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How lean are the smaller ones?

Adoption of lean practices and impact measurement in medium-sized manufacturing firms in Finland

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ABSTRACT:
Traditionally, Lean philosophy can be summarized as “doing more with less”. Thus, having well-planned and efficient operations can give manufacturing companies a competitive edge through minimizing waste and increasing quality and customer value. The whole potential of Lean manufacturing can be utilized if the ideas are comprehensively incorporated within the organization. This requires resources, which smaller-scale firms might not have available. This study aims to investigate how extensively lean is adopted across these smaller manufacturing organizations in Finland. First, background for the study is provided to give insight to lean philosophy as well as justifications for companies to measure impacts and performance. Next, the empirical part of the paper investigates the adoption of lean tools and measurement of their impact in Finnish production firms. The research limits to the study of active firms that have their own manufacturing operations and are based in Finland. In addition, they have operating turnover over 1 million, but under 10 million euros and employ 15-150 people. The findings suggest that lean philosophy is not highly adopted across smaller scale manufacturing firms in Finland. Additionally, majority of the lean users are flying blind and not measuring the progression of the desired impacts. However, one major limitation of this study is its small sample size, thus the results are merely directive.

KEY WORDS: Lean, Lean manufacturing, Impact measurement, SMEs

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TPS	Toyota Production System. The production philosophy for Toyota automotive factories.
VSM	Value stream map. A lean tool for illustrating every step of a process from acquiring raw material to the finished product in the hands of a customer.
5S	Seiri, Seiton, Seiso, Seiketsu and Shitsuke or Sort, Set in order, Shine, Standardize and Sustain. A lean tool that focuses on the organization of workplace and standardization of ways of working.
MUDA	Waste. Everything that does not add customer-value to service or product. A key concept in TPS.
MURI	Overloading the resources of an organization. Can refer to both physical and human capital.

MURA	Deviations in the process, for example in quality, costs or throughput times.
KRI	Key results indicator. A measure illustrating the critical results of actions. Usually financial measures.
KPI	Key performance indicator. Performance measure that is critical to the organization or specific function.
PI	Performance indicator. A measure of performance, not as critical as KPI.
RI	Results indicator. A measure of results of actions, not as critical as KRI.
JIT	Just in time manufacturing. A management system where purchases, production, and customer orders so that items are made “just in time” before needs.
SMED	Single-minute exchange of die. A lean tool for reducing time of changeovers.
TOC	Theory of constraints. A theory that every system has its constraints and by identifying and improving these bottle necks they will no longer limit the achievement of goals.
PSP	Problem solving process. Standardization of problem solving to decrease time to resolution and results.

1 Introduction

Development and management of supply chains should be viewed strategically, meaning what are the long-term targets and how to build the chain towards these targets systematically. On top of this, supply chains have tactical and operative features needing short term decisions. Supply chains need to balance increasing availability with minimal inventory investments and logistic costs. Even though it is an internal process the main aim is to meet customer demands regarding for example lead times, quality, features and customizations. Thus, the need to balance maximum flexibility with as low production or product costs as possible. (Ritvanen at al. 2011, 136 – 137.)

Ritvanen et al (2011, 136) proposes that for example simplifying processes, minimizing throughput times, customer centricity and eliminating waste as well as errors are key principals in the development of supply chains. To achieve these goals, organizations may aim to adopt Lean philosophy. Originally, the idea was developed in Japan to improve the shop floor practices of Toyota automotive factories. However, ever since it has grown popularity and is now well known and used across industries and even functions. Organizations may try to adopt lean practices by implementing lean tools within their operations. Lean manufacturing refers to the utilized use of input resources, such as time and material, to get the maximum output at the quality level acceptable for the customer (Kumar & Suresh 2014; Womack & Jones 1996).

The general philosophy is usually summarized as “doing more with less”. Thus, having well-planned and efficient operations can give manufacturing companies a competitive edge through minimizing production costs and keeping the quality level of the products. However, if the firm is only interested in the “zero waste”, non-stop running of the production lines there is a chance raw material investments and inventory increases weaken the overall profitability (Belo & Lin 2012, 280; Graban 2012, 18.). Since profit maximization is the goal of all firms regardless of size and product offering (Rothschild 2006: 26), the financial impact should always be examined alongside production efficiency.

Uusi-Rauva (1997, 23) famously stated “you get what you measure”. In other words, to achieve positive business results, people need to be influenced and managed towards targets. Choosing the correct measures of behavior, performance and attitudes plays a key role. If wrong things are measured employees might truly think that they are doing the right things to achieve goals. When metrics are chosen by what is easily available instead of what is needed, behavior is steered towards what is measured instead of what has impact (Spitzer 2007, 29). Once these two are different, it will create unnecessary costs without additional value. Furthermore, having too much data available might lead to too many measures and measuring itself becomes the target behavior distanced from the company goals. Therefore, leading to confusion rather than clarity (Spitzer 2007, 34 – 35).

However, when the challenges of measuring are acknowledged, metrics can be harnessed to their full potential in achieving wanted results. Measuring performance has many important functions, if organization has the capability to realize its significance. According to Spitzer (2007, 15 – 20) these are functions such as steering behavior and bringing visibility and attention to wanted things, for example efficiency. Additionally, the results can be used to give meaningful feedback, motivate, and make high-quality as well as faster decisions. Finally, measuring gives warning signs of problems ahead and increase understanding of for example root causes.

1.1 Objective of the study

The goal of this paper is to explore how lean smaller, Finnish manufacturing firms are. To support the achievement of this goal, the adoption of lean tools is explored through the following research questions:

1. How extensively is lean adopted across medium-sized manufacturing firms in Finland?
2. What are the most common lean tools implemented?
3. What is the perception of the implementation of the chosen tools?

4. What are the perceived impacts of adopting the chosen lean tools?
5. To what extent are these perceived impacts measured?

The first target is to provide background for the study and give insight to lean philosophy as well as justifications and methods for companies to measure impacts and performance. Next in the empirical part of the paper, the adoption of lean tools and measurement of their impact in production firms is studied via survey to clarify the current state. The research limits to the study of active firms that have their own manufacturing operations and are based in Finland. In addition, they have operating turnover over 1 million, but under 10 million euros and employ 15-150 people. These firms will also be discussed as “medium-sized” firms throughout the paper. Thus, the paper attempts to make two contributions while trying to achieve its goal. First, it aims to provide a review of the current state of leanness of medium sized production companies in Finland. Secondly, it explores the existence of measures to assess the impacts in smaller manufacturing firms. Finally, implications for further research are suggested.

The research will widen the discussion related to lean adoption and impact by manufacturing firms of smaller scale. small and medium sized production companies. The research results will provide understanding are lean tools adopted in general, what are the most common tools used and what are the perceptions of the implementation. Additionally, a perspective is offered on how the impacts of lean are viewed and whether these are measured across the target population. Consequently, this provides the practical business environment the opportunity to assess the effects of different lean tools as well as challenge and develop the current ways of working based on measured results. This will allow increased performance of the assessed processes.

However, the paper will not define the effectiveness of different lean tools compared to each other or their impacts in general. The research results will conclude on how small and medium sized companies should allocate their resources to assess the impacts to continuously improve their internal processes.

1.2 Structure of the study

In the following section of this paper, the existing literature on lean philosophy and its application in production environment is discussed. In addition, some theories related to measurement and assessing production performance are explored. These two are combined to provide the theoretical foundation for the development of the measurement system to assess the impacts of lean implementation. In the third chapter the empirical research will be introduced, and the used methods are justified. The research material was collected via a survey sent to 179 companies and the response rate was 17,3%.

Next, the fourth section of the paper will present the research findings. These will be concluded in the final chapter where also the suggestions are made for small and medium sized production companies for lean adoption to improve their operations. Finally, the limitations are discussed as well as topics for future research proposed.

2 Theoretical framework

In the first section of this chapter, existing literature on lean will be reviewed. Firstly, the history of lean philosophy and its purpose are introduced briefly before exploring lean in the production environment context. Next, some of the most common lean tools are defined and their uses explained. Finally, common criticism towards the philosophy is discussed.

The second section of this chapter will focus on ways to assess the impacts of lean implementation. First, starting off with the basics of measuring supply chains and what are the features of good measuring systems according to literature. Finally, discussion on the common challenges regarding measuring and performance management, wraps up the chapter.

2.1 Eliminating process-based waste with lean

After the second world war, the main production philosophy in car industry was to produce in masses to drive down unit costs. However, due to the scarcity of resources the Japanese car manufacturer, Toyota, had to shift focus from mass production towards resource efficiency and the production flow. *Toyota Production System* (TPS) was created, which aimed to utilize short throughput times, customer perspective, low costs, and high quality. One of the main goals for Toyota was to deliver as much value as possible to the customer while creating concepts and tools for utilizing the TPS. Consequently, that was the birth of the thinking we know as lean today. (Womack & Jones 1996, 311; Liker 2010, 3 – 9; Modig & Åhlström 2013, 70 – 73.)

Arguably, lean thinking is based on a holistic approach to organizational philosophy. It can be divided into concepts, operators and tools that try to define reality as accurately as possible and set measurable targets. Efficiency is achieved if the operators, meaning employees, have adopted rationality in practices, choices and use of lean tools. To achieve this rationality, lean thinking needs to be successfully implemented within the

organization. Lean should be viewed as a way of doing work collectively and as a result, organizations are able to reach efficiency in their processes. (Liker 2010, 10 – 15; Sergei & Lusiani 2013.)

The main goal of lean philosophy is to manage the everyday processes of an organization without creating any waste. The processes should be creating value, which is defined from the perspective of the customer. Thus, all the improvements to the processes should be driven by customer needs. The needs can be defined in a *value stream map* (VSM), which is a tool to support the standardization of the operational processes. Standardization supports in making the processes as fluent, repeatable and wasteless as possible. As a result, the workflow increases, and a push is created for continuous flow. The goal is not to settle with good, instead to strive for better by continuously improving. (Womack & Jones 1996; Graban 2012, 18.)

Hines et al. (2004) divides the lean principles into two different perspectives: strategic and operational. The strategic approach focuses on increasing customer satisfaction, whereas the operational aims to eliminate waste within the internal operations of the organization. Improving the efficiency of functions with lean principles should take into consideration both approaches. As a result, the relationship between costs and value can be explored and used as basis for decisions.

In another point of view, Joosten et al. (2009) explores lean principles from operational, socio-technical, and cumulative perspectives. Operational perspective is defined as elimination of waste and as a result increasing value. Operations should be limited to the process phases, where lean tools may be utilized and are implemented. All other internal processes are obsolete and should be discontinued. Furthermore, the socio-technical perspective focuses on making work easier, especially on the parts that have received critique and are viewed as difficult by the employees. Finally, the cumulative perspective aims to have the operational and socio-technical perspectives in balance. As a result,

synergies and increased performance is obtained in multiple processes. This will lead to cumulative improvement in the efficiency of operations.

Clearly, the views of Hines et al. (2004) and Joosten et al. (2009) present the purpose of lean philosophy as more than a way of working. Instead, it consists of different approaches and perspectives and the collective aim is to minimize costs. However, the philosophy goes even deeper than that. For example, caring for employees is firmly in the center through the socio-technical factors. To summarize, the key to the philosophy of Toyota is to emphasize the importance for organizations to recognize the factors that improve productivity and efficiency (Caldwell 2008).

Thus, improving the efficiency of operations consists of multiple elements. However, eliminating waste and creating customer value through different processes are arguably in the center (Liker 2010.). On the other hand, a successful implementation requires that the organization adopts a culture of continuous improvement, which was also part of the original TPS (Joosten et al. 2009). Next these main elements will be explored further.

The original Toyota philosophy talks about creating continuous flow in the production. The flow should include all the elements on the shop floor. All the way from raw materials to products and even the flow of information. It should be a systematic way of thinking that penetrates through the entire manufacturing system. (Tuominen 2010, 6; Kimsey 2010, 53.) The target of this flow is to minimize the time from the beginning of the process to the end. Traditionally, in a manufacturing environment, the beginning of the process is acquiring raw materials and the final phase is getting full payment from customer (Liker 2010, 87).

An effective way to create flow and minimize time is to implement demand-driven pull model to plan manufacturing. It can be utilized for the entire process. When the signal for manufacturing is coming from actual demand, all that is not bringing value for the customer should be, as a result, eliminated from the process. In other words, only

necessary items are produced, and the waste is again minimized. Arguably, most processes consist of 90% waste and 10% value creation. Thus, it is important that the flow is created by driving improvement of processes. (Liker 2010, 87.)

2.1.1 Waste on the shop floor

The original TPS identifies seven different waste types (*muda*). These are:

- overproduction,
- unnecessary waiting,
- overprocessing,
- unnecessary storing,
- excess transferring,
- unnecessary errors
- and not using the creativity of employees.

(Liker 2010: 27 – 30; Modig & Åhlström 2013, 74 – 76.)

Afterwards, Liker (2010) has argued that all the functions that increase throughput times should be added as an eighth muda. These functions create unecessary movement and excess waiting. The reasearch also defines two other waste types that are not only tied together with muda, but also create muda. They are deviation (*mura*) and overload (*muri*). Muri refers to a state where the capacity of either machines or people is overloaded. This usually leads to problems with quality and safety. Mura on the other hand, is a consequence of muda and muri. It refers to the deviation in production schedules caused by internal issues such as broken machines. Generally, organizations try to minimize waste by addressing muda and neglect the effects of mura and muri. (Womack & Jones 2005, 299 – 302; Liker 2010, 114 – 115.)

As stated earlier, continuous flow and demand-driven pull are effective ways to eliminate waste. Work should be balanced as well as systematic and errors fixed immediately to

ensure quality of products. This is done by visualizing problems and keeping a clean and tidy environment. Everything has its own place. In addition, by standardizing work streams across departments, the internal movement of employees is ensured. (Womack & Jones 2005, 299 – 302; Liker 2010, 114 – 115.)

However, if the resource efficiency is overemphasized the continuous flow might be at risk resulting in efficiency paradox. Arguably, secondary needs arise, and companies need to use resources to fulfill them, thus decreasing the time spent on value creation. This is problematic especially in an environment where deviations are high. In a manufacturing environment this might mean highly fluctuating demand. (Modig & Åhlström 2013, 47 – 68.) On the other hand, if the use of resources is not maximized, making the continuous flow the priority instead, the financial profitability might be compromised. This is due to overinvesting in resources, such as inventories (Vakkuri 2009, 11 – 15).

2.1.2 Review of lean tools and continuous improvement

As mentioned earlier, implementing a culture of continuous improvement is at the heart of lean thinking. One tool to ensure this is *Kaizen* -workshops. Literally translated Kaizen means good change. It is a workshop targeted for all levels of the organization that encourages and challenges employees to improve their ways of working. Kaizen should provide improvement areas within work and the organization and suggest applicable solutions. Ideally, the aim is to build a learning employee and as a result a learning organization. That way each employee can continuously improve own ways of working and the organization. The best result is achieved if the participants are as diverse as possible. To summarize, Kaizen increases conventional knowledge and effectiveness with minimal resources and as a result improve people through processes and gain results slowly, but surely. (Imai 1986, 1 – 12, 24; Mann 2010, 264.)

Also, the VSM was discussed briefly earlier. As said, it is a good tool to bring focus towards customer needs and support standardization of processes. Basically, the method is used to illustrate how the value of the product increases as it passes through the

process from raw material to the hands of the customer. The time of the production process can be used to define the efficiency of the system. The tool is useful in defining the current state and identifying improvement areas. (Moore 2007, 355 – 356; Graban 2012, 18.)

Besides continuous improvement and customer value, a tidy work environment is in the core of lean philosophy in ensuring elimination of waste. 5S is a common tool to support this. The name comes from the Japanese words *seiri, seiton, seiso, seiketsu* and *shitsuke.* The first S, seiri, means to sort, referring to keeping all unnecessary tools and parts away from the workstation. Secondly, seiton meaning to organize to represent that all materials and tools that will be used should be easily available and in sight. The third S, seiso, means cleaning whereas seiketsu is referring to standardization of the cleaning and inspection processes. Finally, shitsuke is sustaining the previous steps as a standard way of working by good self-discipline. As a tool 5S represents what lean philosophy is about, discipline, efficiency, and attention to detail. (Moore 2007, 166; Carreira 2005, 237.)

Other lean tools are for example kanban, andon and poka yoke. Kanban is a system that uses for example cards to illustrate customer needs and when materials should be processed or purchased (Moore 2007, 343). In addition, andon is a visual tool to present for example with different colors where there are problems and errors in the process (Moore 2007, 339). Finally, poka yoke is a tool to eliminate errors in production. For example, organizations utilizing this tool could for example design products that can be manufactured only one way as a mean to eliminate mistakes (Moore 2007, 346).

2.1.3 Common critique on lean practices

Even though lean philosophy has gained popularity across industries, and it is extensively applied, there are challenges related to its utilization. Thus, let's explore few common critiques towards lean practices that are discussed across literature. Firstly, like stated earlier, the origin for the philosophy is in Japan which has a very specific work culture. Generally, the culture is viewed as ruthless and total commitment is demanded from the

employees. On average, a working day in Japan lasts hours longer than for example in Finland. One of the aspects of lean is involving workers to continuously improve ways of working. This might result in increased workload, if unnecessary tasks are not discontinued with development. Due to this the critique is targeted towards employee wellbeing. When the employees are demanded constant presence and strive to perform better there is a risk that the core of lean thinking is realized backwards in typical Western work cultures. What was developed to improve employee satisfaction through eliminating unnecessary tasks is viewed to increase workload. (Joosten et al. 2009; Kollberg et al. 2006; Green 1999, 24-26.)

In addition, Hines et al (2009) has also criticized lean thinking in increasing the workload for employees especially in the beginning of the implementation. Lack of strategy, focus and targets might result in challenges in achieving long-term goals of improving process efficiency and eliminating waste. For example, the Kaizen workshops are viewed as working tools. However, they are easily seen as detached from the day-to-day work and as additional tasks. Thus, the challenge is not understanding the concepts and theories rather than instilling the ideas to the culture of the organization. This requires well executed implementation of the strategy, which of course requires resources in the beginning. Radnorin and Osborn (2013) as well as de Souzan (2009) critique organization in using lean concepts that are too loosely tied to the original way of thinking. Naturally, organizations may want to take shortcuts or pick and choose parts to implement blurring the original idea. According to Womackin and Jonesin (1996) the theory-based lean methods should be implemented exactly the same for each Toyota factory.

Finally, lean can be seen as limiting innovation. This seems to be a general criticism across all industries. Especially, challenges might arise in situations that require flexibility from the supply chain in reaction to quick changes. In addition, too much focus on standardization might decrease motivation and self-determination of employees. The organization should understand that the lean way of working is not suitable for all and modify if needed from the perspective of individuals. This way the learning capacity is better

utilized, and the individuals harnessed in driving continuous improvement through personal motivation. (Vidal 2007; Wang & Huzzard 2012.)

2.2 Assessing the impacts of lean on the supply chain

To minimize the risks discussed in the previous chapter the implementation of lean thinking within an organization should be strategic and systematic. Attention can be guided to the wanted things by defining what to measure. In general, this will give organization its priorities. Therefore, the most crucial part is choosing the right things to measure when trying to influence people to achieve the wanted results. At best, different metrics can be utilized in decision-making and controlling performance. Humans have a basic psychological need to compare themselves to others or to past performances. This results in competition being more effective incentive compared to rules and regulations. (Carreira 2005, 15; Uusi-Rauva 1997, 23.)

However, setting up a measuring system might not always be as simple as it sounds. Firstly, the metrics should be aligned across the organization and send everyone the same message about priorities. Failure to align, will result in contradictions and conflicting actions by different parts of the organization. Secondly, the set of chosen measures should be transparently used to make decisions and steer operations. The competitive nature of humans will not be deployed if the measuring system does not set a clear direction and targets. Additionally, the same result will occur, if there is a feeling that it is impossible to make an impact. Finally, there are cases where absolute numbers might not tell the whole story. Instead, it should be the trend that should be examined to make conclusions on progression. This is true for most satisfaction metrics, for example, where respondents are to rate with a number. In these cases, the answers given are very subjective. However, if the respondents stay the same, the direction of improvement can be analyzed through the trend by continuously repeating data collection. (Carreira 2005, 15; Uusi-Rauva 1997, 23.)

Measurement instruments are a widely studied topic, thus there are many theories available across different literature. Organizations have used metrics for years and the knowledge is transferred to literature which is easily available. Utilizing the practices and learnings based on this literature is justified when organizations are developing their own measuring systems. In this section, the basics of measuring theories are explored. However, the theoretical framework will be limited to measuring the performance of the supply chain with the SCOR-model, which is presented in chapter 2.2.2. This paper examines the use of lean as a tool to improve production efficiency, thus the main goal of implementation should be to improve the performance of supply chains. That is also why the SCOR-model was chosen to be the basis to the measuring system proposed in this paper.

2.2.1 Main elements of a good measuring system

Measuring is an integral part of performance management. It is important that the measurement system is developed with a holistic approach to support business operations such as budgeting, process improvement and planning (Taticchi et al. 2010, 4). Hannus (1993, 79) argues that the fit and functionality of measures is centered around the mission of the organization. The mission should be based on balancing the core competencies and strategical capabilities of the company with customer needs, collaborations, and competitors. Then it can be utilized in defining the critical metrics in achieving business goals. Bhasin (2013, 126) adds on that it is important to consider who are the end users, where in the organization are they and what is the wanted time frame. Additionally, the measures should always be defined to illustrate and support the achievement of key business strategies. Finally, Lönnqvist and Mettänen (2003, 34) specify few main elements that guarantee the credibility and meaningful impact. These are validity, reliability, relevance, and practicality.

Validity of a measure refers to the ability to measure the success factors that it was designed for. If the validity is weak, it means that there is a systemic error and results include information that is irrelevant to the measurement. Next element, reliability,

focuses on exploring the random errors of the values produced. When the measurement results are consistent it will lead to high reliability. The validity and reliability are connected. If the validity is poor, high reliability does not matter since the results are irrelevant. In addition, if there are constant deviations in the values, there is probably a lot of irrelevant factors. The development of these two elements is difficult since the problems are hard to detect. Additionally, if they are detected it is challenging and time-consuming to minimize them. (Lönnqvist & Mettänen 2003, 34 – 36.)

The relevance can be defined by several different approaches. It can be used to illustrate whether the measure meets the specific needs of the end-user. Furthermore, this element is purely situational and defined by its purpose. For example, measures for seasonal information are relevant for a certain point of time. Finally, the practicality assesses the user friendliness and cost effectiveness. When developing measures, the resources needed should be balanced with the achievements. Practicality is poor if a lot of resources are spent in data collection and calculations, but the results cannot be utilized to add value. (Lönnqvist & Mettänen 2003, 36.) Next, let's look at the relevance of performance measures in ensuring lean success.

2.2.2 Importance of measures in lean success

Like discussed previously, a successful performance measurement system gives indication of the direction of progress. It should be a tool to spot problems early by diagnosing the current situation and giving indication on corrective actions. The objective of any organization should be building their capabilities so that such a system can be developed and utilized. (Spitzer 2007, 15 – 20.)

Womack and Jones (2005) supported by Liker (2006) have argued that the aspirations of lean include the following:

- decreasing cycle times,
- decreasing lead times,
- lower work in progress,

- increasing response time,
- decreasing costs,
- increasing flexibility of production,
- increasing quality,
- improving customer service,
- increasing revenue,
- increasing throughput and
- increasing profit.

However, in practice these benefits are hard to quantify. Liker (2006, 2) goes on stating that about 50% of car manufacturers are talking about lean compared to 2% that have actually been able to implement the philosophy to practice. This was also discussed in the section related to lean criticism. The original idea is easily blurred when organizations are taking shortcuts and not going all the way. However, there is no shortcut to constantly getting the impacts listed above. In order to build sustainable lean practices that generate continuous improvements performance measures are needed. That is the way organizations increase visibility on the progress (Bhasin 2008, 675). Setting up performance measures is not easy either, which is discussed next.

2.2.3 Main challenges of measuring

As mentioned before, the amount of resources need to be balanced with the received value when developing measuring systems (Lönnqvist & Mettänen 2003, 36). There are different perspectives on what is the needed number of metrics. However, the main focus is on the larger organizations across literature. For example, Malmi et al. (2006, 31) proposes that a good number would be between 20-25 measures. More precisely, 8-10 indicators should be related to internal processes and the others spread between financial, customer and growth performance. In addition, Parmenter (2015, 19) has created a 10/80/10 rule, which suggests that all organizations employing over 500 people should have 10 *key result indicators* (KRI), around 80 *performance* (PI) *and results* (RI) *indicators* and 10 *key performance indicators* (KPI). There is no consensus across literature for exact

number of measures and the theories are even contradicting and the ranges large. Having too many things to measure seems to be as ineffective as having too few. Today, since there are so many possibilities organizations need to stay focused so that they do not get flooded under all the information that is available. Measuring meaningless things are creating unnecessary costs financially as well as lost opportunities. Useless information tends to confuse more that clarify. (Spitzer 2007, 34.)

As stated, measuring is a good way to bring focus to the wanted things and waken the competitiveness of human nature to strive for continuous improvement. However, it might also have the opposite effect. The measuring process might foster behavior that is not in the interest of the organization by for example choosing wrong measures or using them as basis of rewarding. Spitzer (2007, 22 – 23) argues that this might cause improvement when looking plainly at the values, while the performance of the organization, that actually matters, is declining. They found that the bigger rewards are available, the less attention is paid to the information provided by the metrics. Also, according to Parmenter (2015, 46) employee rewards and bonuses should not be based on KPIs. The argument is that they are too important of an indicator to be sacrificed for individual bonus maximization. There are also other ways, besides financial incentives, to boost productivity of an organization (Parmenter 2015, 28).

Fear is one main challenge related to measuring. Employees become victims in a way if they feel that their actions do not influence the chosen indicators. Bad results may cause negative reactions rather than actions to solve problems. Without the mandate to fail, employees learn that they need to do anything so that the numbers at least look good. No matter what is lying underneath. Motivation and commitment of employees decrease when they are forced to act in a way, they know is wrong or meaningless (Spitzer 2007, 26 – 27). In addition, poor experiences related to measuring mean that there might be negative attitudes from the start. Measuring might be viewed as a way to condemn the guilty and not as a tool for problem solving (Spitzer 2007, 38 – 39).

Finally, the chosen indicators should be aligned with the strategy of the organization so that actions are creating movement to the right direction. Measuring should be directed towards the factors that bring success in the future. In other words, information needs to be linked to strategy as well as the financial performance. Furthermore, it needs to be used to support decision making. (Kankkunen et al. 2005, 19 – 20).

2.3 Justification for lean adoption for Finnish manufacturing SMEs

Like discussed, manufacturing performance has impacts across the whole supply chain. Most typical measures seem to be amounts of scrap and rework, capacity utilization, product quality, inventory levels and turnover, manufacturing costs, cycle times and reliability (Demeter & Matyusz 2011, 156). Zhou (2016, 465) identifies decreasing inventories as one of the primary aspirations for lean implementation for small and medium sized organizations. Furthermore, Demeter and Matyusz (2011) research the impact of lean practices on inventory turnover. The measure was chosen since it can be considered as visible and concrete indicator of performance and effort of the supply chain.

Inventory turn is probably the most known and used financial key figure related to material management of organizations. It analyses the amount of inventory in relation to the actual demand (Ritvanen et al. 2007, 36). The bigger the turn, the less capital is tied in inventories. In addition, as the inventory turn increases the inventory costs decrease. However, this is significant only to a certain point. For example, if inventory turn is increased from 2 to 4, the inventory costs will decrease 50%. On the contrary, the impact on costs will be minimal when increasing the turn from 8 to 9. Thus, it is important to find the optimal inventory turn for each organization depending on the nature of the business and the industry standards. (Hokkanen & Karhunen 2014, 205.)

As mentioned earlier, lean philosophy identifies excess inventories as a form of waste. Additionally, almost all the other sources of waste have impact on overall levels of inventories. For example, overproduction will lead to higher finished goods inventories as companies are producing more than what is demanded. These items may lay useless for

a long period of time. Furthermore, unnecessary waiting leads to increased semi-finished product inventories. Finally, excess transfers between stations tend to increase inventories as raw materials or items may not be visible or present where they are needed. As a result, applying lean management may decrease inventory turns by aiming to eliminate these forms of waste. (Demeter & Matyusz 2011, 156.)

For the reasons discussed above, the justification for lean adoption is defined through improving inventory efficiency. This will be investigated through examination of inventory turnover days, which can be calculated followingly (Sakki 2009, 76):

$$Inventory\ days = \frac{Cost\ of\ goods\ sold}{Average\ inventory\ value} * 365 \quad (1)$$

The obtained figure illustrates the number of days the organization can fulfill demand merely from the current stock at hand. Thus, the bigger the number, the higher the inventory investments. This will also increase the risk that there are excess items in stock, meaning waste.

Figure 1 illustrates the development of inventory turnover days of Finnish SMEs belonging to the industry C Manufacturing. The inventory days are calculated from the financial data provided by Statistics center of Finland. As can be seen, there was a big improvement from 112 to 76 days from 2017 to 2018. After that, there was slight increase over the couple of years, being 82 days in 2020 (Official Statistics of Finland 2022). These numbers are compared with the results of the study by Demeter and Matyusz (2011). In their investigation of the International Manufacturing Survey data, they found the lean organizations having an inventory turnover of 14 days. All though, many things can be done to improve inventory efficiency, there seems to be a business case for lean adoption for smaller scale manufacturing firms. Additionally, judged by this value alone, the hypothesis is that these organizations have not generally adopted lean.

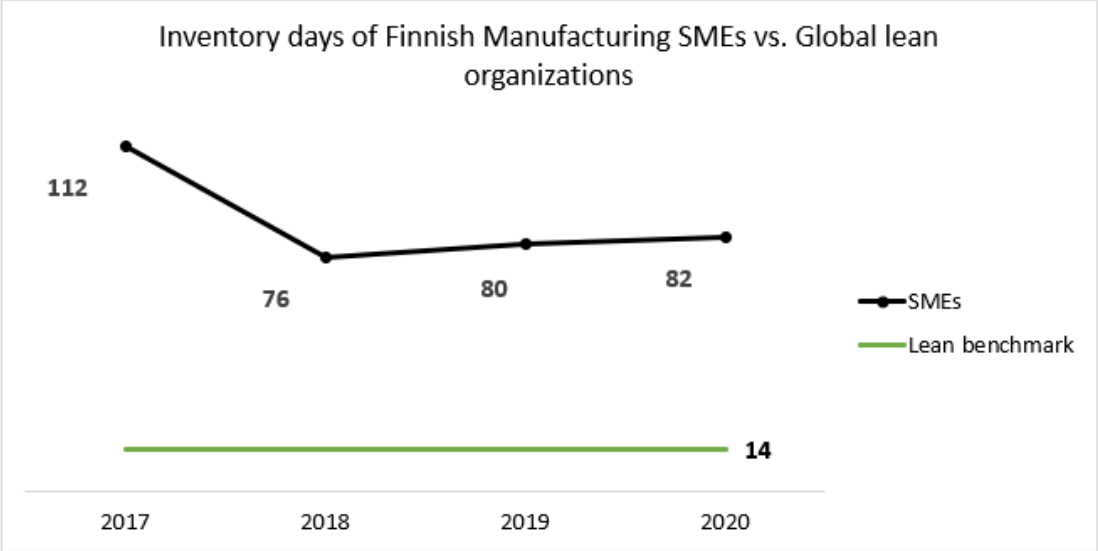

Figure 1. Comparison of inventory turnover days of Finnish manufacturing SMEs and global lean benchmark organizations (Official statistics of Finland 2022; Demeter & Matyusz 2011, 159).

3 Methodology

Research methods refers to the way the data for the research is collected, classified, and analyzed. Quantitative survey is chosen for this empirical research. The aim of the survey is to find out how medium sized manufacturing firms in Finland have adopted lean practices. Additionally, how is the implementation and impact of lean usage perceived. Finally, the survey also is set to find out if the lean organizations measure the impact. Firstly, this chapter presents and justifies the research approach as well as the method used. Afterwards the validity and reliability of the data and results are discussed.

3.1 Research approach

Like mentioned, the goal for the empirical part of this paper is to find out the leanness of medium sized Finnish manufacturing organizations, their perceptions on implementation as well as the impact, and are the impacts measured. Quantitative study usually focuses on finding statistical regularities and dependencies between variables (Alasuutari 2011, 37). The quantitative approach is supported, since the objective is to explore the following dependencies:

- number of lean tools implemented and background variables of operating revenue, profit, number of employees
- the relationship between the perceptions of implementation and impact of lean adoption
- number of aspired impacts reported and the background variables of operating revenue, profit, number of employees

According to Hennink et al. (2011, 10) qualitative research usually provides answers to “why” -questions and is used when trying to provide understanding for new issues or complex questions and processes. Additionally, qualitative research method is suitable when studying for example decision making, social interactions and contexts of different actions. The framework of this study is to explore the causal relationship of lean practices

with variables such as size of company or industry. Furthermore, it does not aim to study the underlying reasons why, so there is no justification for using a qualitative method.

However, couple of open questions are included to the survey to shed little understanding to the underlying beliefs and attitudes of the respondents. Additionally, according to Alasuutari (2011, 23) using a quantitative research approach does not exclude qualitative methods. Nevertheless, it is quite difficult to answer the set research questions by using qualitative approach. In addition, lean itself is not a new phenomenon that would need conceptualizing and the application can be unambiguously presented in numerical terms.

The main goal of this paper is to explore how lean smaller, Finnish manufacturing firms are. Thus, the empirical part of the paper tries to investigate the following questions:

1. How extensively is lean adopted across medium-sized manufacturing firms in Finland?
2. What are the most common lean tools implemented?
3. What is the perception of the implementation of the chosen tools?
4. What are the perceived impacts of adopting the chosen lean tools?
5. To what extent are these perceived impacts measured?

The research limits to the study of medium sized firms that have manufacturing facilities in Finland. The definition for medium sized organization set for this paper refer to companies who employ between 15-150 people and have operating revenue between 1 million to 10 million euros. Next the formation for the questionnaire as well as the sample will be explored further.

3.2 Research method

3.2.1 Defining and testing the questions

The questions for the survey were based on the framework of the topic and the problem proposition. The studies of similar topics by Bhasin (2008) and Leyer (2014) were used as supporting material when defining the questionnaire (Attachment 1). The questionnaire was set to have both open ended and closed questions, meaning semi-structured survey was chosen. It is a suitable method when capturing the perceptions and experiences of the respondents that are hard to capture otherwise (Holstein et al. 2001, 83; Carson & Gilmore, 73). Even though structured survey is a dominant data collection method in quantitative research (Carson & Gilmore, 64). However, it was viewed that such a wide concept as lean would need a little bit more depth to the quantitative answers. By incorporating few open questions, the underlying attitudes of the respondents could be processed alongside. All in all, semi-structured survey was believed to provide the broadest understanding for this study as well considering the research resources in use.

The final survey consisted of 6 sections and a total of 12 questions. Since the scope included manufacturing firms in Finland the language was chosen to be Finnish. In addition to the evaluation questions, the survey also consisted of background factors which were annual revenue, profit, number of employees, sub-industry, and are there any lean tools implemented. In terms of content the survey was set with the following sections:

- Background information
- Adoption of lean tools within the organization
- Implementation and impact of chosen lean tools
- Measuring the impact of chosen lean tools
- Additional notes and remarks

If the organization did not have any implemented lean tools, they filled only sections 1 and 5. Section 2 was about specifying what lean tools the organization has implemented. A list of options for the question was given, and the guidance was to “choose all that apply”. In addition, there was option “other” with instructions to specify if a tool was missing from the predetermined list. Next in the third section, the respondent was asked to evaluate the success of the implementation as well as the impact of lean tools on the supply chain. The aspects were evaluated on a Likert-styled scale from one to five, where one represented poor implementation or no impact and five on the other hand world class implementation or impact. Additionally, the respondents were asked to choose from a predetermined list what are the aspired impacts from the lean adoption. Then, the fourth section consisted of a yes or no question whether the impact was systematically measured and then an open question on how this was done. Finally, the last question was an open question for any free comments about the answers.

The questionnaire was set up in the online portal “Google Forms”. Next, it was pretested with three different decision-makers of the target group, Finnish manufacturing firms. The testing group consisted of two chief executive officers and one chief operations officer. The target was to find out how easy the questions were to understand and what was the time taken to fill out the survey. The test respondents filled out the form and gave feedback on the questions. The feedback was used to finetune some of the wordings of the questions.

3.2.2 Sample

The study was set to define the state of adoption of lean and measurement of its impacts in manufacturing organizations. Choosing a sample to investigate is the first step in defining the sampling strategy (Hennink et al. 2011, 84). Again, due to the resources of the research, the sample was narrowed down active companies in Finland in the industry C Manufacturing. The list of organizations belonging to this industry group was exported from a database called Vainu. The exported group contained a total of 16 885 organization. The aim of sampling for quantitative is to choose a sample that is as representative

of the whole population as possible (Patton 1990, 169; Flick 2004, 167). For this study a criterion sampling was used, meaning choosing a sample based on preset criteria (Patton 1990, 176). This strategy was used to make sure that the sample consisted of relevant cases to the research question. Since, the purpose was to explore medium sized organizations filters for revenue and number of employees was also applied. All in all, the sample was filtered with the following criteria:

- Country: Finland
- Status: Active
- Industry: C Manufacturing
- Operating revenue >= 1 m€ and <10 m€
- Employees >=15 and < 150

The search resulted in 179 firms that then received an email with the link to the questionnaire and the cover letter (Attachment 2). The email addresses were also obtained from the Vainu database and were mainly for the decision makers of the firms. However, the cover letter asked to forward the questionnaire to the relevant person if they themselves were not able to answer. The given response time was two weeks, and a reminder was sent after one week. After the deadline there were a total of 31 answers, resulting in 17% response rate. The following tables describe how the responses distribute within the background variables of subindustry (table 1), revenue class (table 2), employee class (table 3), and profit class (table 4).

Subindustry	Count	%
Metal products	14	45%
Non-metal product	7	23%
Food and beverage	4	13%
Electronics	3	10%
Others	3	10%

Table 1. The subindustries of the survey responses.

Revenue class	Count	%
under 2,5 m€	10	32%
2,5 m€ - 5,0 m€	7	23%
5,1 m€ - 7,5 m€	4	13%
over 7,5	10	32%

Table 2. The revenue classes of the survey responses.

Employee class	Count	%
under 50	22	71%
50 - 100	4	13%
over 100	5	16%

Table 3. The employee classes of the survey responses.

Profit class	Count	%
Under 0%	7	23%
0% - 5,0%	3	10%
5,1% - 10,0%	12	39%
Over 10,0%	9	29%

Table 4. The profit classes of the survey responses.

3.2.3 Analyzing the data

The results were analyzed in Microsoft Excel. The main aim was to illustrate how lean is adopted across the target organizations. Specifically, what are the tools used, what aspirations the organizations have for lean use and are the impacts measured. Additionally, the perceptions of implementation and impact are also demonstrated. Initial analysis was done by descriptive methods. According to Kaur, Stoltzfus, and Yellapu (2018) the main job of descriptive analysis is to summarize data by calculating percentages, averages, minimums, maximums, deviation and so on. This way it is easier to look at the data and do further analysis.

Next, inferential statistical analysis was done to understand how the background factors of revenue, number of employees and profit affect the results. Kern (2013) defines that the aim of inferential analysis is trying to reach conclusions beyond the absolute numbers observed. In other words, the analysis attempts to show relationships between multiple variables. For this paper, the correlation coefficients were calculated to explore relationships.

Additionally, to assess the significance of the results, inferential statistical analysis usually considers the p-values (P). This value evaluates the probability of results being obtained by chance. During the test, the P is compared to a pre-set alpha value. The results are considered significant if P is smaller than the alpha. This means that there is a probability of 1-P that the results may be generalized beyond the sample. In this study, the alpha was set at 5%, which is conventionally used across research. It is based on the claim that the chances of experiencing an unexpected sampling issue is one in twenty. Furthermore, the results will be labelled to be highly significant if the p-value is under 1%, which is also commonly used limit. (Moore & MacGabe 1998, 473.)

The results are concluded in the next chapter. Before that the reliability and validity of the results are discussed.

3.3 Reliability and validity

3.3.1 Reliability

In short, the reliability of the study illustrates how easy it is to replicate to obtain the same results. Meaning that it will be high if the number of random errors is low. Metsämuuronen (2003, 43) states that factors such as the clarity of the metric and the actions of the investigator can affect the reliability of a study. Furthermore, it can be calculated several different ways. Especially for quantitative research there are different types of statistical calculations developed for assessment Hirsjärvi, Remes & Sajavaara 2000, 213).

In order to increase the reliability, an already existing way to measure should be used if applicable (Metsämuuronen 2003, 35). Subsequently, it is already tested with number of people and the reliability has been assessed and illustrated. For this study, an existing questionnaire was not available. Therefore, it was designed for the purpose of this paper. The creation process begins with discovering the theories presented across literature about the topic in question. The applications and impacts of lean in a production environment as well as performance measurement provided the theoretical framework for this paper. Metsämuuronen (2003, 37) argues that a raw version of the metric should be drawn, which may be developed based on the comments of friends and colleagues. Then, a pilot study should be made. In this particular study, a preliminary draft of the questions was made. The questions and specific wordings were then developed further together with the reviewer of this paper. Finally, the questions were tested with three different decision-makers of the target group, Finnish manufacturing firms. The feedback was used to finalize the questionnaire.

Next, data collection also plays part in the reliability of a study. Specifically, the way data is collected. In order to obtain as replicable metric as possible, the questions should be as objective as possible. The questionnaire in this paper was used to explore whether the medium sized manufacturing firms in Finland are using lean tools, what tools are

they using, what aspirations they have for the use and are they measuring the impacts. However, it also included two questions that aimed to find out the perceptions of implementation and impacts. For these questions intending to find out subjective experiences a Likert-styled scale is a common method (Metsämuuronen 2002, 17). In this study, a rating scale from one to five is used based on how strongly the respondent agrees with the statement. When forming the questions, the following aspects should be considered to increase reliability:

- Simple and short statements
- One dimensional statement
- Avoidance of negative statements
- Avoidance of all-inclusive statements

(Metsämuuronen 2002, 20.) These aspects were considered when forming the questions. Finally, the reliability for the study could be increased by ensuring the anonymity of responses. If the responses are public there might be tendency to sweeten them to avoid judgement. Unfortunately, this is a risk in this study as the company name was needed to match the background variables of industry, revenue, number of employees and profit. The aim was to minimize the risk of response distortion by ensuring the anonymity of responses for this final report. It was explained in the cover letter (Attachment 2) that the name is only used to match the background variables.

To assess the reliability of a study a reliability coefficient. It is used to calculate the consistency of parallel of repeated measurement. Parallel refers to measurement happening at the same time using different measures. On the other hand, repeated measurement uses the same metrics at a different point in time. (Metsämuuronen 2003, 44). Repetitions for the questionnaire in this study or any parallel measures was not done. Furthermore, the different parts of the questionnaire could not be compared against each other to assess internal consistency. Therefore, unfortunately the reliability coefficient could

not be calculated. As a result, the evaluation of reliability of this investigation relies largely on the validity of results, which will be looked at next.

3.3.2 Validity

In addition to reliability, also validity is used to assess the quality of research. Validity refers to the ability to measure what is intended. It may be divided to external and internal validity, where the first assesses the generalizability. This is in close relation to choosing the sample. For the results to be generalized to the whole populations the sample needs to be as representative as possible. Usually, the bigger the sample is, the more accurate the results are regarding the whole target group. Furthermore, the sample should be chosen as randomly as possible. (Metsämuuronen 2003, 86; Hirsjärvi, Remes & Sajavaara 2002, 167; Karma & Komulainen 2002, 65.)

Karma and Komulainen (2002, 65) argue that an investigator usually is unable to study the whole target group. This is usually due to practical reasons such as available resources. Additionally, the response rate is rarely 100%. For this investigation, the sample was extracted from Vainu database. The database was chosen since the contact information were also included in the extract. Additionally, the needed filters for revenue and number of employees could be done to get the final sample. Finally, the whole sample included 179 companies that received the survey. 31 organizations responded, resulting in response rate of 17,3%. The low response rate decreases the validity of results. However, the sample included companies nationwide and were chosen quite randomly.

The internal validity of the results is more theoretical in nature. For example, structural validity, content, and criterion validity are forms to examine with internal validity. Basically, are the concepts used according to theories and are they operationalized correctly. Operationalization, means converting the concepts in measurable form. Finally, the predictive validity assesses whether the meter can reliably predict what is being measured. (Metsämuuronen 2002, 87.) For this study, the theoretical framework was set before defining the questions for the survey. The literature about the topic was studied to gain

context for the concepts. Additionally, the means of the questions were discussed with the pilot group to find out are the concepts understood the way they are meant to.

4 Results

In this section, the results from the survey will be concluded. These will be used to answer the research questions defined in the introduction of this paper. Firstly, the extent of application of lean tools in medium sized manufacturing firms in Finland will be explored. This is done by analyzing the percentage of firms that have implemented lean tools out of the sample. In addition, the most common lean tools and aspired impacts will be presented. Next, the perceptions on implementation and impact are analyzed. Finally, the extent of impact measurement done by the lean organizations will be examined.

4.1 Adoption of lean tools

In the beginning of the survey sent to the 179 companies, the organizations were asked if they have implemented any lean tools. The responses are outlined in Figure 2. 36% out of the 31 respondents stated that they have adopted at least 1 lean tool, whereas majority of 64% had no tools implemented. In addition, the figure also displays the number of tools implemented by the lean organizations. Minimum number of lean tools implemented by the respondents was 3 tools, which represented 10% of the total respondents. On the other end of the spectrum, the maximum number was 9 tools by 3% of the total sample. Majority of the organizations that had adopted lean were using three to five tools, which accounts for 30% of all the organizations.

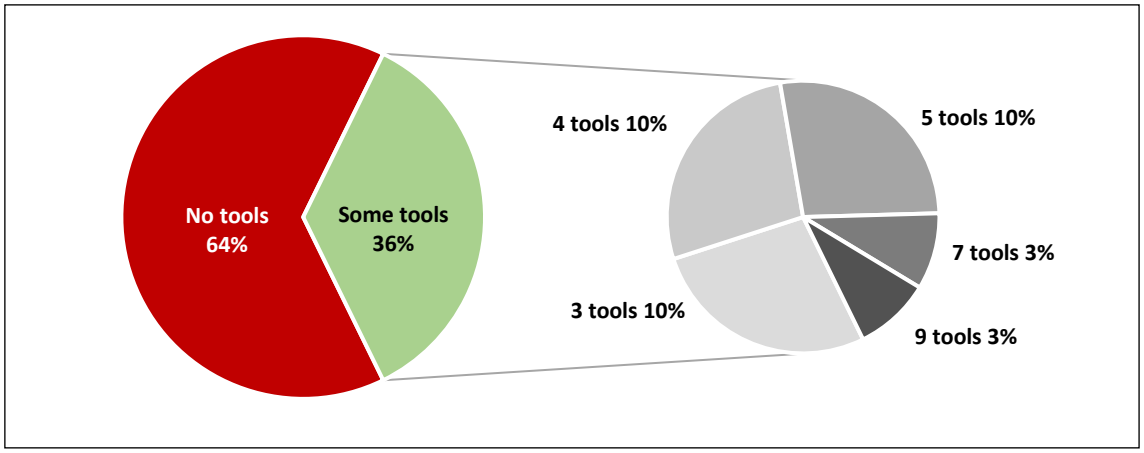

Figure 2. Adoption of lean tools.

To expand the analysis, it was investigated how does the background variables of subindustry, operating revenue and number of employees play part in the adoption of lean tools. Table 5 illustrates that organizations manufacturing non-metal products seem to have implemented lean tools slightly more frequently than the respondents on average with 43% of the group using lean tools. On the other hand, 25% of the "food and beverages" -group report to have lean implemented. Otherwise, the subindustry of the organization does not seem to play a big part on how the responses are spread between lean users and non-users.

Lean adoption by subindustry	No tools	Some tools	Average no. of tools
Metal products	64%	36%	4,8
Non-metal products	57%	43%	4,3
Food and beverages	75%	25%	3,0
Others	67%	33%	5,0
Electronics	67%	33%	7,0
Grand Total	**65%**	**35%**	**4,7**

Table 5. Adoption of lean tools by subindustry.

However, the size of the company seems to have a little more role in lean implementation. First of all, table 6 illustrates the lean adoption by revenue class, which suggests that when the revenue of a company is over 5,0 million euros the chances of having some lean tools in use is 50%. This can be compared to 29% when the revenue is

between 2,5 to 5,0 million and 20% when revenue is under 2,5 million euros. However, the more significant measure seems to be number of employees, since all the respondents having over 100 employees reported to using at least one lean too. This is displayed in table 7.

Lean adoption by revenue class	No tools	Some tools	Average no. of tools
under 2,5 m€	80%	20%	3,5
2,5 m€ - 5,0 m€	71%	29%	4,0
5,1 m€ - 7,5 m€	50%	50%	3,0
over 7,5	50%	50%	6,2
Grand Total	**65%**	**35%**	**4,7**

Table 6. Adoption of lean tools by revenue.

Lean adoption by employee class	No tools	Some tools	Average no. of tools
under 50	77%	23%	3,6
50 - 100	75%	25%	3,0
over 100	0%	100%	6,2
Grand Total	**65%**	**35%**	**4,7**

Table 7. Adoption of lean tools by number of employees.

These assumptions were further investigated by looking at the correlation between the number of implemented lean tools and the size of the company. Again, size was analyzed from two different perspectives of operating revenue as well as number of employees. Firstly, figure 3 displays that the respondents with revenue over 7,5 million had five to nine tools in place in comparison with three to four tools when the revenue was under 7,5 million. This is further supported with figure 4 which illustrates the same story that companies employing over 100 people reported using more tools. This is logical since, the same organizations are probably belonging to both groups. However, there was a difference in the strengths of the relationships between the number of tools implemented, amount of operating revenue and number of employees. The correlation coefficients which are seen in table 8, suggests that the number of tools implemented have stronger positive relationship with number of employees with coefficient of 0,7. On the other hand, the relationship between number of tools implemented and amount of

operating revenue is moderate with coefficient of 0,4. The p-values are also displayed and illustrate the same story. The relationship is significant when the number of tools is compared to the operating revenue. However, it is highly significant when compared to the number of employees.

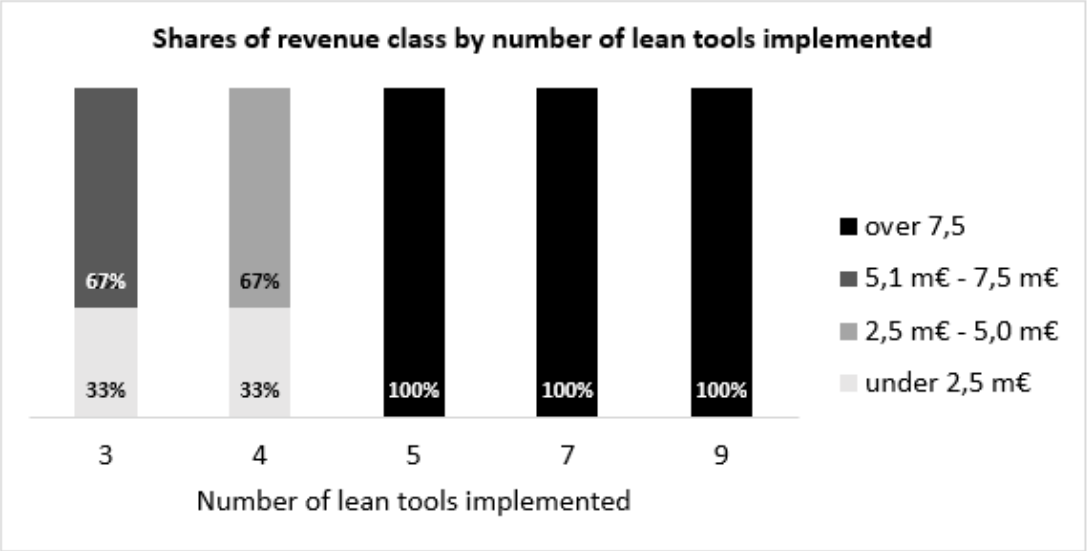

Figure 3. Shares of revenue class by number of lean tools implemented.

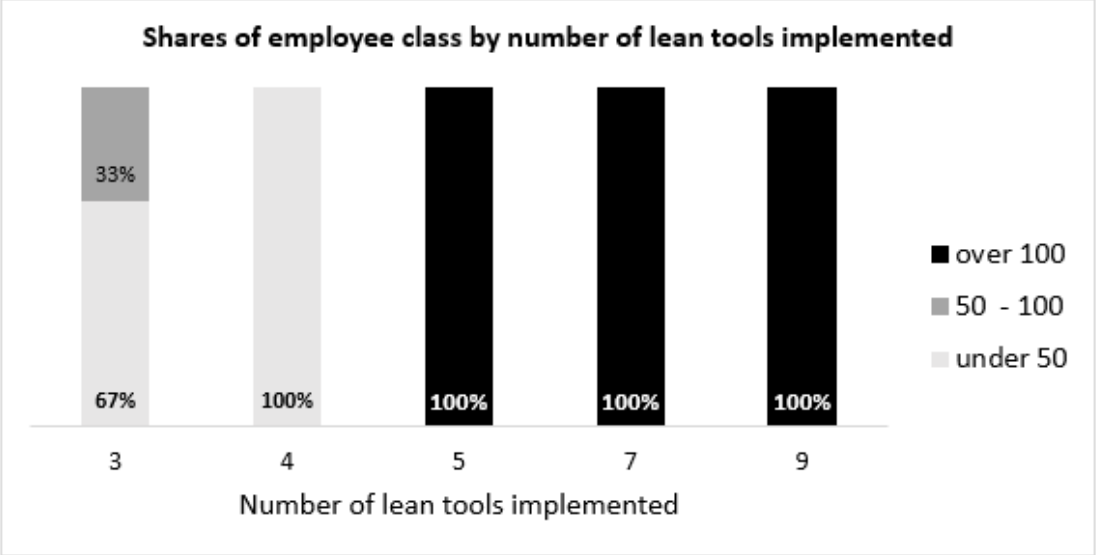

Figure 4. Shares of employee class by number of lean tools implemented.

Number of tools implemented			
	Correlation coefficient	p-value	Significance
Operating revenue	0,4113117989	0,0215172705	Significant
Number of employees	0,7163445579	0,0000058433	Highly significant
Profit margin	0,0507002400	0,7864981500	Not significant

Table 8. Correlation between the constant variable number of tools implemented and independent variables operating revenue number of employees and profit margin.

Finally, table 9 lists the most common lean tools implemented by the respondents of the survey. The most common tools were 5S with 100% and VSM with 73% of lean users reporting to have them in place. The third place was shared by Kaizen, pull-model, Kanban, and *Just-in-time* (JIT) which were implemented by a little over half of the lean users. On the other end of the spectrum only 9% were using simulation, standardization of processes and products, 5-times-why, daily management and PSP.

Tool	%
5S	100%
Value stream mapping (VSM)	73%
Kaizen	55%
Pull model	55%
Kanban	55%
Just in time (JIT)	55%
Line balancing	45%
Single-minute exchange of die (SMED)	36%
Single piece flow	36%
Theory of constraints (TOC)	27%
Simulation	9%
Standardization of processess and products	9%
5-times-why	9%
Daily management	9%
Problem solving process (PSP)	9%

Table 9. Most common lean tools implemented by the respondents.

4.2 Perceptions on implementation and impact of lean

Next, the perceptions of the implementation and impact are explored. Firstly, table 10, illustrates the wanted impacts by the organizations that had implemented lean. The top five aspirations for the lean users were to improve supply chain management (100%), carry less stock (73%), higher profitability (73%), higher productivity (73%) and reduced lost or down time (64%). On the contrary, improved teamwork (18%) and improved market share (9%) were not viewed as wanted impacts for lean usage by the respondents. Interestingly, high profitability is viewed as lean aspiration, however, it has no significant relationship between either lean implementation, or the number of tools implemented by the responding organizations. This was illustrated in table 8, which displays the correlation coefficients are close to 0, meaning no relationship. Additionally, the p-value was over 0,5, meaning no significance.

Impact	**%**
Improve the supply chain management	100%
Carry less stock: finished, WIP and raw materials	73%
Higher profitability	73%
Higher productivity	73%
Reduced lost or down time	64%
Attain improved delivery records	55%
Increased competitiveness	55%
The elimination of waste	55%
Increased efficiency	55%
Improved employee performance	45%
Improved customer service	45%
Lower manufacturing costs	45%
Improved teamwork	18%
Improve market share	9%

Table 10. Aspirations for lean implementation.

In addition to the aspired lean impacts the respondents were asked to rate the following statements:

- The implementation of the lean tools has been systematic and strategic

- The implemented lean tools have had impact on the performance of the organization

The rating was done on a Likert-styled scale from one to five, where 5 was strongly agree and 1 strongly disagree. Table 11 illustrates the correlation between the two scores and interestingly there seems to be a moderate negative relationship. In other words, meaning that there was a slight tendency for the respondents to perceive the impacts higher than the implementation. However, the p-value suggests that there is no significant relationship between the two scores.

	Correlation coefficient	p-value	Significance
Implementation vs. impact score	-0,397523196	0,2260137805	Not significant

Table 11. Correlation between the implementation and impact scores.

Again, examining by the size of the company broadened the analysis. Table 12 illustrates that as the operating revenue grows so does the average of the implementation scores. Furthermore, table 13 also illustrates same story with the number of employees. This is probably explained by the available resources for successful strategy execution and implementation. However, interestingly the strongest score for the perceived impacts seems to be for the smaller organizations. For example, as can be seen from table 12, the organizations that have operating revenue under 2,5 million perceive the lean tools to have impact on their performance. Additionally, the scores for implementation tended to be lower compared to the scores for impact in the extreme high and low ends of the categories. In the middle categories the scores were the same or implementation a received a slightly higher average score.

Implementation and impact scores by revenue class	Average of implementation score	Scale	Range	Average of impact score	Scale	Range
under 2,5 m€	2,0	Disagree	2-2	4,0	Agree	4-4
2,5 m€ - 5,0 m€	3,0	Neutral	3-3	3,0	Neutral	3-3
5,1 m€ - 7,5 m€	3,5	Agree	3-4	3,0	Neutral	3-3
over 7,5	3,4	Neutral	3-4	3,6	Agree	3-4
Grand Total	**3,1**	**Neutral**	**2-4**	**3,5**	**Agree**	**3-4**

Table 12. Averages and ranges of implementation and impact scores by revenue class.

Implementation and impact scores by employee class	Average of implementation score	Scale	Range	Average of impact score	Scale	Range
under 50	2,8	Neutral	2-4	3,4	Neutral	3-4
50 - 100	3,0	Neutral	3-3	3,0	Neutral	3-3
over 100	3,4	Neutral	3-4	3,6	Agree	3-4
Grand Total	**3,1**	**Neutral**	**2-4**	**3,5**	**Agree**	**3-4**

Table 13. Averages and ranges of implementation and impact scores by employee class.

4.3 Measuring impact of chosen lean tools

In the final section of the survey the respondents were asked whether wanted impacts are measured in any way. Figure 5 illustrates the results. The responses were almost equally split with 55% of lean users reporting to measure the impacts. Remarkably, the existence of measures did not affect the impact scores as can be seen from table 14. An average of 3,5 was given by the respondents that measured the impacts. In comparison, an average of 3,4 by respondents that did not have measures in place. However, there was a bigger difference in average of the implementation score. The organizations that reported to measure the lean impact gave the implementation an average of 2,7 compared to the 3,6 reported by the organizations that did not have measures in place.

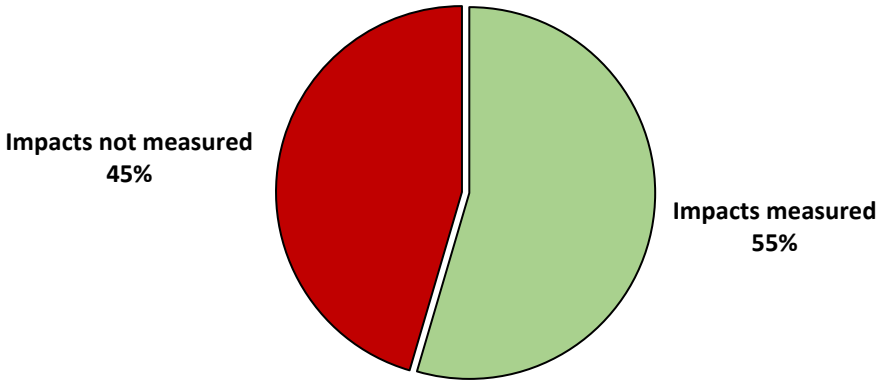

Figure 5. Measurement of lean impacts.

Are impacts measured?	Average of implementation score	Scale	Range	Average of impact score	Scale	Range
Yes	2,7	Disagree	2-3	3,5	Neutral	3-4
No	3,6	Neutral	3-4	3,4	Neutral	3-4
Grand Total	**3,1**	**Neutral**	**2-4**	**3,5**	**Agree**	**3-4**

Table 14. Averages of implementation and impact scores by impact measurement.

Furthermore, measurement was also explored through the different classes. As can be seen from table 15, the slight majorities of organizations manufacturing metal products (60%) and non-metal products (67%) reported to have measures for lean impact in place. However, bigger differences seemed to be for the other three categories. 100% of respondents for the “electronics” category stated to measure lean impacts compared to none in the “food and beverages” and “others” categories. However, good to keep in mind that these three categories represented only 32% of all responses and only 30% of those reported to have implemented any lean tools. Additionally, table 15 illustrates that almost the same number of aspired impacts were chosen disregarding whether the impacts were measured or not. However, for the organizations producing non-metal products the average number was doubled. The respondents who reported to measure impacts chose on average ten aspired impacts, compared to five by the ones that did not measure.

Measurement by subindustry	Impacts measured	Average no. of impacts chosen	Impacts not measured	Average no. of impacts chosen
Metal products	60%	7,3	40%	8,0
Non-metal products	67%	10,0	33%	5,0
Food and beverages	0%		100%	2,0
Electronics	100%	12,0	0%	
Others	0%		100%	7,0
Grand Total	**35%**	**9,0**	**65%**	**6,0**

Table 15. Measurement by subindustry.

Finally, the existence of measures by the number of employees can be viewed from table 16. Interestingly, the measurement of lean impact seems to be at a peak for the organizations employing 50 – 100 people. For that group 100% of respondents reported to have measures in use. Additionally, that group reported having the most aspirations for the lean use with choosing 12 impacts on average. Furthermore, the measuring rate is higher for the organizations smaller than 50 employees (60%) when compared to larger companies of over 100 employees (40%). Finally, the organizations employing under 50 people report to have only two aspirations for their lean implementation when impacts are not measured. This number increases to a little over 7 when the impacts are measured.

Measurement by employee class	Impacts measured	Average no. of impacts chosen	Impacts not measured	Average no. of impacts chosen
under 50	60%	7,3	40%	2,0
50 - 100	100%	12,0	0%	
over 100	40%	10,0	60%	8,7
Grand Total	**35%**	**9,0**	**65%**	**6,0**

Table 16. Measurement by employee class.

Finally, table 17 compares the relationships between the number of aspired impacts chosen by the respondent and the background variables of revenue, number of employees and profit margin. The correlation coefficients suggest that there is a moderate relationship between the total impacts and number of employees. The p-value also suggests that the results are statistically significant. In comparison, correlation for the operating revenue and profit margin is not implied by the coefficient. Additionally, there is no

significance illustrated by the p-value for the revenue. In contrast, there is high significance for the profit margin.

Total impacts chosen			
	Correlation coefficient	**p-value**	**Significance**
Operating revenue	0,2950142422	0,1699945468	Not significant
Number of employees	0,3919298196	0,0389596873	Significant
Profit margin	0,1571710313	0,0013722155	Highly significant

Table 17. Correlation between the constant variable number of impacts chosen and independent variables operating revenue number of employees and profit margin.

5 Discussion and conclusions

5.1 Concluding the results

Managing an efficient, flexible, and responsive supply chain seems to be the challenge of any organization disregarding size or industry. It can really make or break a company and implementing lean tools can have positive impacts on improving the operations. This study aimed to investigate how extensively lean is adopted across the smaller scale manufacturing firms in Finland. The results imply that only 36% of the target organizations have implemented any lean tools into their operations. However, due to the small sample size the results are merely directive.

As discussed earlier, criticism has been presented towards organizations applying the lean concepts too loosely. Thus, the second research question explored the most common lean tools implemented. Majority of the lean users reported to having implemented three to five tools. Like explained, in these cases there is a risk that the lean philosophy is not an integral part of the company culture. Instead, it is viewed as additional work which decreases employee satisfaction rates. On the other hand, this paper presented continuous improvement, customer value and a tidy work environment as the core of lean philosophy in ensuring elimination of waste. These concepts seemed to be internalized by the lean users responding to the survey. 5S, VSM and Kaizen were among the top tools adopted. These are tools conventionally used for organization, illustrating customer value creation, and implementing continuous improvement.

Logically, the size of the company, especially number of employees, effected the number of tools implemented. As the head count of an organization increases, there were more lean tools adopted. More people mean more resources available for implementation. Furthermore, this study aimed to explore the perceptions of implementation and impacts. The quality of implementations was consistently rated lower among the different groups compared to the perception of received impacts. This implies that the desired impacts are well-known, but as literature suggests getting lean truly implemented into

the culture requires resources such as time and hard work. These are things that smaller scale organizations studied might not have easily available.

Most organizations would agree that performing efficiently to reach wanted targets is a desirable goal. This research set out to find out what are the perceived impacts of lean use by the target organizations. All the lean users named improvement of supply chain management as one of their aspirations. The other desired impacts in the top five were decreasing inventories, increasing profitability and productivity as well as decreasing lost or down time. As explained earlier, increasing visibility through measuring is a good tool to steer behavior towards achieving these positive results. Therefore, the final research question was regarding impact measurement. The results showed that 45% of the sample organizations that had adopted lean tools were not measuring the impacts. The rate of measuring was highest for the organizations employing 50 to 100 people. There the size of the organization is probably enough to justify the existence of these measures and the operating environment is small enough to see the link.

In conclusion, lean philosophy is not highly adopted across smaller scale manufacturing firms in Finland. Additionally, the organizations that are using lean tools perceive the quality of implementation to be lower compared to the perceived impacts. Finally, majority of the lean users are flying blind and not measuring the progression of the desired impacts. Especially, the number of employees seemed to be a driving force in the number of lean tools implemented. However, the same relationship was not when looking at the rate of measurement.

5.2 Implications for further research and limitations

This study explores the extent of lean adoption in smaller manufacturing firms in Finland as well as the perceptions of implementation and impact. However, next research could define the financial and operational impacts of lean implementation more explicitly, especially for smaller organizations. There are various of impacts identified across literature and these seem to be carried over as perceptions by lean users to justify lean

adoption. These could now be used to measure the correlations between different levels of lean implementation and performance. This could be used to define the extent of implementation needed to reach the wanted impacts.

The major limitation of this study is its small sample size. 17,3% of all the organizations responded to the survey meaning the results are based on only 31 organizations. This limits any extensive generalizations, even though some general directives for the conclusions can be drawn. The aim of the study was to merely explore the current state and further investigations are needed as outlined above. Additionally, this study includes all companies employing people from 15 to 150. However, in practice a company of 150 behaves more like a larger organization compared to a company of 15 people.

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Appendices

Attachment 1. Survey questions

Lean- kartoitus

OSIO A – TAUSTATIEDOT

	Notes and instructions
1. Yrityksen nimi	*Pakollinen,* *Vapaa tekstikenttä*
2. Käyttääkö yrityksenne mitään lean-työkaluja tehostaakseen toimitusketjuaan? ☐ Kyllä käyttää ☐ Ei käytä	*Pakollinen,* *Valitse yksi, parhaiten kuvaava vaihtoehto*

Jos 2. kysymyksen vastaus ”Kyllä käyttää” → Osio B

Jos 2. kysymyksen vastaus ”Ei käytä” → Osio F

OSIO B – TYÖKALUT

	Notes and instructions
3. Minä vuonna lean-työkaluja on aloitettu ottamaan käyttöön?	*Pakollinen,* *Vapaa numerokenttä*
4. Mitä Lean työkaluja teillä on / on ollut implementoituna? ☐ 5S ☐ Linjan balansointi ☐ Imuohjaus ☐ Kanban ☐ JIT (Just in time)	*Pakollinen,* *Valitse parhaiten kuvaavat vaihtoehdot*

☐ Yhden kappaleen virtaus ☐ Kaizen ☐ Esteiden teoria (TOC – Theory of constraints) ☐ Simulaatio ☐ Arvovirtakuvaus (VSM – Value stream mapping) ☐ Asetusten vähentäminen (SMED -Single-minute exchange of die) ☐ Poka yoke ☐ Andond ☐ Joku muu, mikä?	

OSIO C – LEAN IMPLEMENTOINTI JA VAIKUTUKSET

	Notes and instructions
Arvioi seuraavat väittämät: 5. Edellä mainittujen lean työkalujen implementointi on ollut strategista ja systemaattista. Vahvasti eri mieltä 1 2 3 4 5 Vahvasti samaa mieltä	*Pakollinen,* *Lineaarinen asteikko 1-5,* *1 = vahvasti eri mieltä* *5 = vahvasti samaa mieltä*
6. Mahdolliset perustelut	*Vapaa tekstikenttä*
7. Edellä mainituilla lean työkaluilla on postiivista vaikutusta yrityksen suorituskykyyn. Vahvasti eri mieltä 1 2 3 4 5 Vahvasti samaa mieltä	*Pakollinen,* *Lineaarinen asteikko 1-5,* *1 = vahvasti eri mieltä* *5 = vahvasti samaa mieltä*
8. Mahdolliset perustelut	*Vapaa tekstikenttä*
9. Mitä vaikutuksia arvioitte lean työkalujen käytöllä olleen yrityksellenne? ☐ Kannattavuuden parantaminen ☐ Toimitusketjun hallinnan parantaminen	*Pakollinen,* *Valitse parhaiten kuvaavat vaihtoehdot*

□ Asiakaspalvelun parantaminen □ Toimitusvarmuuden parantaminen □ Tuottavuuden parantaminen □ Tehokkuuden parantaminen □ Työntekijöiden suorituskyvyn parantaminen □ Yhteistyön parantaminen □ Kilpailukyvyn parantaminen □ Markkinaosuuden kasvattaminen □ Varastojen vähentäminen (sis. Raaka-aine, WIP ja lopputuote) □ Tuotantokustannuksien vähentäminen □ Seisokkien vähentäminen □ Hukan vähentäminen □ Joku muu, mikä?	

OSIO D – VAIKUTUSTEN MITTAAMINEN

	Notes and instructions
10. Mittaatteko näitä edellä mainittuja vaikutuksia jotenkin? □ Kyllä mittaamme □ Emme mittaa	*Pakollinen,* *Valitse yksi, parhaiten kuvaava vaihtoehto*

Jos 10. kysymyksen vastaus ”Kyllä mittaamme” → Osio E

Jos 10. kysymyksen vastaus ”Emme mittaa” → Osio F

OSIO E – MITTAAMISEN LISÄKYSYMYS

	Notes and instructions
11. Miten mittaatte edellä mainittuja lean työkalujen vaikutuksia?	*Pakollinen,* *Vapaa tekstikenttä*

OSIO F – VAPAAT KOMMENTIT

	Notes and instructions
12. Mitä muuta haluaisit nostaa esille liittyen lean käytäntöjen omaksumiseen yrityksessänne?	*Vapaaehtoinen,* *Vapaa tekstikenttä*

Attachment 2. Cover letter

Hei,

Opiskelen Vaasan Yliopistossa Tuotantotalouden maisteriohjelmassa. Olen kiinnostunut lean työkalujen käytöstä, sekä niiden implementoinnin vaikutuksista yrityksien suorituskykyyn. Kerään tästä aiheesta tietoa pro gradu -tutkielmaani varten.

Tutkimus on kyselytutkimus, johon tällä sähköpostilla kutsuisin edustamanne yrityksen osallistumaan. Toivoisin kyselyyn vastaamista, vaikka teillä ei olisikaan lean työkaluja käytössä. Olette saaneet tämän kutsun, koska yrityksenne on merkitty kuuluvan C Teollisuus toimialaluokkaan, liikevaihtoa 1-10 miljoonaa euroa, sekä henkilöstöä 15-150 kpl.

Osallistuminen on vapaaehtoista ja luottamuksellista, yrityksen nimi tulee kuitenkin antaa, jotta voidaan yhdistää vastaukset tilinpäätös ja tase tietoihin, joista käyttöpääomaa ja kannattavuutta tarkastellaan. Lopulliseen tutkimukseen ei kuitenkaan yrityksen nimiä julkaista.

Toivoisin vastauksia toukokuun kuluessa, eli viimeistään 31.05.2021. Jos mieleenne tulee mitään kysymyksiä tai tarvitsette tukea vastaamiseen, voitte olla yhteydessä allekirjoittaneeseen.

Jos te ette ole oikea henkilö vastaamaan tähän kyselyyn välittäisittekö sen eteenpäin?

Tutkielman ohjaajana toimii Josu Takala Vaasan Yliopistosta, puh. 029 449 8321. Opinnäytetyö julkaistaan Vaasan Yliopiston kirjaston portaalissa osoitteessa https://www.tritonia.fi/fi/e-opinnaytteet. Kaikki tutkimukseen osallistuneet yritykset tulevat saamaan yhteenvedon tuloksista, josta näkee mihin muut valmistavan teollisuuden yritykset tavanomaisesti sijoittuvat. Vaikka tulokset ovat nimettömiä, voi niitä käyttää vertailemaan omia vastauksiaan vertaisiinsa.

Kiitän jo etukäteen ajastanne.

Ystävällisin terveisin,

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