CHARACTERISTICS OF A LEAN COMPANY

A quantitative study analysing the characteristics and environment of a lean company

Thomas Hendrik Kok
Mikaela Azelius
Milos Cuskic

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Abstract

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The purpose of this study is to comprehend what the characteristics are for companies that use lean, and where they operate. Earlier studies are often from a qualitative approach, where this study instead will be from a quantitative approach with survey data. The study presupposes two research questions; *What characterizes a lean company with regards to performance/targets, incentives/people, & macro-level factors*, and *In what regions are lean practices more common and how do the factors regarding performance/targets & incentives/people differ between the regions*? The study is realised with survey data from the World Management Survey, Sustainable Development Report, and the World Bank. The findings suggest that companies using lean often use a high level of other modern management practices such as focusing on long-term goals or non-financial performance. Other findings show that the regions Europe, North America, and Oceania have a larger scale of lean implementation than the regions East Asia, South America, and Asia. The most findings correspond with earlier previous studies and the most of the findings are as expected.

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1. Introduction

Lean manufacturing is a Japanese management style from the 1950s which has gained ground all over the world since then (Pearce & Pons, 2019). The goal of lean manufacturing is to reduce all types of waste, such as the waste of natural resources, and/or the waste of time. This can be used to achieve higher levels of sustainability in the company due to the lower amounts of waste. Many papers have argued for this being the case (Hajmohammad et al., 2013, Henao et al., 2019, Yang et al., 2010, Jørgensen et al., 2007, Maskell & Kennedy, 2007), and thereby, lean could be an important contributor to the worldwide issue of climate change. The issues being sorted with the help of lean are often about a lack of effectiveness and high amounts of wasted assets. It could be argued that the problems solved by lean are bigger than only corporate issues, if lean could help in the battle against climate change, it would benefit a large number of individuals around the world. After all, the biggest companies represent over 70% of world carbon emissions (Griffin, 2017), which indicates that companies could play a large role in the reduction of carbon emissions and other environment harming activities. It would be of high interest for companies within manufacturing to use lean in their processes because the gained effectiveness can also increase financial results and profitability.

1.1. Purpose and Research Gap

Since lean has become a widely used concept all around the world, the research on the topic has increased as well. From all the research papers done on lean management, a substantial share is done through qualitative analysis, a case study is performed, and is thereafter used to define or analyze lean. The reason for this is that much within lean is difficult to quantify, after all, lean is quite qualitative in its characteristics. It is, however, easier to quantify the effects of lean, for example, profit or waste (Pearce & Pons, 2019).

Another way of working with quantitative workways is to analyze lean management through survey data. However, in total, quantitative research is underutilized and makes up only a small portion of lean research (Pearce & Pons, 2019). This creates a need for more quantitative studies on lean which this paper aims to contribute to. Especially survey studies are, according to Pearce & Pons (2019) underutilized and consist of only five percent of total lean research. Lean surveys can be used to quantify questions of a more qualitative nature, such as to what extent lean management techniques have been introduced in the company.

Furthermore, it is still important to consider what survey data is valid, it is after all hard to quantify management methods and it is easy to make mistakes such as subjectivity in the surveying (Esaiasson et al., 2017). However, this study uses a dataset that satisfies the requirements for an objective survey. Another lack from some of the quantitative studies done on lean is that many surveys only use smaller sample sizes which leads to fewer respondents. Something this study also strengthens by using larger sample sizes.

Many of the quantitative survey studies done on lean have focused on finding if certain factors affected either the use of lean or the effectiveness of lean including Fullerton & Wempe (2008) and Bloom et al. (2007; 2010; 2012; 2014; 2017). Not many papers have done overviews over how different types of factors together are related to the implementation of lean. This study aims to contribute to the field of lean studies by creating a better understanding of what kind of companies use lean, what they are characterized by and what kind of goals they find important. The difference with other studies lies in the fact that several factors are considered in this study, with a special interest in the overall topics of *performance/targets* and *incentives/people*.

The first topic regards what kind of performance the company favors, and what kind of targets they focus on. This could include the performance of sustainable practices, or reaching certain goals for sustainability or other stake and shareholders. The second topic regards how the company works with its employees. An important factor of lean is *lean thinking* which means that the employees in a company need to have a special lean mindset to make the concept of lean effective (Ng et al., 2004, Othman & Khalil, 2018, Barney & Kirkby, 2004). The aim is to understand how certain employee policies are related to a company using lean. What kinds of policies do lean companies use?

Other factors being analyzed are on the macro level. To draw accurate conclusions from a worldwide dataset can be challenging. Therefore, some country factors will also be analyzed. This is done to understand what kind of countries lean companies most often operate in, and what these countries are characterized by. By doing so we will be able to shade light over where lean companies operate, and what kind of macro factors they are related to. To tackle the problem with differences across the world, an analysis will be done where different parts of the world are being compared with one another. These parts of the world are divided into six different regions: *Europe, East Asia, North America, South America, Oceania,* and *Africa*.

The findings of this study hope to be of use for future research by creating an understanding of what lean companies are characterized by and where they operate. The research questions answered in this paper are:

-*What characterizes a lean company with regards to performance/targets, incentives/people, & macro-level factors?*

-*In what regions are lean practices more common and how do the factors regarding performance/targets & incentives/people differ between the regions?*

The main data used in this study is collected from the World Management Survey. Other sources of data are collected from the World Bank and the Sustainable Development Report. The data from the World Management Survey is commonly used by papers such as Bloom et al. (2007; 2010; 2012; 2014; 2017). The data is structured around a variable measuring the level of lean implementation in a company, whereafter different independent variables will help us analyze the correlations between different factors and the implementation of lean practices.

2. Theory and Previous Research

2.1. Background to Lean

Lean is all about reducing waste. Waste is defined as anything that doesn't add value to the product. Lean manufacturing is divided into two main pillars: *Jidoka* and Just-In-Time (JIT). The goal is to create high-quality products, at the lowest possible cost and with the least amount of waste (Gupta & Kumar Jain, 2013). The implementation of lean manufacturing goes through four different stages. Firstly, identification of wastes in the system needs to be done. The organization should first know where the waste is created to reduce waste. Secondly, the different kinds of waste need to be identified, waste can be of different characteristics, for example, time waste or material waste. The third step is to find a solution for the root of the causes, this also includes seeing a difference between causes and root causes. The last step is finding and testing solutions, it is important to follow up on the results continuously and to train employees accordingly. It might take time for an implementation to show its results so patience is often needed (Gupta & Kumar Jain, 2013). *Figure 1.1* below shows some basic lean concepts and the two main pillars of JIT and Jidoka.

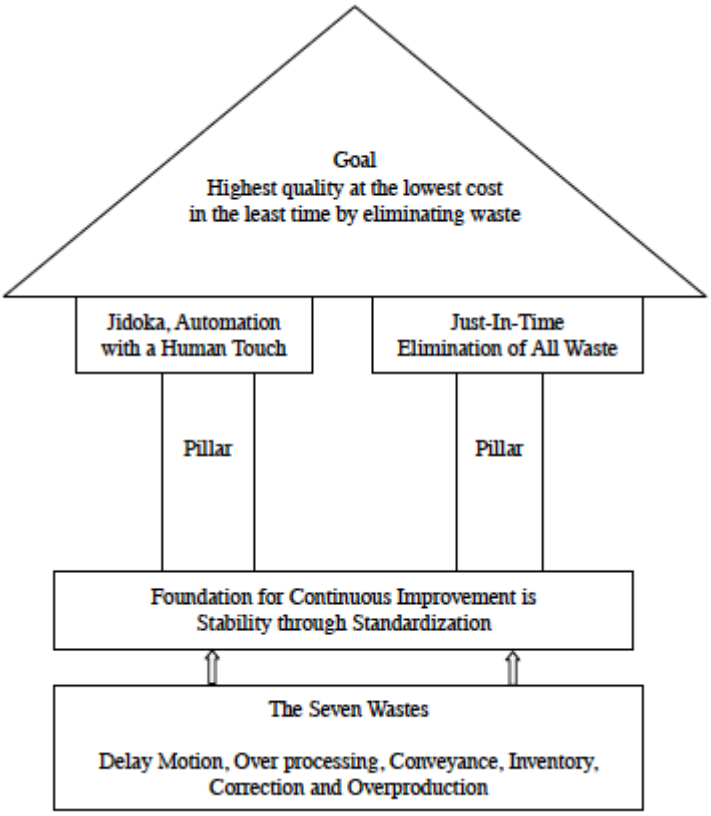

Figure 1.1 Basic Lean Concepts (Source: Dennis, 2007)

Lean gained ground during the 1970s and 1980s as a Japanese management system, at first it was believed to only work in some special Japanese companies with managers that required a special way of thinking, but when more research and implementation started to spread, the rest of the world started to realize that the Japanese had developed a superior management system (Pearce & Pons, 2019). The first real success outside of Japan was an MIT project; the International Motor Vehicle Program (IMVP), which introduced lean to the rest of the world and showed that it was here to stay.

2.2. Lean and Sustainability

Some papers analyze how supply management and lean dispense can boost an organization's environmental accomplishment (Hajmohammad et al., 2013, Henao et al., 2019, Yang et al., 2010, Jørgensen et al., 2007). Findings show that a company may implement the principles of lean and supply management in order to foster a positive environmental impact. '*Supply management as well as lean activities provide means by which environmental actions can be encouraged leading then to improved environmental performance'* (Hajmohammad et al., 2013). Lean manufacturing has a positive incentive for all three Triple Bottom Line (TBL) posts, which are operational, environmental, and social (Henao et al., 2019). Besides having a facilitating impact on these factors, lean manufacturing can promote social and environmental aspects, which thereafter produces financial returns. Furthermore, others argue that sustainable achievement is not the outcome of lean manufacturing itself (Yang et al., 2010). Lean should be extended from a normal waste reduction in order to increase efficiency, to a larger focus on environmental waste reduction increasing environmental efficiency. It is emphasized that the organization´s environmental performance may increase through a hybrid implementation of lean manufacturing and environmental management practices (Yang et al., 2010).

It is commonly argued that lean and sustainability often are associated with each other through waste reduction of raw materials or to create economic stability (Jørgensen et al., 2007). However, there should be a larger emphasis on the sustainability of lean itself. This means to create a lean thinking and/or lean culture which gives employees and managers a special mindset helping them to make good lean decisions. Many companies have struggled to achieve long-term profit from implementing lean, which is commonly presented by the literature (Jørgensen et al., 2007, Maskell & Kennedy, 2007). This is suggested to become

avoidable when implementing both the performance side of lean and the culture/mindset side of lean (Jørgensen et al., 2007, Maskell & Kennedy, 2007).

2.3. What kind of Companies use Lean

Some studies have analyzed how Non-Financial-Manufacturing-Performance (NFMP) mediates the relationship between lean and financial performance (Fullerton & Wempe, 2008). Findings suggest that using NFMP measures in the company makes lean more effective compared to no NFMP measures. In other words, NFMP is a good mediator between lean and financial performance, it has a significant effect on profit. It is argued that these kinds of findings create a better understanding of why some results on how lean affects financial performance are inconsistent with each other (Fullerton & Wempe, 2008).

Having a successful implementation of lean is partly dependent on how shop floor employees are involved in the decision process (Fullerton & Wempe, 2008). Findings show that when shop floor employees have more to say about different kinds of decisions, lean becomes more effective, this can be described by the fact that on floor employees have a better understanding of the processes on the work floor, which means that they know better what is needed for improvement, making the lean more effective (Fullerton & Wempe, 2008).

Different characteristics of ownership are argued to have different outcomes on the success of the company's management. Private equity and 5+ shareholder companies management scored the highest in Bloom et al. (2012) quantitative survey. Companies with higher average management scores are more likely to embrace modern manufacturing practices such as lean manufacturing. Family-owned companies on the other hand are less likely to implement new or different practices to improve. The fear of change is more prevalent in “family-run” companies since they have consequently higher personal costs (Bloom et al., 2012). Gokaldas Exports are an example of a large family-owned business that did not want to embrace lean management practices, only reluctantly after rising competition in Bangladesh, numerous field trips to Asia, and plenty of interventions from the family. Resistance to change occurs to a greater extent in family-owned companies but it's not exclusively an ownership issue. General Motors had a hard time implementing the Toyota Production System in the 1980s and 1990s, indicating that new management practices take time and require the whole company's ability and willingness to change. The lack of understanding and implementation

techniques demonstrates why some companies may not change their old management practices even though they are ineffective and costly compared to more modern management practices (Bloom et al., 2017).

The level of education, whether looking at managers or workers, is strongly correlated with high management scores. It's not implausible to deduce that a manager with an MBA or college education is most likely aware of different modern management practices such as lean manufacturing and their benefits to the company. Educated workers are also correlated with high management scores, indicating that it may make the implementation process easier if the workers have knowledge about lean manufacturing. For instance, many lean manufacturing techniques are dependent on the worker´s initiative and performance (Bloom et al., 2017).

Another factor that would make lean more effective is talent management (Othman & Khalil, 2018). If done properly it can be an effective way of bringing in lean thinking among employees. It is argued that in companies that need high levels of creativity, it is of high importance to reduce factors creating demotivation, such as organizational injustice, poor working environment, or bad rewards for performed work (Ng et al., 2004). Factors like stress can also be demotivating, and thus reducing productivity. (Ng et al., 2004, Barney & Kirkby, 2004). Demotivation can result in time losses of up to thirteen hours. It is thus argued that it is of high interest of the company to reduce this time waste, and lean can be a good solution to this problem (Ng et al., 2004, Othman & Khalil, 2018).

There are other important factors that need to be implemented in the company to provide support for lean manufacturing activities (Fullerton et al., 2014). Examples include accounting and information technology. The strategic influence of management accounting is highly emphasized, due to the fact that it provides financial stability and contributes to the decision-making in the organization. Critics against the implementation of traditional management accounting with lean manufacturing claim that it leads to decision-making that is in contradiction to the lean principles. However, empirical findings show us that the lean perspective in accounting management contributes to waste reduction and helps to maximize the organization's capacity (Fullerton et al., 2014).

Information and clear measuring systems are critical when implementing any management practice and when managers were asked to objectively score how well their company was

run, they tended to overestimate their management performance. Suggesting that their subjective assessment did not correspond to reality. The manager may not be aware of the need for better practices which can result in a poor run company (Bloom et al., 2017).

2.4. What kind of Countries use Lean

Quantitative surveys of manufacturing management at a global level provide an opportunity to read and measure results from different countries and also to make comparisons. One study has found and measured differences between companies and countries using data from the survey approach of Bloom & Van Reenen (2007). They found that Central Asian transition countries such as Kazakhstan and Uzbekistan score very poorly in management productivity and they are less likely to have implemented lean practices. Central Asian transition countries' scores are below developing countries such as China. Central European transition countries such as Lithuania and Poland are in contrast only slightly behind developed Western European countries such as Sweden (Bloom et al., 2012). Management practices differ across countries and companies within countries and it has been calculated that they are positively associated with several measures of a company's performance, for instance, productivity and profitability. Factors such as product market competition, ownership, human resources, labor regulation, multinational status, education, and information seemed to be important factors in influencing the quality of the management (Bloom et al., 2010; 2012).

Transition countries in Central and Eastern Europe have since the 1990s increased substantially with policies focusing on what is believed to sprout good growth performance, such as liberalizing trade, competition and uphold a stable macroeconomic environment (Bloom et al., 2012). Building on the notion that strong competition drives out poorly managed companies and also improves performances from incumbent managers who in response sprout behavior changes in order to survive. Companies with a higher management score in Bloom et al. (2012) survey believed they had many competitors. The transition countries´ product market competition score is in the intergovernmental economic organization, so-called OECD below average (Aghion et al., 2010). Suggesting that their product market competition is not as competitive which enables low productive companies to survive and there will be no incentive to improve and discover best practices such as lean management (Aghion et al., 2010). Bloom et al., (2012) suggest that a more effective

competition policy would increase companies´ performance in transition countries, especially in Eastern nations.

Different countries tend to emphasize and excel in different styles of management (Bloom & Van Reenen, 2010). For instance, Swedish companies were better at monitoring than US companies but on the other hand, the US was better at creating incentives. These country management styles tend to be carried over in multinationals countries as well. Tougher labor market regulation correlated negatively to incentives but could on the contrary correlate positively to monitoring or targets, as in the case of Swedish companies versus US companies (Bloom et al., 2010).

It is a common idea that Japanese companies are ahead when it comes to lean, which comes from the fact that they were the first country where it gained ground (Gupta & Kumar Jain, 2013, Pearce & Pons, 2019). However, it is argued that too much lean can create large-scale issues (Cusumano, 1994). This is due to the high implementation of lean and especially JIT has created unrealistic demands creating traffic jams and other gridlocking issues. This is because too many factories demand just-in-time deliveries gridlocking the country. In other words, there is a need for high-quality infrastructure to keep up with a just-in-time supply chain, to avoid a gridlock like in Japan during the 1990s.

2.5. How does Lean Affect the Company

When looking at the empirical evidence on how lean manufacturing affects a company and its employees it should be noted that there is a large number of papers. It is thus hard to present all findings, but some of the most prominent ones are being presented down below. In an MIT manufacturing plant, an eight-hour advantage in labor hours per car was gained after implementing a lean-approach. Other companies saw a large reduction in complaints after implementing lean. Some empirical findings found that the quality of the products increased after implementing lean, and by this, the total sales went up as well (Barney & Kirkby, 2004, Henao et al., 2019). However, other empirical findings show us that lean sometimes could lead to conflicting situations when to choose between continuing manufacturing or focusing time on improving the system. In some companies, it was found that this led to a backlog in manufacturing. In some companies, continuous improvement became a form of firefighting and constantly looking for ways to improve while not putting the focus on actual

manufacturing. Other companies implemented too much responsibility on managers, and less on employees, making the lean process ineffective (Barney & Kirkby, 2004).

One part of lean manufacturing is that it requires employees to be engaged in the goals and tasks they perform. If they don't have this engagement, this could lead to the lean system not fulfilling working empowerment. It is also a common finding that employees get more stressed under a lean organization. Which goes against the principle of working empowerment (Barney & Kirkby, 2004).

The application of just-in-time would eventually reduce the costs of the organization, through the delivery of every part being at the right place at the right time (Boyd et al., 2002). The implementation of the just-in-time concept results in direct and indirect costs, which the organization needs to evaluate. The redirection of the organization might result in increased costs, as well as the training of the employees. The just-in-time concept might have a positive impact in the longer term when the introductory costs have paid off. Furthermore, it is claimed that although net income increased, an adoption of JIT is not a guarantee of an increase in sales (Boyd et al., 2002).

2.6. Summary of Findings and Expectations

The general findings from the literature review show us that lean is a useful method when working with sustainability and long-term goals (Hajmohammad et al., 2013, Henao et al., 2019, Yang et al., 2010, Jørgensen et al., 2007, Maskell & Kennedy, 2007). Other findings show us that there are factors that can make lean more effective such as the existence of non-financial goals or high involvement of employees (Fullerton & Wempe, 2008, Ng et al., 2004, Othman & Khalil, 2018, Barney & Kirkby, 2004). When looking at what kind of companies use lean, we can see that bigger companies with a larger share of higher educated employees are more welcoming to modern manufacturing practices (Bloom et al., 2012; 2017). Looking at what countries use lean, the findings show us that transition countries generally have fewer lean companies than developed countries, and things such as good competition regulation improve modern manufacturing practices (Bloom et al., 2010; 2012, Aghion et al., 2010).

From these findings, this study will look further into what kinds of companies use lean with the specific topics of interest being *performance/targets*, *incentives/people,* and *macro-level*

factors. The specific characteristics being analyzed are *non-financial performance, long-term goals, talent management, sustainable countries, countries with a high industry share,* and *regional differences*.

2.6.1. Limitations of Findings

Some of the findings presented in this chapter are in some ways limited. The findings by Fullerton & Kempe (2008) were done with a low number of respondents (121), which creates the possibility to look further into the effects of NFMP on lean by using a bigger survey with a higher number of respondents. In the paper by Hajmohammad et al. (2013), the sample size was yet again put into question, and their study was only studying the suppliers, which can be limiting the results. This paper will contribute to some of these limitations by using a larger number of respondents.

2.6.2. Expectations and Hypotheses

The first pair of hypotheses regard how *performance and targets* are related to the level of the implementation of lean. It is firstly argued that a higher level of Non-Financial Manufacturing Performance targets makes the use of lean more efficient (Fullerton & Wempe, 2008). It is thus of interest for the companies to implement lean together with the use of NFMP targets. Thus we expect the following:

H_{1a}*: Having a high level of non-financial goals has a positive impact on the level of lean implementation.*

As mentioned earlier, lean is suggested to be more effective in the long run, it is hence of interest for the company to focus on long-term goals (Jørgensen et al., 2007, Maskell & Kennedy, 2007, Boyd et al., 2002). Hence, the next hypothesis is:

H_{1b}*: Having a high focus on long-term goals has a positive impact on the level of lean implementation.*

The next two hypotheses regard the topic of *incentives and people*. It has been argued that talent management could make lean more effective since TM´s core activities are about meeting the needs of the company's human capital (Othman & Khalil, 2018). Many of the lean manufacturing techniques are dependent on the workers´ initiative, involvement, and performance (Bloom et al., 2017), having TM makes for an effective way to mobilize the

incentive for a lean thinking company (Othman & Khalil, 2018, Fullerton & Wempe, 2008). It is therefore of interest to the company to have high levels of talent management. Firstly, we look at how companies can keep their talents by rewards, and we expect that a higher level of rewards has a positive impact on lean implementation.

H_{2a}*: Having high levels of rewards has a positive impact on the level of lean implementation.*

The second part of the talent management analysis will look at how companies manage to attract talented employees. Similar to above, because it is argued that talent management improves lean effectiveness, it is of high interest to attract new talent. Therefore we expect that companies with higher levels of lean implemented, also have higher levels of practices trying to attract new talent.

H_{2b}*: Having high levels of talent-attracting practices has a positive impact on the level of lean implementation.*

The third set of hypotheses regard the *macro-level factors* of the countries the companies operate in. Firstly, because lean is argued to help achieve sustainable goals (Hajmohammad et al., 2013, Henao et al., 2019, Yang et al., 2010, Jørgensen et al., 2007), we expect that lean companies are more represented in sustainable countries.

H_{3a}*: Companies with high levels of lean implementation are more common in sustainable countries.*

Something that to our knowledge has not been tested much before is how the share of workers in the industrial sector in a country affected the level of modern manufacturing practices. We expect that countries with a high share of workers in the industrial sector will be able to benchmark themselves better, which in combination with high competition will lead to a higher level of lean implementation.

H_{3b}*: Companies with high levels of lean implementation are more common in countries with a high share of workers in the industrial sector*.

Lastly, when comparing the different regions of the world with each other, we expect that the regions Europe, North America, and Oceania will have a higher usage of lean, and South America and Africa will have less lean implemented. We expect this because arguments say

that developed countries use more modern manufacturing technologies (Bloom et al., 2010; 2012), and the above-mentioned regions are overrepresented by more developed countries. The reference region will be East Asia because this is the region of origin for the lean mindset.

H_4: *The regions Europe, North America, and Oceania will have higher levels of lean than the regions East Asia, South America and Africa.*

3. Methodology

3.1. Method

The method used in this study will be of quantitative character, one of the main reasons for this is that it is argued that there is a deficit of quantitative lean studies (Pearce & Pons, 2019). A qualitative case study would also have been an option to answer the research question, however, this will limit us in time and will ultimately result in a smaller sample size. When over-generalizing the results from a small sample, the risk occurs that the validity of the study is lower. The risk of subjectivity is also reduced by doing quantitative analysis. A quantitative study enables us to use a large sample and make more accurate approximations of an entire population (Esaiasson et al., 2017). Although, even when using a quantitative method, carefulness is of high importance, even after using statistical methods there is a risk of drawing inaccurate conclusions.

To answer the research questions and test the hypotheses, a method built on three different parts will be used. The first part consists of basic descriptive statistics showing the shares of each level of lean in each region. This will enable us to see where lean is the most common. The six regions used in this study are *Europe, East Asia, North America, South America, Oceania,* and *Africa*. The choice for East Asia only and not the whole of Asia is because the data limits us to only eastern Asian countries (India included). *Table 3.1* shows all the countries used per region.

The second step of the analysis will consist of both univariate and multivariate regression analyses between the level of lean implementation and each of the independent variables. All independent variables will be tested in a univariate regression first, after which they will be tested in multivariate regression analyses, both after their topic (*performance/targets*, *incentives/people,* and *macro factors*), and an analysis testing all the variables in the same model. The independent variables will be explained more thoroughly later in chapter 3.2.2., but they consist of *non-financial performance, long-term goals, rewards, attracting talent, sustainable countries,* and *countries with a high industry share*. All these variables show the company's use of the variable in question, not the performance or results. This part of the analysis will enable us to see how each independent variable is related to the implementation of lean by itself, and in combination with other variables. This part of the study will not

consider the different regions as presented in *table 3.1*, instead, all companies surveyed will be tested in the same model.

Table 3.1: Countries per Region

Europe	East Asia*	North America	South America	Oceania	Africa
Germany	*India*	*USA*	*Argentina*	*Australia*	*Ethiopia*
Spain	*China*	*Canada*	*Brazil*	*New Zealand*	*Ghana*
France	*Japan*	*Mexico*	*Chile*		*Kenya*
GB	*Myanmar*	*Nicaragua*	*Colombia*		*Mozambique*
N. Ireland	*Singapore*				*Nigeria*
Greece	*Vietnam*				*Tanzania*
Ireland					*Zambia*
Italy					
Poland					
Portugal					
Sweden					
Turkey					

*East Asia will act as a reference region in the third part of the analysis.

The third and last step of the analysis will consist of different regression analyses showing differences between regions in a statistical way, instead of descriptive as in part one. In this part, all countries will be coded into group variables according to the different regions. East Asia is chosen as a reference region because it is where lean has its roots (Cusumano, 1994). After this, interaction variables will be coded which will enable us to see differences in the effect of the independent variables between the regions. These variables are *(1) Region X Non-Financial Performance, (2) Region X Long Term Goals, (3) Region X Rewards,* and *(4) Region X Attracting Talent*. Note that no macro variables are used in step three as this step already considers national differences. Lastly, regression models are done showing us what the level of lean is relative to East Asia, and what the differences are between the independent variables across the regions. This part will enable us to see in which region lean is the most common, and what characteristics are more common in the different regions.

3.2. Material

The material used in this study comes from the World Management Survey (WMS), which is a project that aims to measure the unmeasurable parts of the production process in large manufacturing companies, and by this create a better understanding of the *black box of productivity*. It started in 2002 and has since done surveys and interviews and has grown significantly to become a large provider of management data for different kinds of purposes[1]. The specific data used in this study is gathered from the dataset *Manufacturing: 2004-2014 combined survey data (JEEA 2014)*, which is a dataset consisting of over 11.300 manufacturing firms from 35 different countries. The data shows us the average values for all companies between 2004 and 2014, which makes the values in the dataset accurate over this period, with less risk of one year having many extreme values. The fact that the number of respondents is high and that many countries are represented enables us to analyze more accurately compared to a small sample size (Esaiasson et al., 2017).

Unlike more qualitative case studies, the WMS dataset uses random sampling which is important when doing quantitative analysis (Bloom et al., 2014). The variables in the dataset are gathered through a specific method aiming to measure management practices. They use an interview-based evaluation method giving scores between one to five where one represents low practice, and five represents high practice. There are in total eighteen key management practices being measured, divided into three different sub-categories; *monitoring, targets,* and *incentives/people management*. The interviews use a double-blind technique to secure more accurate scores. This means firstly that the respondent doesn't have any knowledge that they are being scored, and secondly that the interviewer does not have any prior knowledge of the company in question, making the answers and interpretations of answers more objective (Bloom et al., 2014).

3.2.1. Dependent Variable

The dependent variable used in this study is based on the questions regarding the *Introduction of Lean (Modern) Techniques, (Level of lean).* The variable is based on a score of one to five where five represents high usage of modern lean techniques, and one represents low usage of modern lean techniques. Each company gets its score based on the following questions: *(1) 'Can you describe the production process for me?', (2) 'What kinds of lean (modern)*

[1] https://worldmanagementsurvey.org/about-us/

manufacturing processes have you introduced? How long has this practice been in place? Can you give me specific examples?', and *(3) 'How do you manage inventory levels? What is done to balance the line? What is the takt time of your manufacturing processes?'* After this, the interviewer sets a score according to a scorecard, where score 5 means that almost all aspects of modern lean have been introduced, score 3 means that some aspects of modern lean have been introduced, and 1 means that few aspects of modern lean have been introduced. The interviewer can also set scores in between these values such as 2 and 4.

3.2.2. Independent Variables

The first independent variable is the level of *non-financial performance* in the company. It is based on the questions regarding *types and balances of targets*. The variable is scored in the same way as the dependent variable on a score between one and five. A score of one means exclusively financial goals, and five means a balance between financial and non-financial goals. The interview questions asked for setting this score are *(1) 'What types of targets are set for the company? What are the goals for your plant?*', and *(2)* '*Tell me about the non-financial goals.'* This variable is relevant for testing hypothesis H_{1a}.

The second variable regarding the topic *performance and targets* is the level of *long-term goals* in the company. This variable is based on the questions regarding the *time horizon of targets*. It is similar to the other variables coded on a scale from one to five, where one means having the main focus on short-term goals, and five means long-term goals which then are translated into short term targets, i.e. high use of long-term goals. This variable is based on the interview questions *(1) 'What kind of time scale are you looking at with your targets?', (2) 'Which goals receive the most emphasis?', (3) 'Are long term and short term goals set independently?'*, and *(4) 'Could you meet all your short-run goals but miss your long-run goals?*' This variable is relevant for testing hypothesis H_{1b}.

The topic regarding *incentives and people* is divided into two independent variables, each slightly different but both with the aim to understand the talent management within the company. The first one is rewards. This variable aims to measure the company's reward system with the goal to *build a high-performance culture through incentives and appraisal.* Building on a score measuring system from one to five. Where one shows no systematic approach to identifying good and bad performers and rewarding them proportionately, i.e.

rewards have no relation to performance. The higher the score, the more focus on performance and achievement in relation to the individual. Five means high levels of rewards for achieved targets. Four questions were given to the respondent *(1) 'How does your appraisal system work? Tell me about the most recent round?', (2) 'How does the bonus system work?', (3) 'Are there any non-financial rewards for top performers?',* and *(4) 'How does your reward system compare to your competitors?'.* This variable is relevant testing for hypothesis H_{2a}.

The other independent variable with the goal to measure talent management is built on the topic of *Distinctive Employee Value Proposition.* With the purpose to test the strength of the employees´ attractiveness for the company. Talent is the focus of this question giving answers to what importance talent management has within the company. The score counts from one to five, reflecting the variable being measured. Score one indicates that the company's competitors offer stronger reasons for talented people to join their companies. A score of five on the other hand indicates that the company provides a unique value proposition above their competitors to encourage talented people to join their company. The questions asked are as follows: *(1) 'What makes it distinctive to work at your company as opposed to your competitors?', (2) 'If you were trying to sell your firm to me how would you do this (get them to try to do this)?'*, and *(3)'What don't people like about working in your firm?'.* This variable is relevant for testing hypothesis H_{2b}.

All the variables from the World Management Survey (dependent variable and variables regarding *performance/targets* and *incentives/people*) are recoded into a scale from one to four. The reason for this is that the data is built on average scores, meaning that many companies have scores including decimals. Thus, these variables are coded into four categories being *(1): score between 1-1,99, (2): score between 2-2,99, (3): score between 3-3,99,* and *(4): score between 4-5*. This means that in the regression analyses, the highest possible score on these variables is four, and not five as in the survey. It should be noted that in the descriptive overview, the coding is as in the survey and the scores and means are all on a scale from one to five. To avoid confusion, this is being clarified under each table.

The last topic which regards the *macro-level* factors uses variables gathered from external sources outside the WMS. The first variable testing the macro level is how sustainable the

country of operation is. This variable is based on data from the Sustainable Development Report, which is a report presenting how well countries fulfill the United Nations' Sustainable Development Goals (SDGs). This score is based on a scale from zero to three, where three means full integration of the SDGs, and zero means no integration of the SDGs. These four scores are based on a larger score between 0-100, which is recorded to fit the model better. This variable is relevant for testing hypothesis H_{3a}.

The last independent variable is the share of workers in a country working in the manufacturing industry. This variable is gathered from the World Bank and is based on a scale from zero to two, where zero means no workers work in the industrial sector and two means that relatively many workers work in the industry sector. These scores are also based on data reaching from 0-100 and are recorded to fit the model better. Data is collected every year which enables us to find the year-specific data we need. This variable is relevant for testing hypothesis H_{3b}.

3.3. Limitations and Scope

There are certain identified limitations that should be considered with the data used in this study. Firstly, the collected data from the World Management Survey did not have an equal amount of countries represented through the interviewed respondents in the study. The distribution between the continents is distinctly Europe-dominated. This could in theory lead to more accurate scores in different parts of the world, however, all countries had a high number of respondents, which could still result in accurate results. Secondly, there are some limitations regarding the interview method. Even though they use a double-blind technique, there is a risk for the interviewer setting higher scores throughout the interview as the first few questions gave high scores. Also, the respondent from the company could give inaccurate information. Firstly, some information might be sensitive or confidential to share and is thus not said in the interview, secondly, there is a risk of the respondent answering better than what the reality actually is. The WMS is trying to reduce these risks by the double-blind technique, but it is not without any risks. Another limitation is that the data is gathered with the help of many different interviewers speaking many different languages. This could potentially both result in subjectivity and risk of misinterpretation because the questions are in different languages. If not all respondents understand the questions the same, it might give inaccurate results. However, training the interviewers tries to reduce this risk.

3.3.1. Ethical Aspects

It is also of high importance to consider the ethical aspects of a study like this one (Esaiasson et al., 2017). It is for instance important that the data is presented in a transparent way in order for the reader to be familiar with the collectors of the data (in our case the WMS), and that no credit is taken for other individuals' work (Esaiasson et al., 2017). It is hence of importance to note that we don't have any relation to the World Management Survey and that the main data used for this study is all theirs. Another important ethical aspect is that we don't fabricate or forge the data in order to create more pleasurable results (Esaiasson et al., 2017). This is taken into account when presenting our data, where we try to be as transparent as possible to ensure the reader that we don't fabricate or forge the data.

4. Results & Findings

In this chapter, the results and findings of the study will be presented. Firstly, a descriptive overview of the different variables will be done, with a special interest in the dependent variable (level of lean implementation). After this, regression analyses will be presented, firstly showing univariate models showing the correlations between the dependent and independent variables. After this, multivariate models will be presented showing the correlations by category and as a total model. Lastly, models will be presented showing the differences in the level of lean and the independent variables across the different regions.

4.1. Descriptive Overview

Figure 4.1: Use of Lean by Region

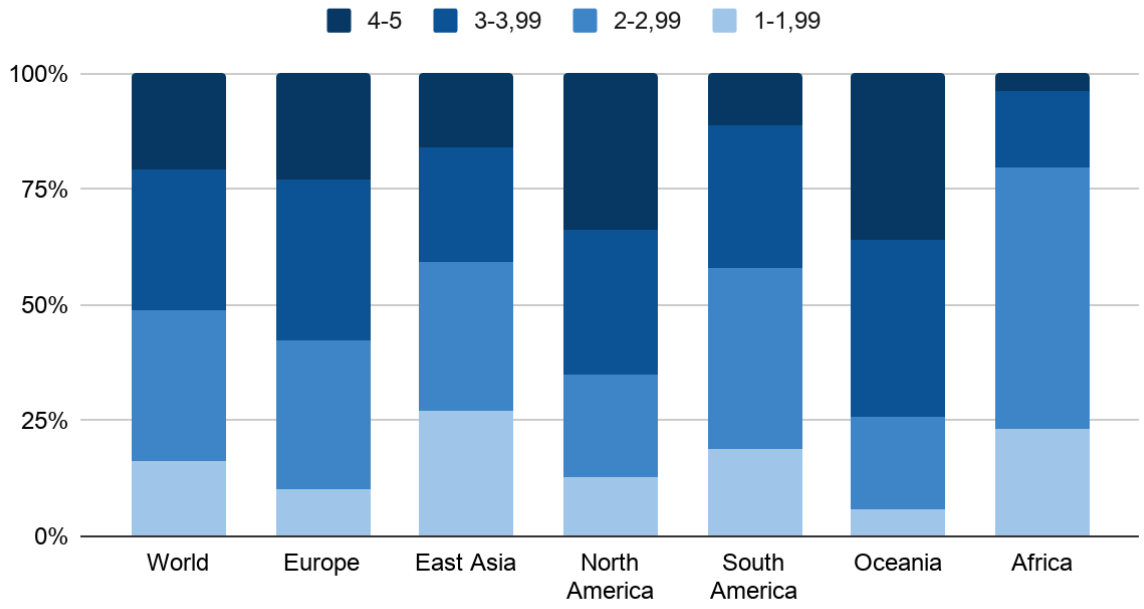

Figure 4.1 is a descriptive model showing to what level each region has implemented lean. The data is based on the dependent variable, *Level of lean.* We can see that the regions Europe, North America, and Oceania, in general, have more companies using a high level of lean practices compared to East Asia, South America, and Africa. We can see that Europe, North America, and Oceania all have more companies with higher levels of lean (3-3,99 & 4-5) than the world average and that the regions East Asia, South America, and Africa have more companies with lower levels of lean (1-1,99 & 2-2,99) than the world average. In general, the world average is about 50-50, where on the world level, the two highest scores make up 51 percent of the companies, and the two lowest scores 49 percent. The scores of

Europe are the closest to the world average. In Europe and Oceania, 3-3,99 makes up the most common score, in East Asia, South America, and Africa the most common score is 2-2,99, and in North America, the most common score is 4-5. It should be noted that Oceania and Africa both have high differences between lower and higher scores. In Oceania, the two highest scores (3-3,99 & 4-5), make up 74,2 percent of all the companies. While in Africa, the two lowest scores (1-1,99 & 2-2,99), make up 79,9 percent. East Asia has the most manufacturing companies with the least implementation of lean, 27,1 percent received scores between 1-1,99. These findings can give support to *hypothesis 4*, which asserts that the use of lean is higher in the regions Europe, North America, and Oceania than in South America and Africa, however, the figure does not show exact numbers and acts thus more like a schematic general picture. Therefore, *table 4.1* presents the same kind of data, across all variables and in a numeric way. *Hypothesis 4* will be reassessed in the third part of this chapter.

Table 4.1: Descriptive Statistics Showing Frequencies for all the Variables, in the World and the Different Regions

	World	Europe	East Asia	North America	South America	Oceania	Africa
	Level of Lean						
Mean	3,556	3,703	3,394	3,86	3,345	4,043	3,008
Std. dev.	0,991	0,932	1,034	1,027	0,91	0,886	0,738
Score 1-1,99 (%)	16,1	10	27,1	12,9	18,8	5,7	23,1
Score 2-2,99 (%)	33	32,5	32,4	22	39,2	20,1	56,6
Score 3-3,99 (%)	30,3	34,5	24,5	31,2	30,7	38,4	16,6
Score 4-5 (%)	20,7	22,9	16	33,8	11,3	35,8	3,7
	Non Financial Performance						
Mean	3,584	3,756	3,373	3,755	3,426	3,812	3,131
Std. dev.	0,981	0,941	1,036	1,001	0,916	0,969	0,756
Score 1-1,99 (%)	15,9	11	25,3	13,3	16,7	13,1	19,3
Score 2-2,99 (%)	29,8	26,5	28,9	25,4	37,1	18,6	51,8
Score 3-3,99 (%)	34,2	38,5	29,2	33,8	33,2	42,1	25,3
Score 4-5 (%)	20	24,1	16,7	27,5	13	26,1	3,6
	Long Term Targets						
Mean	3,683	3,836	3,535	3,931	3,442	3,839	3,212
Std. dev.	0,991	0,937	1,053	0,945	0,987	0,96	0,846
Score 1-1,99 (%)	14,6	9,6	21	9,1	20,3	11,5	22,5
Score 2-2,99 (%)	26,2	24,4	26,5	20,9	31,3	21	38,6
Score 3-3,99 (%)	35,5	38,5	30,5	37,7	32,3	39,8	34
Score 4-5 (%)	23,7	27,4	22	32,3	16,1	27,8	4,9
	Rewards						
Mean	3,418	3,225	3,695	3,706	3,178	3,689	3,371

Std. dev.	0,92	0,916	0,858	0,91	0,896	0,825	0,824
Score 1-1,99 (%)	18	23,6	10,7	10,3	25,2	6,7	20,5
Score 2-2,99 (%)	34,5	40,1	24,5	29,6	39,4	34,4	35,5
Score 3-3,99 (%)	35,3	26,7	49,3	39,4	27,9	42,3	40,4
Score 4-5 (%)	12,2	9,7	15,4	20,8	7,6	16,6	3,6
	Attracting Talent						
Mean	3,827	3,921	3,726	4,044	3,641	3,97	3,465
Std. dev.	0,809	0,795	0,825	0,783	0,789	0,699	0,754
Score 1-1,99 (%)	6	4,7	8,1	4	7,2	3,5	9,7
Score 2-2,99 (%)	24,9	21,6	27,2	16,5	33,8	15,3	40,5
Score 3-3,99 (%)	49,6	50,4	48,7	50,6	46,6	61,9	43,5
Score 4-5 (%)	19,5	23,2	16	28,9	12,4	19,3	6,3
	Sustainability Index						
Mean	2,308	2,821	1,697	2,737	2,227	2,25	0,781
Std. dev.	0,07	0,383	0,562	0,44	0,419	0,433	0,637
Score 0 (%)	2,4	0	0	0	0	0	33,6
Score 1 (%)	11,3	0	35,5	0	0	0	54,7
Score 2 (%)	39,4	17,9	59,2	26,3	77,3	75	11,7
Score 3 (%)	46,9	82,1	5,3	73,7	22,7	25	0
	Share of Workers in Industry						
Mean	1,15	1,344	1,414	1	1	1	0,117
Std. dev.	0,5	0,475	0,493	0	0	0	0,321
Score 0 (%)	6,3	0	0	0	0	0	88,3
Score 1 (%)	72,8	65,6	58,6	100	100	100	11,7
Score 2 (%)	20,8	34,4	41,4	0	0	0	0
N	11 701	4177	2415	1860	1809	601	839

Note that the macro variables (Sustainability Index & Share of Workers in Industry) are based on a country value, hence all companies from the same country share the same value. The mean is based on a scale from 1 to 5.

Table 4.1 is a compilation of all the dependent and independent variables. With descriptive statistics showing frequencies for all the variables based on manufacturing companies divided into different regions[2]. The *Level of Lean* shows a numeric representation of *figure 4.1*, supporting previous findings as from *figure 4.1*. The table shows us that East Asia has the lowest level of *Non-Financial Performance*, with the lowest scores making up 25,3 percent. However, when looking at the two lowest scores, Africa has the highest share with 71,8 percent of the companies receiving a score between 1-2,99. North America has on average the highest level of *Non-Financial Performance*, with a value of 27,5 percent in the interval 4-5. Among the *long-term goals*, the regions are much alike, with the exception of Africa

[2] Appendix 1 presents similar frequencies by each country instead of the region, for the variable *Level of Lean* only.

with only 4,9 percent of the companies scoring between 4-5. Among *Rewards* and *Attracting Talent*, it is hard to make out any significant differences only considering *table 4.1* since the scores are similar, with the exception of Africa scoring lower on the highest score for both variables. However, it should be noted that Europe surprisingly scores the lowest of all regions on the *rewards* variable. The *Sustainability Index* and *Industry Share of Workers* show us the scores for each company on a national level, all companies from the same country will share the same score. For all scores of 0 in *table 4.1*, it shows that there in this region are no countries with such a score. The companies from all regions are generally located in more sustainable countries, where Europe stands for the highest number of companies in sustainable countries. Africa stands out as the least sustainable region being the only region having countries with a score of 1. As well as the fact that there are no African countries in this data with a score of 3. For the *Industry Share of Workers,* most of the regions' percentage is located around score 1, except for Africa, where 88,3 percent of the companies operate in a country with Score 0, no African countries received score 2. In North America, South America, and Oceania, all countries receive a score of 1, which can depend on these three regions having the smallest number of countries represented in the data.

4.2. Implementation of Lean by Factor

Table 4.2: Univariate Regression Models on all the Independent Variables, Dependent Variable Being Level of Lean Implementation

Variable	Coefficient	Constant	R^2	N
Non-Financial Performance	0,481 (0,008)***	1,098 (0,020)***	0,228	11 701
Long-Term Goals	0,472 (0,008)***	1,069 (0,020)***	0,225	11 701
Rewards	0,373 (0,010)***	1,404 (0,021)***	0,114	11 701
Attracting Talent	0,512 (0,010)***	0,910 (0,027)***	0,169	11 701
Sustainability Index	0,381 (0,012)***	1,261 (0,029)***	0,081	11 701
Industry Share of Workers	0,188 (0,019)***	1,924 (0,023)***	0,009	11 701

Significance levels: +: p< 0,1, *: p< 0,05, **: p<0,01, ***: p<0,001
Note that the constant and the variables *Non-Financial Performance, Long Term Goals, Rewards,* and *Attracting Talent* are based on a score from 1-4. *Sustainability Index* on a scale from 0-3. *Industry Share of Workers* on a scale from 0-2.

Table 4.2 provides an insight into the level of lean implementation and the independent variables of the study through univariate regression models. The table indicates that there is a correlation between the application of lean and our independent variables. The correlation between the variable of *non-financial performance* and lean manufacturing is strongly positive, due to the fact that the highest possible effect is 1.924 points of the scale, which on a scale from one to four is a large increase. In other words, companies that use a high level of non-financial targets, in general also use lean to a greater extent. There are clear indications that *long-term goals* have a strong positive correlation with the level of lean implementation, the highest possible effect is 1,88 points of the scale. This means that if companies embrace long term-goals, they on average also implement a higher level of lean.

When looking at the variables regarding *incentives/people*, we can see that the same counts for these variables. The data presents a high positive effect on the score through the variables *rewards* and *attracting talents*. This means that when a company uses a high level of talent management, either through a reward system, or activities attracting talented employees, the level of lean is on average higher. The table also indicates that there are positive correlations between lean and the *sustainability index*, with the highest possible effect of this variable being 1.143 points of the scale. Furthermore, another discovery in the table is that a country's share of workers in the industrial sector is positively correlated with the level of lean implementation. In other words, operating in a country with a higher share of workers in the industrial sector has a positive effect on the level of lean implementation. That being said, the effect is not that strong, the score of this variable is only 0.188, which means that the highest possible effect is 0,376 points of the scale, which is a low increase on a scale of one to four. It should also be noted that the R square is low for the *Industry Share of Workers* variable, indicating that it might not be a good explanatory variable.

Most of these findings are in line with the expectations and will be assessed and controlled through a multivariate regression analysis down below.

Table 4.3: Multivariate Regression Models the Three Main Topics, and on all Topics in one Model, Dependent Variable Being Level of Lean Implementation

Variable	Performance/ Targets	Incentives/ People	Macro Factors	All Categories
Non-Financial Performance	0,316 (0,009)***			0,217 (0,009)***
Long-Term Goals	0,306 (0,009)***			0,218 (0,009)***
Rewards		0,228 (0,010)***		0,137 (0,009)***
Attracting Talent		0,409 (0,011)***		0,188 (0,011)***
Sustainability Index			0,392 (0,013)***	0,214 (0,011)***
Industry Share of Workers			-0,043 (0,020)*	-0,077 (0,016)***
Constant	0,761 (0,021)***	0,706 (0,028)***	1,285 (0,031)***	0,045 (0,033)
R^2 Adjusted	0,296	0,205	0,082	0,353
N	11 701	11 701	11 701	11 701

Significance levels: +: p< 0,1, *: p< 0,05, **: p<0,01, ***: p<0,001
Note that the constant and the variables *Non-Financial Performance, Long-Term Goals, Rewards,* and *Attracting Talent* are based on a score from 1-4. *Sustainability Index* on a scale from 0-3. *Industry Share of Workers* on a scale from 0-2.

Table 4.3 presents four multivariate regression models testing the same independent variables grouped after category, and one model testing all independent variables in one analysis. This model creates the possibility to control and strengthen the correlations from the univariate models. The findings are similar to the previous findings, when the topic *performance/targets* is analyzed, the same correlations are found between the level of *non-financial performance* and *long-term goals*. When used in the same model they became somewhat weaker, but still significant and arguably strong. The variables regarding *incentives/people* also show the same kinds of correlations. *Rewards* and *attracting talent* both have a positive effect on the level of lean implementation. Both correlations are somewhat weaker in this model but in general still strong. The model analyzing the *macro factor* variables is somewhat more different from the earlier findings (*table 4.2*). The *sustainability index* has the same correlations as before, however, it has become stronger. Surprisingly, the effect of the *industry share of workers* has become negative instead of positive and is not as statistically significant as the univariate model, which could indicate that it is an uncertain correlation. When looking at the model

testing all variables at once, we can find the same correlations as in the first three models, and the negative correlation of *industry share of workers* is more significant now. However, two different directions of correlations make it a highly uncertain variable. It should also be noted that the constant is statistically insignificant in the model testing all independent variables which could indicate that it is hard to predict the constant value with this many variables in one model.

4.3. Comparison Between Regions

Table 4.4: Multivariate Regression Models Comparing Regions and Variables Across Regions, Reference Region Being East Asia

Variable	Europe		North America		South America		Oceania		Africa	
Non-Financial Performance	0,240 (0,013) ***	0,284 (0,020) ***	0,254 (0,016) ***	0,284 (0,021) ***	0,246 (0,015) ***	0,284 (0,019) ***	0,265 (0,018) ***	0,284 (0,020) ***	0,258 (0,017) ***	0,284 (0,019) ***
Long-Term Goals	0,198 (0,012) ***	0,152 (0,019) ***	0,210 (0,016) ***	0,152 (0,020) ***	0,187 (0,015) ***	0,152 (0,019) ***	0,161 (0,018) ***	0,152 (0,020) ***	0,175 (0,017) ***	0,152 (0,019) ***
Rewards	0,158 (0,013) ***	0,227 (0,023) ***	0,155 (0,018) ***	0,227 (0,025) ***	0,210 (0,017) ***	0,227 (0,023) ***	0,206 (0,021) ***	0,227 (0,024) ***	0,189 (0,020) ***	0,227 (0,023) ***
Attracting Talent	0,160 (0,014) ***	0,150 (0,023) ***	0,181 (0,019) ***	0,150 (0,025) ***	0,165 (0,018) ***	0,150 (0,023) ***	0,158 (0,022) ***	0,150 (0,024) ***	0,164 (0,020) ***	0,150 (0,023) ***
Region	0,325 (0,023) ***	0,505 (0,075) ***	0,348 (0,028) ***	0,357 (0,097) ***	0,183 (0,026) ***	0,205 (0,084) *	0,549 (0,039) ***	0,835 (0,151) ***	-0,054 (0,034)	0,210 (0,107) +
Region X NFP		-0,076 (0,026) **		-0,075 (0,032) *		-0.106 (0,032) ***		-0,117 (0,050) *		-0,174 (0,046) ***
Region X LTG		0,071 (0,025) **		0,130 (0,032) ***		0,087 (0,030) **		0,056 (0,049)		0,088 (0,042) *
Region X Rwrd		-0,098 (0,028) ***		-0,148 (0,036) ***		-0,041 (0,034)		-0,107 (0,053) *		-0,157 (0,045) ***
Region X AT		0,013 (0,030)		0,074 (0,040) +		0,039 (0,037)		0,034 (0,060)		0,082 (0,050) +
Constant	0,253 (0,038) ***	0,131 (0,057) *	0,160 (0,047) ***	0,131 (0,060) *	0,138 (0,044) **	0,131 (0,055) *	0,180 (0,054) ***	0,131 (0,058) *	0,188 (0,050) ***	0,131 (0,055) *
R^2 Adjusted	0,326	0,329	0,362	0,366	0,34	0,342	0,366	0,368	0,333	0,338
N	6592	6592	4275	4275	4224	4224	3016	3016	3254	3254

Significance levels: +: p< 0,1, *: p< 0,05, **: p<0,01, ***: p<0,001

Note that all scores are based on a scale from 1-4.

When analyzing the differences between the different regions using the region variable and interaction variables, several findings are made. *Table 4.4* presents two different regression models for each region, except for East Asia as it acts as the region of reference for the analysis. The first model (the left column for each region) consists of all the independent variables on the *performance/targets* and *incentives/people* topics, used on the specific region only, whereafter a region variable is computed to measure the differences between the specific region and East Asia. If this variable is positive, it means that the region has on average a higher use of lean practices than East Asia. From all these models, it can be seen that the four independent variables show similar results as in previous models (*Table 4.2 & Table 4.3*), meaning that the same types of correlations exist in all the regions above, only somewhat weaker than in earlier models. Another finding from the first model is that the regions Europe, North America, South America, and Oceania all have a positive region coefficient, suggesting that they all have a higher use of lean practices than East Asia. The only region not showing a positive correlation is Africa, however, this negative result is not significant and we can hence not draw any conclusions from this. These results also show us that Oceania has the strongest positive correlation which suggests that they have the largest use of lean practices among the regions. The first model also works as a possibility to control for the correlations by adding one more model.

The second model in *Table 4.4* (the right column for each region) goes into further detail on how the effect of the different independent variables differs between the regions, where East Asia again acts as the region of reference. The same independent variables and the region variable are used, followed by the interaction variables testing how the effect of the independent variables differ between the regions. If the interaction variable is positive, it means that the effect of the independent variable on lean is larger in the specific region compared to East Asia. Firstly, it can be seen that all the independent variables share the same types of correlations (negative/positive) as the previous models, showing that these correlations are well-founded after being controlled for through several models. Secondly, the region variables show the same types of correlations (negative and positive) as earlier. For the case of Africa, we can yet again not draw any conclusions, the coefficient is positive, but not significant this time either.

When looking at the changes in effects between the regions, the results are more different from each other. Starting with the change in the effect of non-financial performance, we can

see that the effect of having a high use of non-financial goals has a smaller effect in Europe, South America, and Africa compared to East Asia. North America and Oceania also have signals of this effect, however, their scores are not statistically significant enough. The convergence effect of having non-financial targets is 0,284 points of the scale for East Asia, 0,208 points of the scale for Europe, 0,178 points of the scale for South America, and 0,11 points of the scale for Africa. This might suggest that the effect on the level of lean by having non-financial targets is the largest in East Asia, however, we can not find any significant changes with North America and Oceania which makes this suggestion incomplete.

There is a larger effect of having long-term goals on the level of lean implementation in Europe, North America, and South America compared to East Asia. The convergence effect of this variable is 0,152 points of the scale for East Asia, 0,223 points of the scale for Europe, 0,282 for North America, and 0,239 for South America. This might suggest that the effect on the level of lean from having long-term targets is the largest in North America, however, the statistically insignificant results from Oceania and Africa should be considered first. The effect of having a reward system on the implementation of lean is smaller in Europe, North America, and Africa compared to East Asia. The total effect of having a reward system in Asia is 0,227 points of the scale, in Europe, 0,129 points of the scale, in North America, 0,079 points of the scale, and in Africa, 0,07 points of the scale. The effect of having a reward system differs the most between the regions, as the effect for Asia for instance is existent, while it in Africa almost is zero. There are no statistically significant results from South America and Oceania for the change in the effect of having a reward system on lean. The last variable, attracting new talent, has no statistically significant results on any of the regions, meaning that it is not possible to say in which region the effect is larger.

5. Conclusions

The aim of this study is to create a better understanding of what kind of companies use lean, and where they operate. This is done with special regards to the topics of *performance/targets*, *incentives/people,* and different *macro factors*. The study is realized through a quantitative method using survey data from the World Management Survey. The reason for this is that it is argued that there is a deficit of quantitative studies regarding the concept of lean (Pearce & Pons, 2019). Moreover, previous studies have often focused on one specific correlation between lean and a specific factor, without comparing multiple variables from different topics. Furthermore, these studies have often focused on the effect of the variable on lean, and not if these companies also use lean to a greater extent (Fullerton & Wempe, 2008, Bloom et al., 2007; 2010; 2012; 2014; 2017, Ng et al., 2004, Othman & Khalil, 2018, & Barney & Kirkby, 2004). The research questions answered in this study are *What characterizes a lean company with regards to performance/targets, incentives/people, & macro-level factors*, & *In what regions are lean practices more common and how do the factors regarding performance/targets & incentives/people differ between the regions?* With these questions in mind, different variables were chosen, thereafter seven different hypotheses were derived (4 main hypotheses with sub hypotheses). There is support for six out of these seven hypotheses among the findings.

The first part of the findings shows us that there on average is a higher use of lean in the regions Europe, North America, and Oceania than in the regions East Asia, South America, and Africa. This is a finding that could correspond with findings done by Aghion et al. (2010) and Bloom et al. (2012) who suggest that there is a higher use of lean in developed countries. Looking at the dataset shows us that a majority of the countries in these regions are from developed countries, especially in Oceania where both Australia and New Zealand count as developed countries. Another finding from the descriptive overview was that Africa, in general, scored lower than the other regions for all variables, sometimes with large discrepancies to the trends of the other regions. Except for the variable *rewards* where Europe surprisingly scored the lowest. We could see that in most regions, especially the ones with a high level of lean, the higher values are more common. This might already suggest that there is a positive correlation between a high level of these variables and a high level of lean. This will be discussed more thoroughly down below when the statistical analysis is discussed. This part of the results is mainly connected to the second research question regarding in what

region the company operates. It could be said that there is a higher use in the regions Europe, North America, and Oceania, while lean is used to a lesser extent in East Asia, South America and Africa, despite East Asia being the home region of lean. However, these differences will be discussed more thoroughly when discussing the third part of the findings.

The second part of the findings assesses how the different independent variables affect the level of lean implementation. The aim is to both univariate and bivariate analyze the correlations between these variables and the level of lean. The findings show us that there is a positive correlation between the use of lean and using a high level of non-financial goals, long-term goals, reward systems, talent-attracting practices, as well as a positive correlation between the use of lean and operating in a sustainable country. However, there is no sufficient evidence on if operating in a country with a high share of workers in the industrial sector also increases or decreases the level of lean. This corresponds with findings by, Fullerton & Wempe (2008), Jørgensen et al. (2007), Maskell & Kennedy (2007), Boyd et al. (2002), Bloom et al. (2017), Othman & Khalil (2018), Hajmohammad et al. (2013), Henao et al. (2019), & Yang et al. (2010). These papers were in general unified in their findings that using a high level of modern management practices would make the lean implemented more effective. Resulting in that many companies use lean to a greater extent. We can hence suggest that companies, when using modern management practices, often use a high extent of modern management practices in different ways and that it is more uncommon that companies only use one or a few of these practices. This is something that future studies could go deeper into. The fact that lean practices are more common in sustainable countries could have several reasons, the first being that the sustainable countries often also are developed countries, leading to a higher ability to invest in sustainability. Another reason could be that there in sustainable countries is a higher level of infrastructure making sustainable lean practices easier to implement, such as a good waste management system.

The third and last part of the findings aim to illustrate the differences between the regions when it comes to the level of lean implementation. In addition, it also provided insight into how the independent variables had different effects on the level of lean implementation between the different regions. The findings show that all regions had on average a higher use of lean practices than the reference region East Asia, except for Africa where no significant difference was found through the analysis. This corresponds with the expectations and with earlier findings, both by earlier papers such as Aghion et al. (2010) and Bloom et al. (2012),

who suggest that there is a higher use of lean in developed countries, and by our first part of the analysis (the descriptive overview). By statistically getting the same results, we strengthen the findings made earlier. When looking at the differences in the effect of the independent variables between the regions, the results found nine significant differences in the effects between the regions. Where the effect of the level of non-financial performance and rewards in general was lower in the rest of the world compared to East Asia, the effect of the level of long-term goals was in general higher in the rest of the world compared to East Asia. There has not been as much research on these topics to connect the findings to, it is hence harder to find accurate explanations. Oceania shows no significant differences in the effects of the independent variables, it is also the geographically closest to East Asia which might suggest that the effects are similar in this part of the world. Europe is the region that shows the most differences compared to East Asia, which can be a result of the fact that European countries had a high level of lean among the regions. We suggest that it could depend on the fact that there are other more important factors in Europe that are related to the use of lean, leading to a smaller effect of the level of non-financial goals and rewards. One of these important factors could be the level of long-term goals which has a stronger effect in Europe. The same counts for North America. The low European scores on the *rewards* variable can also have affected this result. The results from Africa show that the effect of the level of non-financial performance and rewards are less in Africa compared to East Asia. It could be suggested that because their level of lean is low, the effect of the independent variables also becomes low. Africa shows no significant results that any of the variables would have a stronger effect than in East Asia. That being said, it should be noted that these conclusions are not built on any previous research, it would therefore be interesting to in the future conduct a study trying to analyze these differences more thoroughly.

In summary, the findings of this study can give support to six out of the seven hypotheses. There is no support for hypothesis H_{3b}: *Companies with high levels of lean implementation are more common in countries with a high share of workers in the industrial sector*. In other words, we can say that companies with a high use of lean practices, in general also have a high use of non-financial targets, long-term goals, reward systems and talent attracting practices. It could also be said that lean companies are more common in sustainable countries. However, there is no evidence that shows if the share of a country's workers in the industrial sector has any effect on the level of lean used in the company. In addition, the

regions Europe, North America and Oceania have in general a higher use of lean than the regions East Asia, South America and Africa. The effects of the different variables had differences in all regions compared with the reference region (East Asia), except for Oceania.

This paper contributes to the field of lean-studies by showing in a statistical way that a company with high use of lean practices often has a high use of other modern management practices as well. These findings are in line with previous studies, mainly because previous studies have found these modern management practices to be strengthening the effectiveness of lean. Therefore we expected them to be commonly used among companies using lean. Another contribution is that there is a higher use of lean in the regions Europe, North America and Oceania, which also is in line with previous studies because there are many developed countries in these regions. Also, lean is more common in sustainable countries. The findings from this study can give companies prior knowledge to how other companies implement lean. It is a common thing to use more modern manufacturing practices combined instead of only a few. Even though this study doesn't go into the effects of these practices, it could be argued that the high implementation of different practices together works well, and that it is a credible choice. This is similar to studies by Ng et al. (2004), Othman & Khalil (2018), Fullerton & Wempe (2008), and Fullerton et al. (2014), who argue in different ways that it is of interest to the company to use several modern manufacturing practices at once in order to get more effectiveness in the practices. Companies could also use some of the results when choosing what country to expand to. If there is an interest in using lean practices, it might be of interest to expand to a more sustainable country. Because lean is more common there, it is likely that lean works well there, i.e. it is a credible choice.

The aim of this paper is to find what a lean company is characterized by with special regards to *performance/targets*, *incentives/people*, and *macro-level factors*. The findings can be of use for future studies within the area of lean. It is interesting for future studies to go further into explaining the differences between the regions, maybe through a qualitative approach. It would also be interesting to analyze differences over time, has the use of lean changed over time and are the independent variables still relevant at a different time. Hopefully, newer data will become accessible shortly which will enable future studies to find differences over time.

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Appendix

Appendix 1. Use of Lean by Country

Country	Mean	Std. dev.	N	Score 1-1,99 (%)	Score 2-2,99 (%)	Score 3-3,99 (%)	Score 4-5 (%)
Argentina	3,588	0,858	415	9,9	36,1	39,3	14,7
Australia	4,06	0,884	451	6	18,2	39,7	36,1
Brazil	3,252	0,958	814	24,4	37,8	25,8	11,9
Canada	3,914	1,083	418	14,8	18,7	26,8	39,7
Chile	3,337	0,824	410	15,1	43,7	33,7	7,6
China	3,419	0,949	873	18,2	36,2	31	14,5
Colombia	3,218	0,894	170	22,4	42,4	26,5	8,8
Ethiopia	3,313	0,785	131	16	40,5	39,7	3,8
France	3,822	0,959	490	10	26,3	35,1	28,6
Germany	3,793	0,922	430	8,6	29,1	36,7	25,6
Ghana	2,837	0,587	98	25,5	66,3	7,1	1
Great Britain	3,705	0,966	889	12,4	28,6	35,2	23,8
Greece	3,779	0,875	416	6,3	32,9	37,5	23,3
India	2,84	0,945	711	47,3	28,1	18	6,6
Italy	3,785	0,875	437	4,1	38,9	31,4	25,6
Japan	3,913	1,039	127	11	25,2	25,2	38,6
Kenya	3,341	0,776	182	9,9	54,9	26,4	8,8
Mexico	3,633	1,016	406	16	28,6	31,5	23,9
Mozambique	2,551	0,704	107	55,1	36,4	6,5	1,9
Myanmar	2,925	0,683	147	24,5	61,2	11,6	2,7
New Zealand	3,993	0,894	150	4,7	26	34,7	34,7
Nicaragua	2,759	0,691	83	38,6	47	14,5	0
Nigeria	2,991	0,513	111	12,6	76,6	9,9	0,9
Northern Ireland	3,605	1,051	119	17,6	29,4	27,7	25,2
Poland	3,315	1,042	238	26,9	31,1	25,6	16,4
Portugal	3,275	0,855	193	15,5	52,3	21,2	10,9
Ireland	3,53	1,043	161	21,1	25,5	32,9	20,5
Singapore	3,751	1,176	406	23,4	14,3	26,1	36,2
Spain	3,734	0,844	214	5,6	35,5	38,8	20,1
Sweden	3,981	0,83	258	4,3	22,5	44,2	29,1
Tanzania	2,808	0,639	146	29,5	62,3	6,2	2,1
Turkey	3,618	0,746	332	2,1	47,9	36,1	13,9
USA	4,028	0,954	953	8,5	18,6	34,5	38,4
Vietnam	3,311	0,759	151	9,9	57	25,2	7,9
Zambia	2,953	0,7	64	21,9	65,6	7,8	4,7

Note that the mean is based on a scale from 1 to 5.