the background motivation was taken into consideration. The research questions focused the research in a clear direction, creating a "what, why and how" framework (Bryman et al., 2011, p. 12, Brantlinger et al., 2005, Taylor et al., 2016, Mason, 2002).

The research questions were formulated in the context of finding information about the Lean cultural prerequisites and how, if possible, a Romanian construction company could implement them. Implementing Lean tools and culture will improve the work environment and employees' satisfaction, having a direct influence on work efficiency and waste reduction, no matter what its form, given, therefore, the major concerns regarding the inefficiency of the construction sector and its negative environmental impact. These thoughts were framed and honed after taking the master program courses and in the special courses 'Lean management', 'Construction, processes and management', 'Leadership' and 'Urban metabolism'.

The theoretical information provided by these courses was extremely interesting, triggering new questions and ideas about how to improve and develop the construction industry's current ways of doing business, and to contribute to creating a sustainable environment. Additionally, since the academic literature about Lean in the Romanian construction industry is limited, this thesis seeks to contribute to the academic literature with new information and findings.

3.2.2 Company selection

The Romanian construction industry was chosen as a study background for this thesis as a result of a desire to learn more about it, through personal familiarity with the work environment and relations between employees and companies. Moreover, the author has previous work experience in Romanian construction industry and this thesis represented an opportunity to take an academic approach to his accumulated practical knowledge.

The study company was selected as the author has former work experience with them, especially with the top management level, being familiar to some extent with their work practises, and he was motivated to discover more information, now from an academic viewpoint, about work relations inside the company in the context of Lean management cultural prerequisites. Since the company's employees and top management had no knowledge of Lean management, the use of the word 'Lean' was avoided in the interview process.

3.2.2.1 Company data

The collection of the data was conducted at Mitre Building Construction (MBC), a Romanian construction company, which operates all over the country and has, as well, a few small international projects in countries from European Union countries such as France, Portugal and Germany.

This company started as a small finishing company, being set up in the year 2000 by the owner of the company, who has a construction engineer bachelor's degree. Nowadays, the company conducts small to medium construction projects, mainly as a general contractor, and has gained trust among partners and clients, and enough financial stability to sustain its contracts' economic requirements. Moreover, the company has built trustful and collaborative relations with different sub-contractors, especially in the plumbing and electrical sector, working with them almost on a permanent basis for all its contracts.

Most contracts are gained either through direct attribution from clients, due to the long-term relationship which the company has created with them by demonstrating reliability, trust, good quality work and by keeping to agreed time schedules, or through bidding actions. The owner of the company has avoided working with the public authorities, focusing on private companies, with whom he tried to cultivate long-term relationships.

According to ListaFirme (2018), the company's financial data, such as turnover, net profit, debts, fixed assets, current assets and equity, are provided for a period of ten years, from 2007 to 2017, in *tables 3.1* and *3.2*. In *table 3.1* values are expressed in the Romanian currency, RON, while in the *table 3.2* the values are expressed in the currency of the European Union, EUR. The exchange rate considered for the conversion was of 1 EUR = 4.6288 RON, which was the value given by the Romanian National Bank on 25th May 2018 (BNR, 2018).

Year	Turnover (RON)	Net profit (RON)	Debs (RON)	Fixed assets (RON)	Current assets (RON)	Equity (RON)
2017	8.558.629	1.809.833	1.924.783	3.399.773	1.225.951	1.825.899
2016	6.618.527	1.695.129	3.031.526	2.637.104	2.757.887	1.709.164
2015	5.063.695	415.461	1.944.633	2.531.859	2.658.598	1.826.665
2014	28.818.658	278.588	5.612.747	5.764.226	3.822.605	2.123.585
2013	28.071.747	114.775	2.396.445	3.791.998	1.191.481	1.938.033
2012	8.979.287	100.147	2.634.421	2.949.497	1.491.416	1.823.258
2011	6.017.896	26.565	2.501.669	3.162.735	1.125.045	1.848.111
2010	23.201.768	1.045.330	3.263.757	3.140.114	2.498.413	2.411.046
2009	15.744.458	1.012.678	4.777.782	2.319.728	4.065.715	1.615.716
2008	11.619.564	965.038	847.994	1.577.175	637.122	1.104.850
2007	1.007.799	134.812	258.390	97.793	300.409	139.812

Table 3.1 MBC's financial data (RON)

Year	Turnover (EUR)	Net profit (EUR)	Debs (EUR)	Fixed assets (EUR)	Current assets (EUR)	Equity (EUR)
2017	1.848.995,20	390.993,99	415.827,64	734.482,59	264.852,88	394.464,87
2016	1.429.858,06	366.213,49	654.926,98	569.716,56	595.810,36	369.245,59
2015	1.093.954,16	89.755,66	420.116,01	546.979,56	574.360,09	394.630,36
2014	6.225.945,82	60.185,79	1.212.570,64	1.245.295,97	825.830,67	458.776,57
2013	6.064.584,13	24.795,84	517.724,90	819.218,37	257.406,02	418.690,16
2012	1.939.873,62	21.635,63	569.136,93	637.205,54	322.203,59	393.894,31
2011	1.300.098,51	5.739,07	540.457,35	683.273,20	243.053,28	399.263,52
2010	5.012.480,12	225.831,75	705.097,87	678.386,19	539.753,93	520.879,28
2009	3.401.412,46	218.777,65	1.032.185,88	501.151,05	878.351,84	349.057,21
2008	2.510.275,67	208.485,57	183.199,53	340.730,86	137.643,02	238.690,37
2007	217.723,60	29.124,61	55.822,24	21.127,07	64.899,97	30.204,80

Table 3.2 MBC's financial data (EUR)

Figure 3.1 plots variations in the company's profit and shows an increasing profit over the last 6 years, even though the company's turnover has fluctuated, as shown in *figure 3.2*. It is observed that there was a substantial increase in profit for the years 2016 and 2017, and that fixed assets reached a maximum value in 2014, the same as the company's turnover.

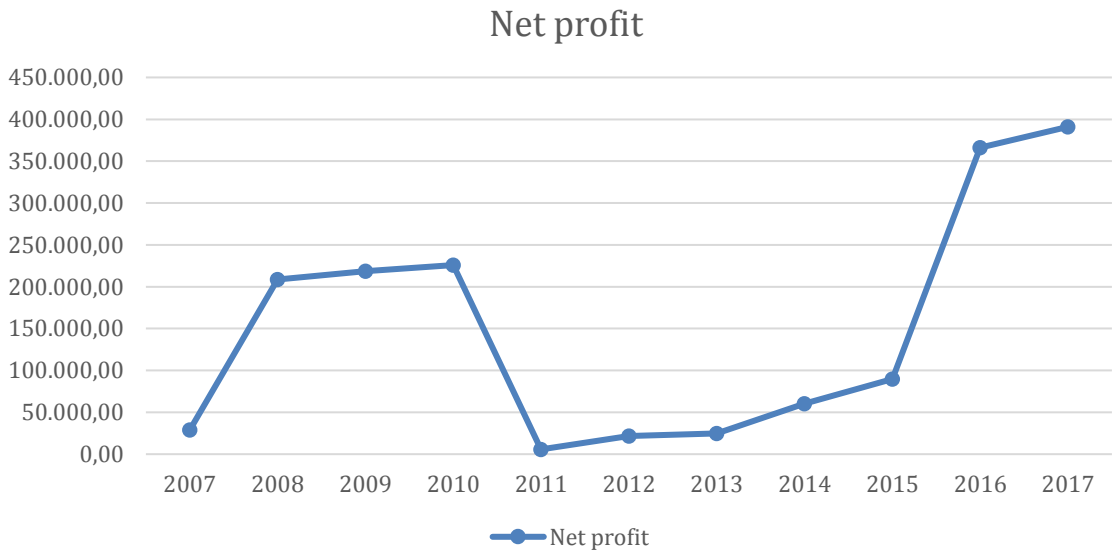

Figure 3.1 MBC's profit between 2007 and 2017

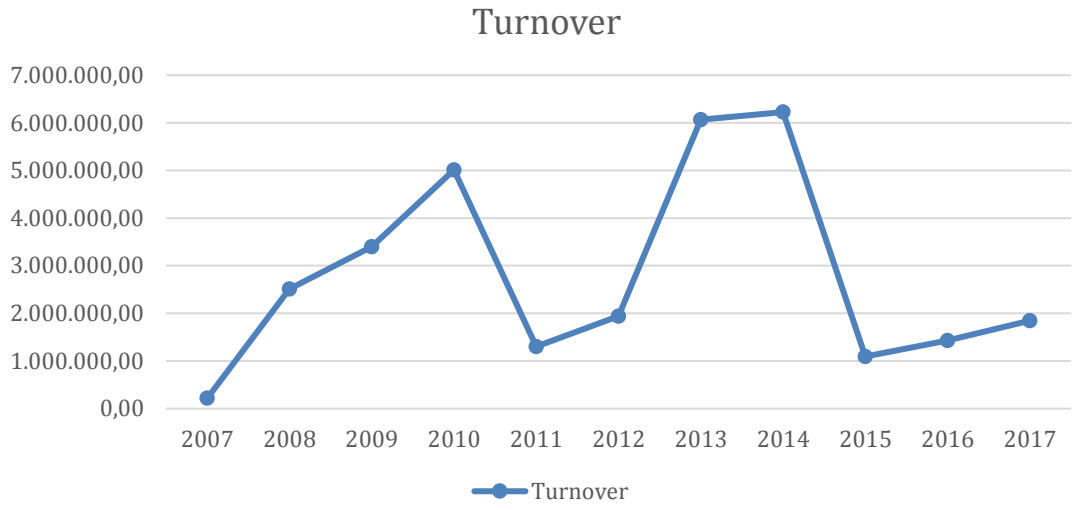

Figure 3.2 MBC's turnover between 2007 and 2017

Currently, the total number of employees in the company is 38 regular workers, number which sometimes increases by leasing workers from other partners, if the project size and the short execution times necessitates such measures, 2 site engineers, and 5 office employees based in the Bucharest headquarters, doing the administrative work. From a hierarchical point of view, the site engineers and administration office have a collaborative relationship, being directly subordinated to the owner of the company, who takes all the major financial and non-financial decisions.

The average number of regular workers between 2007 and 2018 was of 30 employees per year. *Figure 3.3*, shows the year-on-year variations in the number of employees in the company, starting with the year 2007 until 2018 (ListaFirme, 2018).

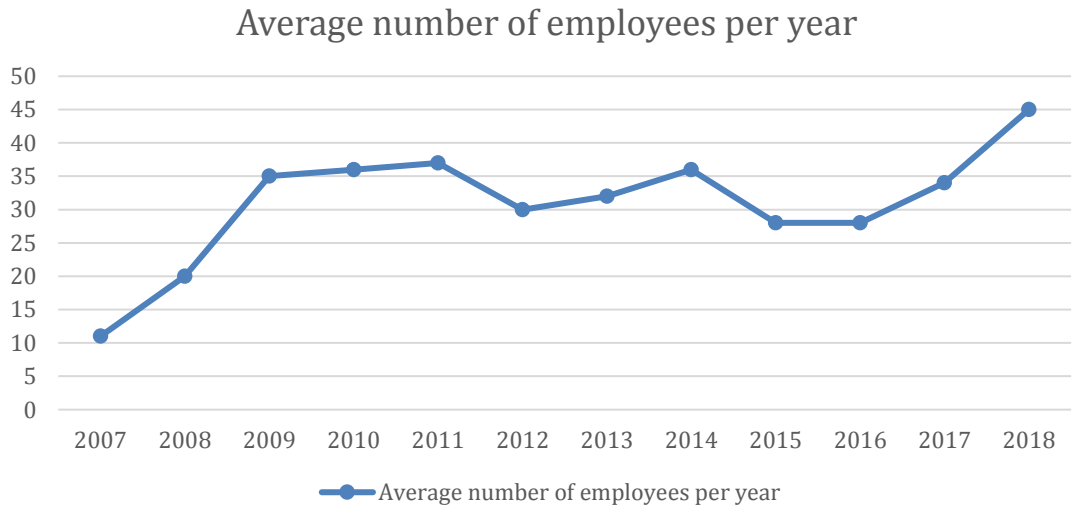

Figure 3.3 MBC's average number of employees per year between 2007 and 2018

The company's site engineers handle different projects all over the country, travelling around in rotation, depending on the distances, project difficulties or other personal problems. The teams for each project are distributed according to the size, schedule time and technical difficulties, varying from 5 to 20 workers, and each of the Site Engineers might be handling more projects at once.

The company owner is also actively and directly involved in the projects' execution, assisting the site engineers, and travelling even more between the projects and the office or other meetings with the clients.

3.2.2.2 Project data

When the interviews were conducted, the MBC company was executing construction works, as a general contractor, for a commercial centre, which was situated in Arad city. This city is located approximatively 600 km from Bucharest, where the company has its headquarters.

Beside this project, the company was conducting another smaller project in Bucharest and another one in Sinaia, a town located about 150 km from Bucharest. The Arad project was the biggest one in terms of budget, time schedule and quantity of construction works.

The construction works required for the commercial centre of Arad comprised 3 multi storied buildings, named A, B and C, with a total gross area of 10,760 square meters. The works for this project were complex and diverse, consisting of the structural rehabilitation of the entire buildings, and total refurbishment of the buildings' interiors. The refurbishment works included all the electrical installations, interior compartmentations, both masonry and drywalls, and HVAC systems, the old ones being demolished and dismantled, in favour of a new layout and installations, according to the new commercial design of the investor. Repairs to the buildings' roof were also conducted by making a new thermal and hydro isolation, and new elevators and escalators were installed.

The structural works involved reinforcing the beams, the slabs and the columns of the buildings with composite materials, reinforced concrete, metallic structures or loadbearing masonry, depending on the area and project specifications.

The contract format is a traditional one, the contract stipulations being in house made in-house by the client, through its own legal department. The design had been previously outsourced to a different company, which was contracted directly by the client. Moreover, the client has its own technical department inside its company to supervise and coordinate every construction project, including this one.

MBC company has a long-term relationship with this client, having worked together for almost 10 years, on 6 projects similar to this one, mainly refurbishing the existing buildings, but in some cases erecting new adjacent buildings as commercial spaces or multi-story car parks.

3.2.3 Interviewees identification and selection

To collect the thesis's empirical data, 12 interviews were conducted. The interviews sought to involve different working levels from the construction site, the distribution being made in the following manner, with:

- with 4 workers who were working in unqualified position;
- with 5 workers who were working in qualified position;
- with 2 site managers;
- with 1 site manager from the electrical subcontractor.

The interviewees were identified and selected according to their experience and position in the construction field, but also taking into consideration other aspects such as age, background education and qualifications, employment duration and job requirements.

3.2.3.1 Interviewees

There were conducted 12 interviews in total, from which 4 interviews with 4 workers who were working on low-skilled positions, another 5 interviews with 5 workers who were working on highly-skilled positions and 3 interviews with the 2 site engineers from MBC company and 1 the site engineer from the electrical subcontractor.

For simplicity, the Site Engineers will be notated as, Site Engineer 1 and Site Engineer 2 from the MBC company, and from the electrical sub-contractor as Site Engineer 3.

The interviewees' age, qualification, studies, position in the company, years of employment and experience in the construction industry, are shown in the *tables 3.3, 3.4* and *3.5*:

	Interviewee 1	**Interviewee 2**	**Interviewee 3**	**Interviewee 4**
Age	50 years	63 years	29 years	40 years
Qualification	industrial machines mechanic	welder	-	electrician
Other qualifications	-	-	-	-
Studies	10 classes - trade school	8 classes	6 classes	12 classes - trade school
Position	MBC low-skilled worker	MBC low-skilled worker	MBC low-skilled worker	MBC low-skilled worker
Year of employment in the company	10 years	8 years	9 years	3 years
Working experience in the construction industry	10 years	10 years	9 years	22 years

Table 3.3 Low-skilled workers

	Interviewee 5	Interviewee 6	Interviewee 7	Interviewee 8	Interviewee 9
Age	30 years	42 years	41 years	30 years	32 years
Qualification	industrial machines mechanic	industrial machines turner	plumber	mechanic	tailor
Other qualifications	electrician	land phone coupling, machinist	mechanic, welder	-	-
Studies	12 classes - trade school	12 classes - trade school	12 classes - trade school	12 classes - trade school	8 classes
Position	MBC highly-skilled worker - painter, drywall layer, (multiple jobs)	MBC highly-skilled worker - painter, drywall layer, (multiple jobs)	MBC highly-skilled worker - plumber, welder, drywall layer, (multiple jobs)	MBC highly-skilled worker - painter, drywall layer, (multiple jobs)	MBC highly-skilled worker - painter, drywall layer, (multiple jobs)
Year of employment in the company	8 years (1 year break (working in Germany and returned 4 months ago)	3 years	3 years	10 years	9 years (1 year break - working in Germany and returned 1 year ago)
Working experience in the construction industry	11 years	9 years	19 years	10 years	11 years

Table 3.4 Highly-skilled workers

	Interviewee 10	Interviewee 11	Interviewee 12
	Site engineer 1	Site engineer 2	Site engineer 3
Age	41 years	48 years	30 years
Qualification	industrial machines mechanic	lawyer	electrical engineer
Other qualifications	-	mechanic	-
Studies	10 classes - trade school	University level	University level
Position	MBC site engineer 1 / team leader	MBC site engineer 2/ team leader	IMSA site engineer 3 electrical subcontractor / team leader
Year of employment in the company	14 years	19 years	7 years
Working experience in the construction industry	14 years	19 years	7 years

Table 3.5 Site Engineers

3.2.4 Data collection

The objective of the interviews was to collect specific data regarding work environment from the construction site, and the relationship type between the company and the employer. The interview questions were formulated according to the findings from the academic literature and focused on discovering the interviewees' personal thoughts and reflections.

3.2.4.1 Interviews process

The interviews had a semi-structured form, in which a list of main questions was formulated and used as a conversation framework and topic checklist (Hanson et al., 2011). Therefore, the interview allowed for free discussion and the interviewees had the opportunity to formulate their own comments.

According to Colwell et al. (2002), this type of semi-structured interviews increases the accuracy of the findings and the amount of available information, to eliminate potentially dishonest statements, which can occur due to the interviewees' different evaluation of the reality (Styhre and Josephson, 2006), thereby allowing the interviewer to identify different aspects of people's thoughts and experiences (Hanson et al., 2011). The model described by Peter Ibarra from Taylor et al. (2016, p. 351) was used as a template for the interviews, following three main parts: the background questions, the work situation questions and the perspective ones. According to Mason (2002), to gather accurate data, the researcher must focus also on active listening during the interviews, reformulating interesting findings with new questions to obtain more data, balancing the talking with listening, and observing verbal and nonverbal signals.

Before conducting the interviews, all the interviewees were informed about the topic of the thesis, and that the interview was being conducted only for academic purposes. However, the questions did not contain any reference to Lean nor any of the Lean concepts and theoretical background, as the intention was to discover the interviewees' own reflections and thoughts

All the interviews were conducted face to face, in the Romanian language, and have been recorded in a digital format, with some notes being taken during the interviews to synthesize the gathered information. This procedure increased the accuracy of the data analysis, decreasing the likelihood of misunderstandings or oversights (Hanson et al., 2011).

The interviews were conducted over a period of three days, each interview having, in average, a duration of 1 hour and 30 minutes. The interviewees were asked between 100 and 125 questions, varying in content and structure according to the consistency and content of the interviewees' answers and opinions. The questions were formulated to find information regarding the employees' own opinions, feelings and thoughts about work environment and work relationship with the other co-workers from the site. After the interviews were finished, all the data were transcribed in writing, translated into English and then synthesised in a central table for a good overview. All the interviews' questions can be found in the thesis's appendix, named 'interview questions'.

3.2.4.2 Observations (case study)

Along with the conducted interviews, a form of ethnographic research was conducted as well. Therefore, a case study was done through participant, and in this case, personal observations. Selection of what to observe involves the researcher immersing himself into the working environment without interfering or influencing the work process, and by observing, taking notes and pictures of the current situation of every day work (Bryman et al., 2011).

During this process, the focus was on identification of the work environment state and work efficiency by analysing the non-value-adding activities among Cano et al. (2015)'s 110 barriers and 51 critical success factors in the implementation of Lean in the construction industry by Lean management, and the collaboration between the workers.

The observations were performed over three working days, on the same schedule as the working force, observing the construction processes which were being executed at that time on the construction site.

The interviews and the observations are complementary in gathering information of the given topic and by observing real life working situations more specific questions were formulated in data collection (Hanson et al., 2011).

3.2.5 Data interpretation and analysis

The collected raw data was processed and interpreted by considering the theoretical framework. These data were transformed into results by using an iterative process and immersing oneself in the substance of the collected data, trying to *make sense* of it (Hanson et al., 2011), to understand the interviewees' thoughts and beliefs regarding the work environment, the relationship between the employer and the company and the level of motivation and satisfaction.

All these data were interpreted through the lenses of lean management cultural prerequisites, to identify openness towards Lean principles tools. The barriers and success factors, which will allow Lean culture implementation and development, were investigated through this analysis, extracting from the interviews the current state of the work environment in which the employees were conducting their work.

An attempt was made through this analysis to identify both common and different aspects between the empirical data and the theoretical framework.

3.2.6 Conclusions

In this section, both facilitators and inhibitor factors were discussed to assess the company's capacity to implement Lean management tools and cultural prerequisites, the extent to which this implementation could be performed and what future actions might be possible. Suggestions were also made regarding possible future research in the area to extend the current findings.

3.3 Reflection upon the chosen method

This qualitative research method was chosen as people's attitudes, believes and opinions were being explored and it was more suitable for studying individuals and groups (Brantlinger et al., 2005). This method helped the author to gain understanding via a bottom-up approach to the everyday work life. At the same time, it gave sufficient freedom for the researcher to approach new unexplored areas which occurred and developed and were relevant for the thesis topic as the process progressed.

3.4 Limitations

During the research process and thesis elaboration several limitations were encountered.

One of them was that the academic literature on Lean management cultural implementation was hard to find, despite the vast number of downloaded documents. Furthermore, just a few studies were found regarding implementation of Lean management tools in the Romanian market, and for the construction sector, this lack of information was even more accentuated, and almost no data could be found through the mentioned research sources. Moreover, even articles with data about Romania construction industry context were limited, leading to the situation where the author used his own experience from the field to make assumptions about work environment and culture.

Another limitation of the chosen method was that the interpretation of the collected data required a level of "*plausible interpretation*", the analysis of the data having the possibility to be subjected to potential biases from the author part (Bryman et al., 2011).

Moreover, there was the possibility that even the interviewees, during the actual interviews, might alter the image of themselves, presenting therefore an imagine or situation which was different from the real work situation. Styhre and Josephson (2006) referred to this practice as "*people saying one thing and do another*". One thing noticed in the interviews was that some of the interviewees answered with the 'correct' answer as it is supposed or desired to be, in contrast with the real situation from the site.

Additionally, the owner of the company could not be interviewed, even if he expressed the consent for the interview. Due to his long travelling times and busy schedule, it was not possible to schedule the interview in the time frame appointed during the thesis elaboration. Also, the current client of the company was not interviewed, as none of its representatives were present in site during the period of conducing the interviews and the case study.

Additionally, the researcher was limited to the studied environment and in his ability to extrapolate the findings on a general scale (Bryman et al., 2011). Moreover, the presence of the author might unwillingly have altered the social environment causing inaccurate data to be obtained.

3.5 Reliability and validity

These two criteria are important in assessing the performance of the chosen method. Reliability is a notion which evaluates the repeatability of the study in similar environments, while validity, which is the most important criteria, questions the integrity of the conclusions (Bryman et al., 2011). Since the research method is a qualitative one and these criteria are hard to assess, it was decided to follow different qualitative measures such as *credibility, transferability, dependability, trustworthy and quality indicators*, to maintain objectivity and remove potential biases during the research (Brantlinger et al., 2005, Bryman et al., 2011, Hanson et al., 2011).

3.5.1 Credibility

The measure was undertaken by submitting the research data to the teacher supervisor. Moreover, the data was also reviewed in the peer review and opposition sessions held by the school department.

3.5.2 Transferability

This specific measure was covered by clear detailing and description of all the steps and methods performed in conducting the research. Description of the process has been designed to allow the possible transferability of the findings to other situations.

3.5.3 Dependability

The dependability measure can be decoded as an audit process of the data analysis and collection procedure. Therefore, for the third parties to audit and asses the research data, all the notes and transcripts have been kept and attached to the present thesis in the appendix chapter. Moreover, all the interviews have been recorded.

3.5.4 Quality indicators

During the elaboration of the thesis, the quality indicators were constantly evaluated and assessed. According to Brantlinger et al. (2005) quality indicators are about *interview process* (such as number and quality of interviewees, their proper identification, adequate number and location setting, interview duration, researcher's acceptance in the work environment, researcher's minimal impact on the work environment, data collection and recording), and *data and document analysis* (such as whether sufficient theoretical data and meaningful documents are collected, whether documents are stored, described and cited carefully, whether conclusions and reflections are provided, and the connection between theory and data collected). All these indicators have been undertaken as part of the thesis elaboration and have been discussed thoroughly in the previous subchapters

3.5.5 Trustworthy

To ensure the trustworthy of the thesis, the *triangulation method* has been used during the development of the theoretical framework and empirical data. This method derives from the Triangulation Theory and increases the trustworthiness of the data collected as multiple sources or perspectives are used to analyse and understand a single set of acquired information (Merriam, 2015).

Considering that the author had previous work experience with the company and possible unintentional biases might emerge, it was consulted an external auditor, a former Chalmers graduate of the same master programme, to underpin the findings and their logic.

Moreover, the interviewees were informed about the academic purpose of the questions and that the data gathered will be used only for the elaborating the thesis and answering the research questions. It was clear stipulated that there were no good or bad answers to the existed questions and the answers will not have any repercussion on their professional status in the company. Additionally, free discussions were encouraged during the interviews, to build an environment where participants will feel comfortable and express themselves in a free and honest way. In the end of the interviews, the participants were asked about the quality of the questions and if they want to add or retract anything.

3.6 Ethical considerations

To encourage freedom of speech and to limit any kind of restriction, all the interviews were anonymised. The names of the workers were not recorded from the interviews to avoid the chance that they might fear that they might upset the employer or other co-workers. The interviewees were informed about this prior the interview and the general focus was on the quality of the data gathered.

3.7 Other clarification

As the interviews were held in the Romanian language, the translation of the documents into English language was done by the author. Extra attention was paid during the translation process to have the same meaning and content in the context, as there were situations when direct translation did not reflect correctly the intention of the interviewee.

4 EMPIRICAL FINDINGS

This chapter presents the empirical findings obtained during the interviews and the case study, being divided in two parts. In the first part, the case study is presented, describing the observations made regarding the work environment and employees' work relations, while the second part presents the interviews conducted.

4.1 Case study

The case study was conducted for a period of three days, notes and pictures being taken regarding the status of the work floor, the work environment in general and work relations on site.

4.1.1 Work force deployment

All the workers who were working in this project, were brought from Bucharest, and there was no employment from the local area. The workers were stationed at the project for a period of 2 to 3 weeks, after which they had 4 days of leave. Some workers were even rotated to and from other projects, depending on their personal needs and the qualifications required to execute the works at that time. Transportation, accommodation and supplementary daily payments were provided by the company during travelling time.

At the time of the case study, the work force allocated for this project consisted of 23 workers from MBC, who were involved in executing the drywall and masonry partitions for the commercial areas, the bathrooms and clients' offices, roof insulation and painting. The structural works to strengthen the buildings were finished at the time when the case study and interviews were conducted. Most of the work force was now being used mainly to complete all the finishing works required for the second floor of building A, which had a schedule for delivery of the following week. Other workers, forming a team of 4 people, were working to finish the thermal and hydro insulation of the roof top of building C, working together with a team of 3 workers from a specialised sub-contractor. Another team of 6 workers, who were lent from construction partner for a period of 1 week, were conducting general evacuation works, as the site was filled with rubbish and waste materials from the demolition works. Three other subcontractors where present on site, with teams varying from 2 to 6 people for the execution of the electrical works and HVAC systems, and for installing glass panels, doors and windows.

On site both Site Engineers were present, following to do the work rotation. Site Engineer 2 arrived in site one day before the interviews were conducted. Site Engineer 1 was in the third week of work on the site, scheduled to leave in the next two days, after he had briefed and informed his colleague about the site status and work progress. During the case study and interviews, none of the client's representatives from the technical or other departments were present on site, and the company owner was in Bucharest, as he was supervising the project there and travelling to the project from Sinaia.

However, the owner of the company had a meeting with the client technical department regarding the project execution from Arad which was held in Bucharest. According to a phone discussion with him, that meeting discussed issues concerning the general time schedule of the works, details about work execution, delivery of the second floor of building A (as the tenants according to their contract needed to enter into their spaces to start working on them), and on issuing the invoice for the works executed.

For this project, usually the owner of the company is present on this site around 3 to 4 days per week, working together with the site engineer, but as the situation demands, he travels back and forth to Bucharest or other projects.

4.1.2 Collaboration between workers

Usually, the workers were organised in teams of 2 to 4 people. The teams were formed by the Site Engineer especially during the work day, considering the workers qualifications, expertise and cooperation/affinity between each other. The level of quality required for a specific task was also considered, and more- or less-skilled workers being allocated to perform that task. Other criteria were the urgency of the task and what the workers had previously been working on, whether it could be delayed, or the work could be done by another team.

The teams consisted of both highly- and low-skilled workers and it could be observed that the workers cooperated well with each other, and usually one of them took charge of and responsibility for the work, while the others followed his instructions. The workers showed respect for each other and the low skilled ones showed appreciation for the highly skilled ones. There were jokes and a relaxed atmosphere in some teams, and a more professional one in other, where accomplishing the task was the focus.

When problems in executing the works were recorded, all the members in the team contributed their own opinion, with different solutions therefore being tried. In the case of a more difficult technical problem, one of the workers, usually the most qualified one or the one in charge, went to the Site Engineer and asked for clarification. There were situations when the Site Engineer could not be found, and the team would improvise a solution which would allow the work to continue, even if it were against the Site Engineer's initial indications. Nevertheless, when the Site Engineer returned and inspected the works, he approved the new measures taken by the team. Moreover, he admitted he did not have all the facts when he gave those work instructions and said that the team had done a good job thinking of a new solution.

During the lunch breaks, a fragmentation could be observed between the workers according to their personal affinities to other workers. The highly-skilled workers preferred to spend their lunch hour with workers of the same level, even having discussions about their personal lives, 'insider' jokes and knowing detailed information about each other.

Going further with this observation, this fragmentation could be also seen on the work floor, the teams being organised, as mentioned above, according to their personal affinities. But this situation was not regarded very well by all the workers, as it was thought that some workers due to their personal relations benefits of extra credit regarding their professional qualifications assessment. Nevertheless, the Site Engineer tried to avoid possible conflict situations which could be generated from these discussions and he tried to treat all the workers fairly, sometimes even explaining to them why he had taken some decisions in making a specific team.

Regarding the collaboration with subcontractors' teams, usually there was just a professional relationship, the organisation of the works being decided by the Site Engineer. There were situations when they helped each other, either sharing tools or having small internal discussions about where to work so as not to inconvenience each other. No other discussions or conflicts between them were observed.

4.1.3 Work organisation

During the case study, Site Engineer 2 showed much better work organisation skills than Site Engineer 1, as he was present permanently among the workers on site during the whole day, supervising and coordinating the works, and knowing at every moment what was the componence of each team and what they were doing and where.

Site Engineer 1 was not so often seen on site, as he performed different activities outside the site, such as going directly to the suppliers, ordering and supplying materials or going with a car for service maintenance. Usually these activities were done by phone or by sending one of the workers, who was responsible for the car as a driver, to supply the materials or handle different other activities. It is hard to estimate at this point if this behaviour of Site Engineer 1 occurred only because he was complemented now by Site Engineer 2, and he considered that he could focus on other activities, or whether this was his general manner of organising work. When he was present on site he was involved together with Site Engineer 2 in the organisation and supervision of the works.

It was interesting to observe that no morning meetings or briefings were held by the Site Engineers with the workers regarding the activities which were to be conducted for that day. This situation occurred because the Site Engineer walked among the workers and instructed them regarding the works which needed to be carried out even from the previous day. In case of changes, which could happen at any moment of the day, upon the Site Engineer receiving usually a phone call from the owner of the company with the new instructions, any necessary measures were taken by either forming a new team or by prioritising the established work in a different way. It was rarely the case, when the team finished their job, that they needed to go to the Site Engineer to ask for a new task, as the Site Engineer, during his walks through the site, could estimate for every team the completion time for the current task and assign new tasks or take other appropriate decisions.

Moreover, the workers and the Site Engineers were living in the same accommodation place, a small pension outside the town rented by the company for a long period of time, and they all left the pension at the same time, sharing three vans for transportation to the site. During the departure and travelling times, small discussion regarding work activities took place and the workers could be briefed about any changes.

It was customary, every morning, for the owner of the company to have phone discussions with both Site Engineers regarding the works' status and the planning for the current day. Moreover, discussions were held also during the day, to solve different problems and take appropriate actions.

For task execution, the workers did not follow any precise work procedure, beside the technical steps which the task required. There was no common standardisation for the working procedures, with every team organising their work according to their beliefs and experience.

Long waiting times were observed when the workers were organising before starting a new activity, as the team had to go to the storage space to bring some specific tools to perform the activity or to search through site for the required materials. There were often situations when workers forgot something and someone from the team was sent to bring the forgotten item. In this situation the workers were just waiting without doing anything else, and several occasions were observed when the workers waited for periods from 5 minutes up to 15 minutes. This situation occurred even in the presence of the Site Engineer, who thought that these problems are inherent in a site and could happen to anyone, and that the workers deserved a small break while the forgotten items are brought. During the execution of the task, the workers were focused on the work, without trying to delay or postpone the work, and it did not matter if the Site Engineer was present or not, the work rhythm was the same, a good and intense one.

On site there were used, as visual information, only drawings and technical plans were used, which were placed on several walls of the construction site, see *figures 4.1* and *4.2*. In this way any worker could check the drawings, but during the case study no workers were observed to study them, just the Site Engineers on different occasions when they were planning and organising the works.

Figure 4.1

Figure 4.2

Figures 4.1 and 4.2 Visual information on site

Beside these plans and drawings, there were no other documents regarding the work schedule or procedures. The work schedule was dictated or imposed by the owner of the company, and for the work procedures, the workers considered that their experience was enough, and that it could guide them through any work. In the case when new materials were used on site, the Site Engineer followed the producer's instructions from the packaging, which gave the necessary work instructions.

4.1.4 Site organisation

The general aspect of the site was one of carelessness, messiness and disorganization and the construction and waste materials were deposited almost all over the site, see *figures 4.3, 4.4,4.5, 4.6, 4.7* and *4.8*.

Figure 4.3

Figure 4.4

Figure 4.5

Figure 4.6

Figure 4.7

Figure 4.8

Figures 4.3, 4.4,4.5, 4.6, 4.7 and *4.8* Construction site state

For the tools, equipment or more expensive materials items, which were not so large in volume, there was a small storage space adjacent to the buildings, which was previously a technical space for the commercial centre, see *figures 4.9, 4.10, 4.11* and *4.12*.

Figure 4.9

Figure 4.10

Figure 4.11

Figure 4.12

Figures 4.9, 4.10, 4.11 and 4.12 Site storage place

There was no one in charge of the storage place, the key being held by the Site Engineer and handed over to workers who requested access to the storage. The materials, tools and equipment were taken from there without recording this action in any documents, and more, any worker could ask for the key. There were also situations when the storage was unlocked and anyone from the site could enter.

In general, the materials were dispersed all over the site, the only action taken being an attempt to keep the same materials in the same place and not mixed with other materials, see *figures 4.13, 4.14, 4.15* and *4.16*. In the working area there was indeed a higher degree of cleanliness, and constant sweeping and removal of the waste materials was conducted either by the workers themselves or by a special team tasked only with cleaning. But this action was taken only in the working areas, the rest of the site being neglected, see *figures 4.17* and *4.18*.

Figure 4.13

Figure 4.14

Figure 4.15

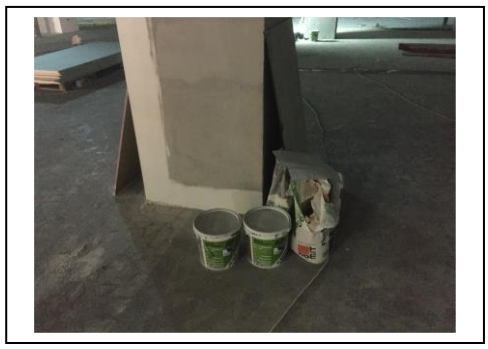

Figure 4.16

Figures 4.13, 4.14, 4.15 and *4.16* Materials storage on site

Figure 4.17

Figure 4.18

Figures 4.17 and 4.18 Cleaning the work place

In the previous weeks, before the case study, intensive demolition works had been conducted, and the debris had not been evacuated until this time. On the second day of the case study, the 6 workers who had been lent by a partner company, started the evacuation of all the materials resulting from the demolition works, an action which was not finished until the study was ended.

The site organisation place occupied a small interior yard between the buildings, part of it being used also by the neighbours, being necessary to let free access. The other part of the interior yard was occupied by company cars, which were parked there, and by some gross materials such as sand, cement sacks, scaffoldings and waste materials, see *figures 4.19* and *4.20*.

Figure 4.19

Figure 4.20

Figures 4.19 and 4.20 Site organisation yard

It could be observed that some materials were sorted, being arranged in different categories, such as the aluminium profiles from the dry walls, cables, transportation wooden pallets and rebars parts, especially materials which could be sold to specific recycling companies, see *figures 4.21* and *4.22*.

Figure 4.21

Figure 4.22

Figures 4.21 and 4.22 Sorted waste materials

The MBC company was not directly involved in this action of reselling these materials, the workers being allowed to conduct this practice to earn some extra money. The other materials, which resulted from the demolition works, such as bricks, gypsum boards, concrete, electrical appliances, and so on, were thrown all together, in some areas occupying almost an entire floor.

The same situation was noticed regarding the remains and scrap materials which resulted from the execution of the new works, such as plastics and cardboards used for packaging, gypsum boards, insulation polystyrene. Moreover, workers' leftovers, after eating their lunch during the breaks, were thrown also in the same place, see *figure 4.5*.

For the rest, food and change area a place in a corner of one of floors of building A was improvised, but with no walls or doors, just some improvised hooks so they can put their cloths, and improvised tables using materials from site. In this place, or adjacent to it, there could be found also tools, materials and equipment which were used on site, see *figures 4.23* and *4.24*. One of the bathrooms from the building A was not demolished so that the workers could use it, following to be refurbished later.

Figure 4.23

Figure 4.24

Figures 4.23 and *4.24* Change and food area

The installation and electrical subcontractors tried to keep their materials in separated, improvised, temporary and delimitated spaces, to keep their pipes, cables, electrical appliances and so on safe. For the most expensive items each subcontractor used a technical room, which could be locked, to deposit them. There used that room also for keeping their clothes and personal items, see the *figures 4.25, 4.26, 4.27 and 4.28*.

Figure 4.25

Figure 4.26

Figure 4.27

Figure 4.28

Figures 4.25, 4.26, 4.27 and 4.28 Subcontractors site organisation

The subcontractor, who was installing the glass panels, the doors and the windows, had materials dispersed all over the site, unsupervised or stored in proper spaces. It could be observed that some of them, such as the glass panels, were damaged. They had no special place for keeping materials or tools, and they were using the van also as a storage, see *figures 4.29, 4.30, 4.31* and *4.32*.

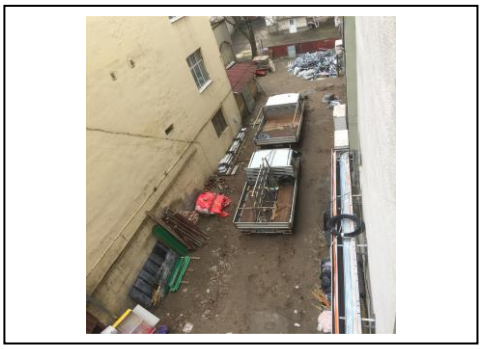

Figure 4.29

Figure 4.30

Figure 4.31

Figure 4.32

Figures 4.29, 4.30, 4.31 and *4.32* Subcontractors site organisation

Regarding the health and safety policy, there were no rules implemented, and even basic requirements were not respected. None of the workers wore protective helmets, and just a few have protective boots. None of the workers wore high visibility vests, although this is not a mandatory clothing article as, according to Romanian legislation, they are not required, except in cases when a high tower crane was being used on the construction site, see *figures 4.17, 4.18* and *4.33*. The electrical subcontractor was the only team on the site to wear all three clothing articles, boots, helmets and vests, see *figure 4.34*.

Figure 4.33

Figure 4.34

Figures 4.33 and *4.34* Health and safety gear

Moreover, there was a general absence of elementary protection measures, such as rail guards on the stairs or marking on the end of the slabs, where there was no other delimitation, like on the roof top of building C where thermal and hydro insulation works were being executed, see *figures 4.35, 4.36, 4.37* and *4.38*.

Figure 4.35

Figure 4.36

Figure 4.37

Figure 4.38

Figures 4.35, 4.36, 4.37 and *4.38* Health and safety protection

Most of the moving scaffoldings were incomplete, lacking sometimes structural elements or standing supports or ladders. No scaffolding had foot boards for protection against tools falling from them. Tags, numbers, completion papers or any other annex documents were totally missing from the scaffoldings, see *figures 4.39, 4.40, 4.41* and *4.42*.

Figure 4.39

Figure 4.40

Figure 4.41

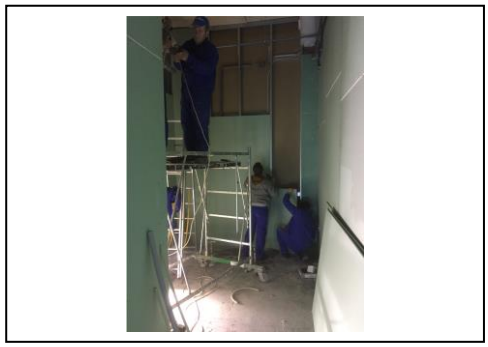

Figure 4.42

Figures 4.39, 4.40, 4.41 and *4.42* Health and safety protection

The workers were responsible for erecting the scaffoldings and none of them complained about their improper usage. Moreover, workers were moving the scaffoldings with other workers standing on them and they did not use the special legs to secure the scaffolding in a fixed position when working on them. The Site Engineer did not take any measures and allowed the work to be carried out in this way, declaring that this was not the normal state of working but that they were in a hurry and he usually took all the protection measures to cover holes, margins, stairs and so on. None of the workers seemed to be concerned about safety rules, or about implementing or doing something towards these aspects, considering that they were paying attention and so they could not get injured.

During welding, cutting with special equipment or other works which generated sparks, fire, flames etc., the workers did not use protective gear and, more, they paid little attention to the other materials around the work place. Indeed, in this situation the Site Engineer drew attention and forced the workers to take corrective action, including using protective glasses and protecting the other materials, see *figures 4.43* and *4.44*.

Figure 4.43

Figure 4.44

Figures 4.43 and *4.44* Health and safety protection

It was interesting to notice that after the site engineer left, the worker removed the glasses, as he declared he cannot work very well with them and nothing could go wrong.

All over the work space, cables were spread in all directions, with no arrangement or organisation. Workers were setting and laying down cables and extension cords as they considered necessary for their work, without following any rule or safety precautions. Once again, the electrical subcontractor was the only team for the site who took the appropriate safety measures during their work, like using special gloves or protective glasses, or even moving or adding more central electrical panels to avoid over agglomeration.

Figure 4.45

Figure 4.46

Figures 4.45 and *4.46* Health and safety protection

4.2 Interviews results

During the interviews, several categories were approached, like general information about the interviewee, educational background and training, general relationship with the company, work relationships and collaboration with superiors, work relationships and collaboration with colleagues and subcontractors' teams, material waste, recycling and some of the lean non-value adding activities such as work space layout, quality issues, error proofing and visual information.

4.2.1 Educational background

An interesting observation which can be drawn from the interviewees' educational background, was that none of them, except Site Engineer 3 of the electrical sub-contractor, had an educational background in the construction industry. The average experience of them in the construction industry was of 13 years. Even Site Engineers 1 and 2 had a different educational background, Site Engineer 1 having graduated from a trade school as an industrial mechanic and Site Engineer 2 having a university degree as a lawyer.

Despite all these, they were acting as Site Engineers on all projects, proving that they had deep technical knowledge and expertise in construction. Site Engineer 1 had 14 years' experience and Site Engineer 2 had 19 years' experience. Both had started on construction sites as unqualified workers, with no skills or knowledge necessary to perform their jobs, and gradually, through time, after gaining experience and knowledge, they had climbed to their hierarchical position.

It can be argued that their position was the same as the one of the foremen, but clearly, they had more power than the foremen did, having the necessary authority to take decisions for the entire site, to order materials, to make payments and to organise the workforce. Indeed, in the legal documents the only site engineer is the owner of the company, who has a construction educational background.

Moreover, it can be observed that most of the workers were not qualified in any of the trades from the construction industry, graduating from different trade schools, except for the site engineer 3 and the worker qualified as a plumber, who graduated a school according to their trade. However, the interviewees presented themselves as qualified or unqualified workers, describing in fact their level of skills, knowledge and expertise.

According to Romanian legislation for jobs classification, workers who do not have a diploma or a certificate, are considered unqualified workers, no matter of their skill level. In this situation, almost all the workers from the interviews were employed, on the legal hiring documentation, as unqualified workers, as their diploma or certification did not correspond to the current trade they were working in.

Regardless of this situation, the company considered, on site, the high skilled workers as qualified ones, and the low skilled workers as unqualified ones, this division being made according to their skills, knowledge and expertise. The unqualified workers were required to perform works such as cleaning, carrying of materials, tools and equipment, and assisting the qualified workers in their tasks. The qualified workers were executing works which required a high degree of skills and knowledge.

Another interesting observation, which can be drawn from the interviews, was that most of the workers started as unqualified workers in this company and after learning and developing their skills and proving their competences and abilities, they have become qualified workers with high skills. The qualification was obtained directly through learning on site, gaining therefore experience and expertise. However, they did not acquire legal documentation to prove their qualification, and except the site engineer 3, none of them was interested in obtaining this kind of documentation.

In the following paper to simplify comprehension, the term ‘qualified worker’ will be used for the highly-skilled and experienced ones, and the term ‘unqualified worker’ will be used for low skilled ones who do not have a high level of work expertise, working in general as support for the qualified ones.

4.2.2 Construction training

The company has not conducted any official training courses for any of the workers, but Site Engineer 2 confirmed that there are discussions about these, with the only obstacle being time, as their activity involved a lot of travelling, being away for several weeks.

The company has shown patience and has created a teaching environment for everyone to learn directly on the construction site. The unqualified, low skilled workers are assigned to highly-skilled, qualified workers, allowing them to see and understand directly how the work should be executed. The Site Engineers contribute to the worker's development, by assessing continuously the workers' skills and assigning them in different teams, considering also possible personality affinities and issues.

According to the Site Engineers, it is very important to create an environment free of punishment, where mistakes are allowed, and where the workers can learn from those mistakes. Another important aspect is to explain the working procedures in a calm way, with no 'trash talking', to show tolerance, respect, trust, understanding and to accept mistakes, fluctuations and deviations as workers can have a different learning capacity and skills potential. One main condition for training success, is workers' willingness to improve and develop themselves, as the company has not forced anyone to move from their current state to an improved one.

An interesting observation which can be drawn is that the workers, especially the ones who had become highly-skilled in the trade, appreciated this opportunity to learn directly on site and the work environment which the company created and provided. They considered that they were coached and taught well, with patience and tolerance, and considering moreover their personal problems and needs.

4.2.3 Work position

The average years of employment in this company for the interviewed workers was 8½ years, most of the workers having around 8-9 years. The company was founded 19 years ago, and Site Engineer 2 had worked there for the entire period, and Site Engineer 1 for 14 years. It is a quite long employment period, especially in the construction industry, characterised by its projects' uniqueness and temporality.

All interviewees declared that they were satisfied with their current role or position within the company, some of them considering that they had learnt and developed a lot during the years spent at this company. They considered that their job was safe, stable, with no risks of getting fired or losing their job due to a poor management. They always had continuity of work, as there was always work to be done, with no interruptions or forced leave.

According to Site Engineers 1 and 2, the company successfully provided work continuity by keeping a relatively small number of employees, around 30 to 35, where in the case of bigger projects the works were subcontracted, or other workers were leased from different collaborators. The company did not engage in hiring new people and firing after the construction's project was over, preferring multiple construction collaborators or to subcontract. In this way the company had successfully formed a core group of workers, with low variations in the workers' mobility, and with a high level of trust regarding employment. Moreover, due to the company owner's managerial skills, contracts had been obtained and distributed in such a way as to ensure works continuity, contracting in general small to medium scale projects.

The reasons, the workers had chosen to start working for this company, were mainly monetary ones, and secondly that the company was highly recommended by a friend or relative, who had worked or was still working in the company.

The workers' motivation for choosing to continue working for the company and not to seek employment at another one, was that they were very satisfied with the way the company's owner treated them, kept his promises, paid the salaries on time, ensured monetary payments for travelling, for work clothes and for transportation, provided legal hiring documents, and that there was a good work environment, very professional and serious. All of them appreciated the job stability and continuity, and none of them showed any concerns regarding a possible lack of work in the future.

Some complaints were recorded regarding the travelling, as they had to be away from their families for long periods of time, and desired to work closer to their homes. Nevertheless, all the interviewees mentioned that they felt satisfied and accomplished after every project was finished, describing a sense of pride and fulfilment for the work they were performing.

4.2.4 Work environment

The work environment was described by the interviewees in very good terms, as being very a professional, stress-free and peaceful one, with good colleagues, development and learning opportunities on site, free of punishment, where mistakes were allowed. Moreover, some of them emphasised on the fact that there is no 'trash talk' or swearing, discussion being taken calmly and in an explanatory way, showing respect and understanding.

Only one worker felt that he was not treated with respect since he had requested repeatedly to be relocated back to Bucharest to be close to his family. This request was not resolved and, more, he felt that other colleagues were considered more important than him and that they had been favoured, since they were relocated before him.

Another two workers from the interviews desired better site organisation, cleaning to be performed more often and materials to be stored adequately, in proper storage areas. They described some other sites, where they had worked, also with this company, but where through the client or management company there had been a much better site organisation and rules were imposed for everyone to be followed. They enjoyed working much better in these conditions, preferring them on all sites. Another worker brought the issue of health and safety rules, being concerned about his own safety when working in the site. He wanted the rules to be imposed and followed by everyone on the construction site, as personal safety is vital.

Another important aspect, which the workers appreciated, was the two-way communication, where they could express themselves freely without any fear of punishment. The Site Engineers seemed to be thoughtful and very helpful, giving clarifications and advices regarding work, and even more contributing to a good team spirit and working atmosphere.

Most of the workers described this company and the work environment as an ideal, perfect one, being very satisfied and pleased with the current conditions of working, and the owner's behaviour and attitude towards employers, management style.

4.2.5 Work relationship with the company's owner

There was a consensus among the interviewees that they had a good work relationship with the owner of the company, this being one of the main reasons, beside the financial one, to remain in this company.

The relationship was in general very professional, based on trust, respect, and honesty. The workers appreciated the owner's abilities to think and act, showing an open mind, being understanding, helping the workers both professionally and socially, adjusting to their needs, and all the time keeping his promises. According to the interviewees this is not a general situation which occurs in the construction companies, with 'trash talking' lack of respect, delayed payments and broken promises being the most frequent situations.

From the interviews it can be stated that the owner values the workers' willingness to learn from a zero base, and to hire them even if they had no construction experience. He put a great emphasis in forming a long-term relationship with them, on creating a good working environment, and on trying to make them loyal to the company. A great deal of attention was paid to workers' personal needs and problems, which made the workers very satisfied and motivated to contribute to their long-term relationship with the company. The owner also showed a lot of patience and understanding in letting the workers learn and acquire the necessary skills to perform the construction works.

In the interviews, none of the workers complained about anything regarding their relationship with the owner of the company, and they all declared that they were feeling quite satisfied, having a general state of wellbeing at the work place.

4.2.6 Work relationship and collaboration with site engineers

The same situation was encountered here, with the interviewees considering that they had good work relationship with the Site Engineers, based also on trust, respect and communication. The workers especially seemed to value the Site Engineers' experience and expertise, especially of Site Engineer 2. It was observed that there is a difference of managing styles between Site Engineers 1 and 2, the second one being calmer, more people-orientated and with good understanding and explanation skills. Site Engineer 1 was more focused on time schedules, materials orders and deliveries, logistics and other organisational aspects.

Site Engineer 2 had very good people skills, knowing how to address them and how to evaluate their abilities to perform a certain task. Also, the workers appreciated his capacity to form the teams, as he took into consideration both technical capabilities and personal preferences. Regarding Site Engineer 1 there were some complaints regarding these aspects, as he sometimes formed inadequate teams.

Site Engineer 1 also had a more personal relationship with the workers, often going out with them in the spare time. In comparison, this action was avoided by the Site Engineer 2, who did not find it a normal way of behaviour. He thought that he must remain in permanent contact with them even outside the working program, to build a good relationship with them. Moreover, even they were travelling, he felt he was responsible for them and tried to oversee their actions.

4.2.7 Work relationship and collaboration with other colleagues

From the interviews it can be concluded that there was also a good relation between workers, very professional, based on straightforward communication and respect. The work load was divided evenly and fairly between the workers, after consulting with each other, discussing and analysing the task which needed to be executed, and considering each one's expertise and experience. During work they helped each other and when problems were encountered they discussed together to find the adequate solution.

All the interviewees declared that they felt good inside their team, working in a relaxed and stress-free environment. They had developed good and friendly relationships between them, as they knew each other quite well after working together for so many years. It was observed that some of the workers have developed even deeper personal relationships between them or even with the engineers or with the owner of the company.

In general, conflict situations between co-workers were avoided, happening quite rarely. In most situations, depending also on the gravity of the situation, the workers declared that they would keep an open mind, even adopting a stand back position, to solve and mediate the problem as fast as possible directly between them.

Seldom, if there was no other solution, would they go to the Site Engineer or owner of the company to help them in fixing the problem. Moreover, the Site Engineers stated that they will focus not only on solving the situation but also on finding the root cause of the problem so as to take adequate measures in the future.

Most of the interviewees, eight out of twelve, including site engineers, recognised the importance of working in a team to successfully accomplish the given tasks. It was admitted that in a team they could share responsibility, help each other, ask for advice, and create a good and joyful work environment. The other four interviewees did not wish to work in teams, as they wanted to assume responsibility on their own for their work, having full confidence in their skills and, at the same time, taking the full blame in case something went wrong.

4.2.8 Work relationship and collaboration with subcontractors' teams

The work relationship with the subcontractor's team was viewed as very professional, with communication being usually limited strictly to the work they performed. There were situations when they helped each other with different tools and materials or discussed how to share the work space if they had to work in the same areas.

Conflict situations were in general avoided, but there were situations where they could appear, due to the lack of respect or desire for collaboration. However, in general, the subcontractors were usually companies with a long relationship with the MBC company, and over the years, communication and collaboration had strengthened between the workers.

According to Site Engineer 3, non-written rules of behaviour, communication and collaboration had been established with the workers from the general contractor, correlating their works easily. Even more, damages, which were caused by the workers from the MBC company, were repaired without any notification, especially when there was no financial implication for the materials. If new materials were required, then the Site Engineers solved the problem between them or addressed it to their owners, who usually quickly found a way to solve the problem.

The same situation was also observed for the MBC company, which made repairs of the damaged work caused by other subcontractors without claims, notifications and other allegations. If the situation was more severe, the Site Engineers or the owners of the companies addressed the problem together and found the proper solution to solve the situation.

This way of thinking, culture, is transmitted to all the workers from the site, to avoid disputes and to solve damages without any hassle. If there are more complicated problems, the workers will address them to the Site Engineer, who will take the adequate measures. If the Site Engineer is not able to solve the situation he will take the problem to the owner of the company.

4.2.9 Skills and qualifications assessment

All the interviewees felt confident that their superiors trusted their abilities and qualifications to perform the required work, and even to let them work without supervision. Only two of the interviewees preferred to work supervised and with clear work instructions, as they did not want to assume higher responsibility for their work. Also, the level of confidence and trust in their skill level to perform the needed work was lower, considering that they needed more confirmation and advice during their work. The rest of the interviewees stated that they could work without supervision, only two of those feeling stressed if they were continuously monitored, as for the others it did not matter, feeling confident in their abilities to perform the given task and capacity to take decisions on their own.

When the interviewees were asked to evaluate themselves their performance and skills, on a scale from 1 to 10, where 1 is the worst value and 10 is the best one, the following responses were recorded, as notated in the following three tables:

	Interviewee 1	**Interviewee 2**	**Interviewee 3**	**Interviewee 4**
How will you evaluate your performance at work?	7-8	8	8	8
How will you assess your skills to perform your work?	7-8	8	8	8

Table 4.1 Personal assessment – low-skilled workers

	Interviewee 5	**Interviewee 6**	**Interviewee 7**	**Interviewee 8**	**Interviewee 9**
How will you evaluate your performance at work?	7-8	7-8	10	10	8
How will you assess your skills to perform your work?	8-9	7-8	10	10	10

Table 4.2 Personal assessment – highly-skilled workers

	Interviewee 10	**Interviewee 11**	**Interviewee 12**
	Site engineer 1	Site engineer 2	Site engineer 3
How will you evaluate your performance at work?	8	9	8
How will you assess your skills to perform your work?	8	10	8

Table 4.3 Personal assessment – Site Engineers

It can be noticed that only four interviewees had total confidence in their skills and abilities to perform the required work, one of them being Site Engineer 2, while the rest of the interviewees admitted that they still had more to learn to improve themselves. This fact was also reflected by their own assessment about their work performance, where all the interviewees except two of them admitted that there was room from improvement and the work could be done better. Site Engineer 2 assessed himself as grade 9, while three of the qualified workers assessed themselves as grade 10, as they considered that they were doing a very good work.

Regarding the issue of working with or without work instructions, opinion was divided, as half of them preferred to work with clear work instructions, and the other half without. Even Site Engineer 1 preferred to work with clear work instruction, with the other Site Engineers 2 and 3 preferring to work without.

Nevertheless, except for two of the unqualified workers, all the interviewees felt capable of replacing any co-worker from their team, in the case of his absence, feeling confident that they could perform the work in the same way or even better.

4.2.10 Work improvement

In general, most of the workers felt confident in stating their own opinions and making new suggestions about their work, even if those ideas were contradictory to their superior's ones. Discussions were taken on the new proposals, being analysed from technical and financial perspectives, and a conclusion was drawn. Their input initiative to make suggestions was appreciated in all situations.

Only two interviewees were not confident to express their own ideas or to make statements contradictory to their superiors', as they considered that they lacked experience and expertise, and that their superiors were more knowledgeable and experienced.

According to Site Engineer 2, these kinds of workers did not have the appropriate professional and educational background and they limited themselves as they considered they were satisfied with their current level of development.

Among the suggestions the interviewees made regarding how to improve work quality and conditions, it was for example suggested:

- to increase the number of members in a team, a request which was suggested by a few workers, as they believed that the current number is low, and they could work better in bigger teams;
- to be allocated a longer execution time for the works, as sometimes there was a high demand to finish the work in a short period of time; also, the increase was requested as the workers believed they could focus in this way more on the quality of the works;

- to learn more technical knowledge and to develop their practical skills, as most of them considered that they could learn more and improve themselves;
- to improve the conditions of the work floor, as sometimes some of the workers considered it disorganised and messy;
- to better supply equipment and tools, even to allocate for each worker their own tool box;
- to improve or change some of the work procedures;
- to learn from others' experience;
- to have better site organisation and coordination;
- to have better execution drawings with more technical details and specification, a suggestion requested especially by the Site Engineers.

Most of the interviewees confirmed that they take some initiative, on their own, to improve their work conditions, even if this is not a regular action.

4.2.11 Superiors feedback

Eight of twelve interviewees declared that they have received both negative and positive feedback from their superiors, which helped them in assessing their current situation and gave the opportunity to improve themselves. They considered it was beneficial and gave them the necessary indications and confirmations about their work.

This feedback gave the workers the necessary encouragement for continuing their development, making them confident and satisfied.

Three of the other four interviewees stated that they would appreciate any kind of feedback and that would also help them to improve themselves, whilst the remaining one considered that he was already doing his best and the feedback would not make any difference.

4.2.12 Material waste and cleaning

The opinion regarding the existing of waste materials on site was divided, as some of them found the situation normal and considered that there was not so much waste material, while the others considered that there are large quantities of waste materials on site which affected their work.

Most of the interviewees considered that all the workers from the site were responsible by themselves for cleaning and removing daily any waste materials, especially after finishing a specific task or at the end of the working program. At the same time, they admitted that there was not always time to perform this activity due to the tight schedules and in this situation a team was formed to perform general cleaning to remove waste.

4.2.13 Recycling

The overall assessment was that recycling was conducted on a very small level on site, as there were no rules regarding this activity, even if most of the interviewees considered that it would be beneficial to recycle, especially for the environment. The workers recycled especially materials such as rebars or aluminium profiles which could be sold to specific recycling companies.

They admitted that they did not take any initiative regarding recycling and considered that rules and regulations should be enforced both by the companies and local authorities. Moreover, they acknowledged that other factors which hindered the recycling activities were lack of education, old mentalities, indifference and laziness. This situation occurred despite the fact that recycling and protection of the environment were highly regarded by all the interviewees.

Most of them showed some knowledge regarding recycling activity, how it should be done and what steps are involved, but there was a common lack of interest in performing this activity. On a personal level, only two of the interviewees were recycling waste materials in their homes, especially since the city hall had implemented such a programme in their villages.

4.2.14 Work space layout

The work space layout was considered by most of the interviewees a normal one, organised and cleaned well enough to allow the works to be executed. However, they felt that a high attention should be paid to different materials or tools laid down in the area to avoid injuries.

There was a common desire to strive for a better and improved layout, much more organised, without materials and tools around them, and without overlapping teams working in the area at the same time.

4.2.15 Quality issues

All the interviewees admitted that problems of quality appeared quite often, and that they tried to take measures to fix the problems by themselves, as they were discovered. In some cases, if the work required a more qualified skill level, the Site Engineer would nominate some other worker to fix the quality issue.

The main causes of these quality problems, mentioned by the interviewees, were:

- lack of interest when conducting the work,
- lack of attention to the technical details or working procedures,
- lack of qualification,
- lack of higher imposed demands from the superiors,
- rush to finish the task due to the short execution times,
- personal problems

The Site Engineers considered that the design problems did not represent quality issues, as the drawings were executed after careful examination and discussions with the client's representatives. They admitted that there had been changes to the present drawings, but this did not represent a major problem, as they were implemented accordingly. Moreover, the owner's direct involvement in supervising the execution of the works ensured a high level of technical accuracy, as he had constant meetings with the client's representative to establish the technical details, in some situations even to a more detailed level than the drawings showed.

No particular problems with the materials suppliers were mentioned during the interviews, as the Site Engineers stated that they themselves supervise the process of ordering and delivering. Usually the company had a general contract with a few suppliers which have warehouses all over the country and in cases where the delivered materials had defects they were replaced by the supplier.

4.2.16 Error proofing

Except the Site Engineers, the workers did not consider error proofing activity important for their work and, even more, they did not engage or take interest in finding the root source of a problem, focusing on just fixing that issue. The workers had not considered or thought previously about this activity, and even the company through its site managers or owner did not request it from the workers.

The Site Engineers showed more interest in these activities, trying both to mitigate and prevent problems, and to find the root cause of that problem, even if there was no material of financial compensation for this activity, as they considered it part of their job.

4.2.17 Visual information

Most of the workers showed no interest in finding visual information on site regarding work procedures, general project information, health and safety rules, and other project aspects, considering that this information would not be useful for conducting their work. They stated that they would not look at or read them, as they knew what to do or would ask for advice from the Site Engineers. Moreover, the workers considered that the Site Engineers should have all the knowledge and information about the site progress, as it was part of their job.

In contrast, the Site Engineers and two of the qualified workers found these data very useful and interesting, helping them to do their work.

For this site, the workers stated that there was no visual information, while the Site Engineers mentioned that there were some technical drawings which were displayed for everyone to see and consult.

5 ANALYSIS

To perform the analysis of the empirical data, by connecting the interviews and case study data with the theoretical framework, it has been chosen to follow and discuss some of the basic values which form a Lean culture. Not all the Lean cultural values were analysed, as this company and its employees do not follow or have any knowledge of Lean management.

5.1 Support and commitment from the management

The interviews indicate that the company's management, represented in this case by the owner of the company and its site managers, is dedicated to helping its employees to learn and develop in their profession. Almost all the workers from the interviews have started on the site with ordinary general non-construction skills and little knowledge about construction works yet, despite this, the company had the patience to allow them to learn and develop. Some of them, after learning and proving their skills and expertise, have been promoted as 'qualified workers', with increased incomes, playing a more important role in the company and on the construction sites. Site Engineer 2 is the best example here, as he started as an unqualified worker, with low construction skills, succeeding to become an important employee for the company, working now as Site Engineer.

The empirical results suggest that the company is dedicated to its people, supporting them in their development, accepting their mistakes and encouraging them to learn and move forward in the company hierarchy. The company tries to make them loyal by helping them also in their personal lives.

There are cases, as Site Engineer 2 stated, when some workers do not want to develop and learn more, being satisfied with their current level. One of the causes for this situation is their poor level of education from school and childhood, which makes it difficult now to develop further. The company would have preferred to stop collaborating with these type of workers, but due to the scarcity of work force which confronts Romania now, it was forced to accept the current situation. It should be noted that the company seeks to find and retain workers, even inexperienced ones, who have an open mind, and are willing to learn and develop themselves.

The workers' training is conducted on site only, directly working with the skilled and qualified workers and under the Site Engineers' supervision. The company embraces this kind of policy, both due to the owner's mentality and thinking, and due to the workforce scarcity, which has forced it to adapt. However, considering that this strategy was implemented from the beginning of the company, it can be stated that this policy is part of company's long-term thinking and not just a temporary solution.

The company has not provided any other courses or training in an academic environment, where certifications or diplomas could have been obtained, so that the workers could be employed as proper qualified workers, or to increase the overall level of competency in the company.

This situation occurred especially due to the long travelling times which prevent the employees staying in the same place for longer periods and the company does not have the possibility to replace them with other workers during the trainings. However, most of the workers manifested an interest to learn and develop more directly on the site and not in the academic environment.

All the interviewees were satisfied with the management's commitment towards its people and the support and help it showed to the workers, both in their professional and personal lives. The workers appreciated this kind of management, and this fact constituted, beside the financial one, a very important reason to stay and work for this company.

It can be stated that there is a deeply rooted culture of people-development inside the company, especially on the management's part, where workers are encouraged, coached and trained to evolve and develop their technical skills. The Site Engineers and the owner of the company understand that this fact is vital for the company's survival and evolution.

5.2 Company's long-term philosophy

It could be concluded that the company has at least a policy of retaining employees and offering permanent work. The workers are regarded as a valuable part in the philosophy of the company, which tries to obtain their loyalty. The company has offered the employees a stable and continuous job, which has made it very respected among the workers. The average employment duration of the employees from the interviews is of eight years and a half, varying from three years to nineteen years, which demonstrates a stable work environment.

However, the company policy is not expressed through written statements or formulated in clear ideas. The company owner proves that he has good managerial skills, he obtains construction contracts and he is successful in keeping the workers in the company, but there is an absence of a clear direction, which can lead to misunderstandings and lack of employees' devotion towards the company itself and their work. The lack of direction is replaced by offering a good working environment, based especially on fulfilling the workers' personal and financial needs. Even the Site Engineers were not involved or did not know the company's long-term philosophy, other than the fact that the company is trying to offer a stable and continuous job. Having a long-term philosophy is very important for giving the employees a sense for their work, making them part of the company's long-term objectives. Moreover, a company with a long-term philosophy will take decisions based on it, and not on the variations of the market or other financial short-term considerations.

An improvement is observed at the electrics sub-contractor, as the Site Engineer stated that he wanted to take the company further, proposing to the owner new ideas for improvement and development. In this way, he was contributing to the company's long-term strategy, being part of it and, more, being more motivated to reach to a joint success.

5.3 Clear definition of roles and responsibilities

Being a relatively small to medium company, it can be stated that the company has a flat hierarchy, the owner of the company taking almost all the important decisions. The Site Engineers are empowered to conduct works on their sites as they considered best, both financial and organisational, but often with input from the owner, as he travels regularly from one site to another. In this way, the company tries to ensure a good work flow, with as few mistakes as possible in the technical drawings and design, and at the same time to boost team morale by showing dedication and solving also their personal problems.

The office team does not have any influence in the organisation of the sites or in the execution of works, having only an administrative role and helping the owner to write and submit bids.

Inside the work teams, roles are established according to the workers' experience, expertise, respect and trust, but there was no clear delimitation of responsibility of the team leader's task. This situation occurred since the Site Engineers were present on site, supervising and being actively involved in the works progress, and acting also as team leaders, coaching and giving advice to the workers.

5.4 Building a culture of collaboration, respect and trust

Both from the interviews and case study, the level of collaboration and trust among the workers was very high. The work environment was extremely appreciated by all the interviewees, trust and respect being mainly the words used to describe it.

One factor, which strengthened and developed this work environment, was the personal relationships formed between the workers, due to the long years of employment in the company, many of them establishing personal relationships between them, or even with the Site Engineers or the owner of the company.

Another factor, which influenced this environment, was the owner's behaviour and attitude of respect and trust in people, which he developed and transmitted to his employees.

In this way, it can be stated that the company has created a culture of good collaboration, where trust and respect are unwritten values about how to behave and act, established and shared among the employees.

Moreover, even the electrical subcontractor has developed a good work environment, based on trust and respect, and has showed also a high commitment to the workers, where their personal and professional needs are fulfilled.

5.5 Building a culture with focus on quality

It was found that the general focus was on fixing the quality issue and not on finding the root cause and mitigating the problem to avoid it in the future. The workers showed good problem-solving skills and cooperation among themselves in finding the solution, but the root cause of the problem was never analysed and exposed to prevent a future occurrence, and the workers just resumed work after fixing the problem.

Moreover, solutions were not shared with the members of other teams and any solving ideas dissipated in time as the team moved to another task or when the team was dissolved, and its members were part of other teams. No worker was interested in finding how a difficult task or problem was solved and they considered that it was each worker's duty to solve that situation and then move to the next task. The found solution helped only the involved workers, as in this way they extended their practical expertise.

However, Site Engineers showed some interest in finding the root cause, especially when there was a quality issue, trying to find out why the designated worker or team had that problem, but the general mechanism of finding the root cause was not well developed as they stopped after a few steps. However, proceeding in this way, they could asses a partial cause and adapt their future decisions accordingly.

Among the main reasons which caused quality problems were lack of interest and attention on the part of the workers, which concurs with the finding that they did not seek to explore the root cause of the problems. The culture of getting quality right first time is not very deeply established among the workers, or even among the Site Engineers, even if there is a strong emphasis on getting the quality right.

5.6 Cleaning, maintaining order and site organisation

From the empirical data it can be stated that there are two interpretations regarding cleaning, maintaining order and site organisation. One is that all the workers and the Site Engineers show a good understanding and knowledge of the requirements and theoretical aspects which involve these activities and another one, opposite from the first one, where the rules are not implemented and respected.

Almost all the workers assumed responsibility for cleaning and maintaining order, especially on a theoretical level, as was clear from the interviews, but this situation was reflected only partially in the site, following the case study. It could not be identified as the main reason which caused this gap, as the Site Engineers and workers declared that the current situation was not a frequent one, and improvements would be made soon. Only two workers admitted that not enough cleaning was done on site and there are not enough rules implemented and followed by the workers to keep and maintain order.

The site organisation was very poor according to the data from the case study, and the Site Engineers stated that the current situation was also not infrequent. The small site layout and other organisational aspects prevented them to acquiring a better attitude to site organisation and they admitted that improvements could be made.

The conclusion can be drawn that there is indeed a lack of rules regarding good site organisation, cleaning and order, despite the theoretical knowledge which all the workers seem to have. Moreover, a clear vision is missing towards how the site should be organised, the general focus being on other construction activities.

5.7 Health and safety

It can be stated that this is a major problem on site, both from the interviews and case study data. Except one worker, who mentioned health and safety rules as very important to ensure his own safety, the rest of the workers payed no attention to them as they considered that they were working in safe condition and they were paying enough attention to avoid possible accidents, even if they were not following the health and safety rules.

On site, numerous situations were encountered where no safety measures were taken, with workers working in very dangerous conditions according to the health and safety regulations, but still the workers considered that they were working in safe conditions.

The site managers stated in the interviews that this is not a normal state and future actions will be taken to remediate these problems. Again, a gap can be noticed between theoretical knowledge and the actual practices on the site. Most of the workers did not admit that there are problems regarding health and safety rules, considering they can take care and pay attention instead.

The general conclusion which can be drawn is that in the company there is a culture of not following health and safety rules, as these rules disrupt work flow, and in general that workers can take care of themselves if they can pay enough attention to avoid any accidents.

5.8 Genchi Genbutsu

Following the empirical data, it can be stated that the site engineers and even the owner of the companies are actively implicated in following the works on site, supervising and coordinating the activities directly from the work floor.

They are in constant contact with the real situation and progress of the works, with the workers' morale and state. This practice was implemented by the owner of the company from the very beginning of the company, this activity being considered as the normal way of conducting works.

Another interesting aspect was that the Site Engineers allocated little of their time to paper work, and this activity was conducted in general also on site, among the workers and not in a private office.

As for the official paper work required by the Romanian laws, only the owner of the company was involved in this activity, as the current Site Engineers did not have any diplomas or certifications in the construction trade which could allow them to sign and fill in the papers. Moreover, according to Romanian legislation, a site inspector was hired by the client to fill in the necessary documentation and submit it to the official state representatives.

5.9 Material waste and recycling

At the time of the empirical data collection, on site there were significant quantities of material waste, with only a very small percentage properly sorted. The general impression of the site, resulting from the case study data, was one of carelessness, messiness and disorganization.

The current amount of debris resulted from extensive works of demolition, and the Site Engineers stated that actions would be taken soon to evacuate all the waste materials.

Except for two workers from the interviews and Site Engineer 3, all the other interviewees found this situation normal for a construction site, and even had the opinion that actually there was not so much waste material on site.

According to this situation, it can be concluded that in the company there is a low standard and requirement for site organisation and waste removal from site, with workers accommodating themselves to this level, considering it the normal way of conducting the site activities.

Regarding recycling, there was a common belief that an external party, such as city hall or other official state representatives, should implement rules and regulations which should be followed and respected. Until that point, no one was prepared to assume responsibility or to act to start recycling on their own, except for cases when there was a profit gain from this activity.

Almost all the interviewees showed good knowledge of the importance of recycling and even of the activities which are involved in recycling, but, at the same time, they show great indifference and laziness towards it.

The culture for material waste and recycling is one of indifference, laziness, and accepting the lowest criteria as the normal way of conducting the activity. However, improvements could be made if new rules and standards were implemented, as there is a common acknowledgment of the benefits of recycling which would have an impact on the material waste.

5.10 Standardised processes

In general, when undertaking construction activities, the workers followed the technical steps required by that activity, but no other standardisation was implemented. Most of the interviewees, according to their skills and technical knowledge, made their own variations when performing the same tasks, being empowered to decide how to conduct their work.

Following the empirical data, it was noticed that there are important waiting times and unnecessary movements during work preparation, due to a poor organisation, lack of clear procedures and improper materials storage. The interviewees found this situation normal, although they admitted some improvements could be made. A similar situation as before was observed, where the workers share two views. The first one is when the workers show that they have some theoretical knowledge about how to avoid materials damage during transportation and manipulation, or what should they do during waiting times. The second one, concluded from the case study data, is the fact that it was seldom the case that the workers actually applied their theoretical knowledge.

Moreover, due to the improper storage of the construction materials, damages occurred during transportation and manipulations, a fact which was corrected by using their problem-solving skills, and technical solutions were found, when it was possible, to use those materials even in that condition.

No visual controls were used to assess work or find information about work procedures and site progress, even when they had been seen to be beneficial on other sites where such a system was implemented. The workers lack the information of the visual controls potential and benefits.

It can be summarised that in the company there is a culture where the highly-skilled workers are empowered to conduct the work in their own way, according to their own habits and thoughts, without adhering to other strict rules or procedures. However, the site managers are supervising their works and progress, and correcting potential technical deviations, showing understanding and acceptance of waiting times or improper materials storage.

6 CONCLUSIONS

In this chapter the final conclusions will be formulated, regarding how the Romanian construction company might implement and develop a Lean culture, considering the current situation. Moreover, some future recommendations and studies are suggested.

6.1 Lean implementation

Following the analysis of the empirical data and the theoretical knowledge about Lean cultural requirements, the conclusion can be drawn that this Romanian company partially fulfils some of the requirements to implement and develop a Lean culture. At the same time, the lack of culture for safety, organisation or standardised processes makes this journey harder.

6.1.1 Success factors

The following section summarises the success factors which will foster a Lean cultural implementation and development in the company.

6.1.1.1 People development

One of the most important success factors which allows Lean culture development is the company's policy of dedication to its employees. By focusing on people, the company is successful in keeping employees for long periods of time.

Each worker is trained, coached and encouraged to develop technical skills and expertise in the construction field. It can be stated that in the company there is a culture for people-development and support in both their personal and professional lives.

This culture is very similar to the Lean culture which Toyota has developed inside its company, people being the "heart and soul" of the Toyota ethos. Every technical process is based on people, and their development is essential for Lean tools implementation and therefore for the company's success.

6.1.1.2 Trust, respect and collaboration

Another success factor, which can foster a Lean culture is a work environment of trust, respect and collaboration among the employees. These are essential for developing a Lean culture, as trust and respect towards and between the employees are one of the main pillars.

The company is successful in having good working teams, where collaboration between them is one of the main aspects. Workers conduct their activities in teams, under a good leadership, showing good technical knowledge and problem-solving skills. Moreover, the company has built a free-from-punishment environment, where mistakes are allowed, and workers can learn from them. Workers are empowered to take technical decisions about their work and they show responsibility and awareness of the importance of their work.

6.1.1.3 Collaborators

The relationship with clients and other sub-contractors or even other companies from the construction industry is built on a good collaboration. By sharing the same values of trust, collaboration, respect, fairness, and commitment to the workers, these companies have been able to develop long-term and good working relationships between them, which have developed over the years. It is interesting to notice that the company has succeeded over the years in retaining as collaborators, companies which are similar to it in their policies. For establishing a Lean culture, it is important to develop good relationships with partners, suppliers and nonetheless with the clients.

6.1.1.4 Genchi Genbutsu

One the company's best attribute is the management's direct and constant involvement in the construction works, knowing both the progress of work and workers' wellbeing. Moreover, the management seeks to build consensus among the workers, when technical decisions are made, with workers taking an active part. Genchi Genbutsu (go and see) is an important pillar in building a lean culture, as it represents one of the core principles of the Lean way.

6.1.2 Barriers

The following section summarises the barriers which must be overcome by the company if it is to implement and successfully develop a Lean culture.

6.1.2.1 Long-term policies and strategies

One of the major drawbacks is the company's lack of clearly-articulated strategies and policies. At the current time, the employees have faith in the management's skills in conducting company business, but they do not know clearly what they are. They are not part of any long-term thinking statements and they do not contribute to the company's development.

Having a long-term philosophy is very important for giving to the employees a sense for their work, making them part of the company's long-term objectives. Moreover, if a company has a long-term philosophy, it will take decisions based on it, and not on the variations of the market or other financial short-term implications. Toyota Company pays particular attention to these aspects, with long-term thinking being formulated as the Principle number 1.

6.1.2.2 Quality and safety culture

Another setback is represented by the lack of a culture of getting the quality right first time or for health and safety. Usually poor quality is caused by the lack of interest and care of the employees when conducting their work, and as for the health and safety all employees consider that they are working safely even if they disregard all the regulations. To successfully implement a Lean culture, these aspects must be solved and embedded thoroughly in the mindset of the employees.

6.1.2.3 Cleaning and site organisation

Cleaning, maintaining order and site organisation are also problems in the current context of the company's way of conducting its construction activities. These are important aspects which could enable and help to develop a Lean culture.

It is interesting to notice that some of theoretical knowledge is already known by the company's employees, but there is a lack of following and implementing them. Lack of a clear policy or of rules and procedures have worked together to create this environment and implementing a 5S tool could help in solving these aspects.

6.1.2.4 Material waste and recycling

The current culture for material waste and recycling is one of indifference and laziness, in an environment where there are no rules and regulations. Even if these aspects are not considered direct Lean cultural enablers, it is important to have them implemented to create a proper working environment and mind set.

6.1.2.5 Standardised processes

To achieve a Lean environment, one of the first actions which must be taken is to standardise each process. Attaining this allows a base line to be set from which any deviation can be observed and therefore corrective actions or measures can be taken.

In the present state, the company does not have any clear standardised processes, beside the technical steps which the construction work requires. The employees show high levels of skills and expertise when conducting the construction works but standardising the work and implementing clear working procedures will foster a continuous improvement environment.

6.2 Concluding remarks

A conclusion can be formulated that this Romanian company partially satisfies some of the requirements to acquire a Lean culture, most important being the focus on employees' development, which has created a good work environment based on trust and respect, and Genchi Genbutsu.

The barriers for developing a Lean culture, such as, lack of culture for safety, organisation or standardised processes, could be overcome by implementing clear rules, procedures and work standardisation, with a close follow up of their implementation. The company could succeed in this way to develop a Lean culture and adhere to Lean management tools and principles.

Visual information, '5 Why' and '5S' are some of the Lean tools which could be used to assist during their application. Beside these rules and procedures, the management should establish and implement a clear long-term vision for the company and make the employees part of it.

The overall impression is that the current state of the company could represent a good basis for the Lean journey if the management were to decide to learn about and follow it. The employees showed good theoretical knowledge and a high level of skills and expertise, the lack of rules, procedures and long-term vision being among the most important problems which the company will have to be overcome.

By a strong management involvement, which the company clearly demonstrated that could have, keeping an open mind towards change and allocating the necessary time and financial resources, the company could develop and implement a continuous improvement environment, being able to reduce costs, increase quality and identify and eliminate waste from non-adding value activities, as well as material waste.

Nevertheless, if the company will start the Lean journey, the guideline suggested by Bakås et al. (2011) should be undertaken for a successful implementation and development.

6.3 Outline of the research questions

Through this thesis it was proposed to study the barriers and success factors for implementing and developing a Lean culture necessary to enable Lean management tools at a Romanian construction company.

The aim was to assess company's flexibility and adaptability to implement Lean management cultural prerequisites according to the established barriers and success factors in order to improve its work environment and employees' satisfaction, so as to reach an improved position where work efficiency can be increased, and waste reduced, no matter what its form.

The research questions which were established for reaching the aim of the thesis, were answered in the following way:

- the first research question *'Why is it important to understand and develop a Lean culture when implementing Lean management tools?'* was answered in the theoretical framework chapter no. 2, especially in the subchapters 2.1.3, 2.1.4 and 2.3.3, but not limited to them.

- the second research question *'What are the barriers and success factors for implementing and developing a Lean culture?'* was answered also in the theoretical framework chapter no. 2, particularly, the subchapter 2.3.1 approaching this aspect. In this subchapter there were identified the main barriers and success factors which companies, especially small and medium size ones, encounter during their Lean journey.

- the third research question *'What is the company's current situation as regards these barriers and success factors?'* was answered in the analysis chapter no. 5, the case study and the interview questions being analysed through the already established barriers and success factors and Lean principles.

- the fourth research question *'What are the possibilities for this Romanian construction company to implement Lean management tools?'* was answered in the conclusion chapter no. 6, especially in the concluding remarks from the subchapter 6.2.

6.4 Further studies

It would be interesting to investigate whether the current context of this company is a common one, spread across many Romanian construction companies, or whether this company represents an exception. This enquiry appeared as the interviews were conducted and the empirical data analysed, and the interviewees referred to other companies in contradictory terms.

These studies might also enrich the limited academic data regarding the work and cultural environment from Romanian construction sites.

Furthermore, it would be exciting to see and follow an actual implementation of Lean management in this company, to analyse the cultural development and effects of the Lean tools.

Additional possible studies, which could be suggested, might be further investigations to other companies' current work and cultural environments to assess their flexibility and adaptability to implement and develop Lean management.

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8 Appendix

8.1 Interview questions

	Introduction
1	*What is your name?*
2	*How old are you?*
3	*What training/qualification do you have?*
4	*Do you have other qualifications?*
5	*Do you have studies in the field?*
6	*What position do you have within the company?*
7	*For how long you have been working for this company?*
8	*For how long you have been working in construction?*
9	*How often to you change the companies for which you are working?*
10	*What is the reason which determine you to move to another company?*
	Position in company
11	*Describe in a few words your current position/role!*
12	*Are you satisfied with your role/position in the company?*
13	*How do you feel in general working for this company?*
14	*Why did you choose to work for this company?*
15	*Do you think you have a stable job without fear of getting fired?*
16	*Have you benefited from additional training in the company that will prepare you to work better?*
17	*How do you think it would look like an ideal work environment for you?*
18	*How do you think it should be an ideal company?*
19	*What is your motivation to come to work and do your job?*
20	*Do you have any social related problems that could interfere with your ability to work?*
	Work relationships
	Chief
21	*Who is your direct chief?*
22	*Do you have any other boss?*
23	*How would you describe the relationship with your chief?*
24	*How is the communication between you and your chief?*
25	*How does the communication take place between you and your chief?*
26	*Do you think your chief knows how to listen and understand you?*
27	*Do you have a personal relationship with him?*
28	*How often do you meet?*
29	*How do you feel you cooperate with your chief?*
30	*What are the negative aspects of the relationship with your chief?*
31	*What are the positive aspects of the relationship with your chief?*
32	*If you have a conflict with your chief how do you proceed?*
33	*How often do you see your chief going on the site, asking questions about current work and problems?*

	Trust (1) of employee in chief
34	*Do you trust the chief's decisions?*
35	*How will you assess chief's ability to take decisions?*
36	*How will you assess chief's ability to lead the team you belong to?*
37	*How will you asses your chief's ability to perform the job duties?*
38	*Do you think your chief is dedicated to the company and the team?*
	Trust (2) of chief in employee
39	*Do you feel that your chief trusts your way of working?*
40	*Do you think your chief trusts you to let you work without supervision?*
41	*When are you given a task, do you receive work instructions?*
42	*Do you think your chief has confidence to let you work without giving you work instructions?*
43	*How do you prefer to work supervised or unattended?*
44	*How do you prefer to work with or without working instructions?*
45	*Do you think the chief helps you to conduct your work?*
46	*Do you think you can talk freely with your chief without getting him angry or to punish you in any way?*
47	*Have you ever come up with new ideas about improving work?*
48	*Have you ever shared these ideas with your chief?*
49	*What happened in this situation?*
50	*Have you ever said "no" to your chief when you thought you were right or the decision taken was wrong?*
51	*What happened in this situation?*
52	*How do you feel when you are working with your chief?*
53	*Have your chief shared with you his feedback about your work?*
54	*What kind of feedback was?*
55	*Did this feedback help you in any way?*
	Team
56	*How many members are in the team you work in?*
57	*How would you describe the relationships with colleagues?*
58	*How do you think you collaborate, cooperate and work with them?*
59	*How is the communication taken place?*
60	*How do you solve possible conflict situations between you and other colleges?*
61	*How do you feel about working in this team?*
62	*Do you prefer to work in team or alone? Why?*
	Other teams/subcontractors
63	*How do you communicate and cooperate with other subcontractors' teams?*
64	*How will you solve possible conflict situations that occur with other subcontractors?*
65	*If someone besides your chief tells you to do something, what do you do?*
	Other questions
66	*On a scale of 1 to 10 (1 worst, 10 best) how will you evaluate your performance at work?*
67	*On a scale of 1 to 10 (1 worst, 10 best), how will you assess your skills to perform your work?*
68	*Do you think your work could be executed better and faster?*
69	*What is it necessary to work better and faster?*

70	*Do you think you can make decisions by yourself about your work?*
71	*Have you ever done anything to improve your work?*
72	*Do you trust the company policy?*
73	*Do you have respect for your chief?*
74	*What do you think and do when a new rule is imposed on the site?*
75	*In general, if you have a problem what do you do to solve it?*
76	*How does the work make you feel?*
77	*Do you consider yourself responsible for your work?*
78	*Are you qualified enough to replace a colleague from your team?*
	Material waste
79	*How much waste material exist around the site, which is not stored or deposited in special places?*
80	*How frequent does it happened to be waste material around the site, which is not stored or deposited in special places?*
81	*Is the waste material a problem to conduct your work?*
82	*Who is responsible with cleaning and gathering of the waste material?*
83	*How frequent is this activity performed?*
84	*Do you take any personal action to clean the waste material?*
85	*Do you recycle waste materials in site?*
86	*Do you recycle waste materials in your private home?*
87	*In your opinion why is not recycling spread on a larger scale in Romania?*
88	*Do you take any actions to reduce waste materials in site?*
89	*What do you think about recycling in general?*
90	*What do you know about the impact of waste materials on the environment?*
	Transportation
91	*How often are delivered materials in site?*
92	*On what base is made this decision?*
93	*How often does it happen to move around the site the stored materials?*
94	*Does it happen to find the stored materials deteriorated?*
95	*Do you take any measures to avoid unnecessary material handling?*
96	*Do you think is it a good measure to have more materials stored in site?*
97	*Do you think that having more materials could affect your activity in any way?*
	Scheduling
98	*How do you plan your daily activities?*
99	*How do you plan specific tasks?*
100	*Are your current work procedures standardised?*
101	*How do you find the work rhythm from the site?*
102	*How do you think should be an ideal state for work planning?*
103	*How often does it happen to do supplementary trips around the site because of a poor planification?*
	Equipment
104	*How often do the electrical equipment brake down?*
105	*What is in general the cause for the malfunction?*
106	*Who is responsible with their maintenance?*
107	*What actions do you take to maintain them in a good condition?*

	Work floor layout
108	*How will you describe a usual state of the working area?*
109	*What actions do you take to have a nice and clean working area?*
	Quality problems
110	*What do you do when quality problems occur?*
111	*Why do you think quality problems occur?*
112	*What actions do you take to avoid quality problems?*
	Error proofing
113	*Do you take any actions to prevent any kind of possible problems which might appear?*
114	*Do you ever try to find the root source of a problem?*
	Set up time
115	*What is the set-up time duration of an activity/task?*
116	*What actions do you take to reduce the set-up time?*
	Visual information
117	*Are any kind of visual information in site regarding the work procedures or about the project?*
118	*Would you be interested to find these kinds of visual information?*
	Waiting
119	*Did it happen to wait for a period until you were able to start your task?*
120	*What actions do you take to reduce these waiting periods?*
	Overproduction
121	*Were there situations when you realised you have worked too much?*
122	*What actions do you take to eliminate these situations?*
	Reworking
123	*How often did it happen to re-do your work?*
124	*What was the cause of this situation?*
125	*What actions do you take to eliminate these situations?*