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SUSTAINABLE LEAN IMPLEMENTATION: A STUDY OF SERBIAN COMPANIES

ABSTRACT: *We aim to identify and analyse the key success factors of sustainable lean implementation and investigate the changes in management accounting and performance measurement systems after lean implementation. We analyse four large, publicly traded Serbian companies that have implemented lean. To introduce diversity into our sample we choose companies from different industries and with different competitive and organizational characteristics. We use a multiple case study method to analyse the motives behind, barriers to, and implications of lean implementation and to examine the management accounting and performance measurement systems of companies implementing lean. Our results suggest that the key factors of sustainable lean implementation are continuous communication of the objectives and importance of the lean project, continuous improvement of soft skills, development of teamwork and employee motivation, dedicated management, a supportive work environment, and continuous monitoring of the implemented changes and results. Our results also point to the importance of changes and improvements in the management accounting and performance measurement systems during and after lean implementation.*

KEY WORDS: *lean implementation, lean sustainability, performance measurement, management accounting.*

JEL CLASSIFICATION: M11, M41, L25

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1. INTRODUCTION

Lean has rapidly grown in popularity during recent decades and an increasing number of manufacturing and service companies have embraced lean principles to improve performance. More recently, however, some authors have noted that besides Toyota, only a few companies have been truly successful at becoming lean (Kiran, 2022; Loyd et al., 2020; Vanichchinchai, 2021). Lean implementation is far from problem-free and companies may experience difficulties in sustaining lean. There are several reasons for lean failure, including failure to manage the process of change (Nordin et al., 2012), focusing only on the short-term application of lean tools rather than on the implementation of deeper overall changes (Dombrowski & Mielke, 2014), and a lack of focus on the development of lean capabilities amongst organization members (Jorgensen et al., 2007). Due to these and other reasons, in many companies the improvements decline over time (Dombrowski & Mielke, 2014).

We aim to identify and analyse the key success factors of sustainable lean implementation and to investigate changes in management accounting and performance measurement after lean implementation. We use a multiple case study method to analyse the motives behind, barriers to, and implications of lean implementation and to examine the management accounting and performance measurement systems of companies implementing lean. Our study is of importance for researchers and practitioners in the areas of production and lean management, performance management, management accounting, and cost accounting. We emphasise that the sample companies operate in Serbia's transitional and developing economy. However, our study does not consider the direct impact of a specific economic environment on lean implementation and can be beneficial to companies in similar economies to that of Serbia.

Most lean research is not grounded in any theory (Danese et al., 2018). Ahlstrom et al. (2021) conclude that "lean is not a theory but has plenty of theoretical underpinnings" and acknowledge "the importance of lean theory for external validity and generalizability, and for the topic to progress in a systematic and scientific manner". Boer et al. (2015) note that in the field of operations management, "theory is the fundamental engine that drives the creation of knowledge". In the field of lean this is also necessary, but very problematic. The problem is how to draw a "theory" for a practice-driven phenomenon such as lean. Nevertheless, our study contributes to the literature in several ways.

The most important theoretical contributions of our study are a comprehensive and analytical review of existing lean experiences and a critical analysis of positive and negative phenomena in the lean implementation process. Our results suggest that some of the key factors of sustainable lean implementation are the continuous communication of the objectives and importance of the lean project; the continuous improvement of soft skills, teamwork development, and employee motivation; dedicated management; a supportive work environment; and continuous monitoring of the implemented changes and results. Our results also indicate some of the key barriers to lean implementation. The identification, understanding, and overcoming of these barriers enable the successful implementation of lean and improvement of company performance. Our results can therefore contribute to raising awareness about the need to identify and manage these factors and barriers.

Most of the experts who deal with lean are of technical (production) orientation. Our research contributes to the integration of knowledge and the learning process of experts from various fields. This more holistic view of lean implementation and the analysis of the interrelationship between lean implementation and lean effects point to the need to apply innovative cost accounting methodologies such as TDABC, and to the importance of these innovations in improving company performance. Thus, our research on the experiences of lean companies also contributes to the development of lean theory in the fields of lean, operations management, and management accounting.

The structure of our paper is as follows. The next section presents the theoretical background and literature review. The third section presents the research methodology, while the fourth and fifth sections present our results and their discussion. The sixth section presents our conclusions.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

Lean is defined in many ways. The absence of a clear definition has several consequences for practitioners seeking to implement lean, as well as researchers trying to capture the essence of the lean concept. Karlsson and Ahlstrom (1996) point out that the lack of a precise definition can lead to difficulties in determining whether or not changes made in an organization are consistent with lean, and consequently difficulties in evaluating the effectiveness of the concept itself. Shah and Ward (2007), on the other hand, argue that a definition of lean is necessary for theory development, while Ahlstrom et al. (2021) argue that the multitude of different lean definitions is one of the reasons making it difficult to understand lean as a theory.

Pettersen (2009) stresses that lean is usually defined in operational terms by pointing to the most frequently mentioned characteristics of lean: time reduction and continuous improvement, just-in-time production, pull system, failure prevention, and production levelling. This list of characteristics is unsurprising given that lean originated in the Toyota Production System (TPS), which relies on two pillars: just-in-time (JIT) and Jidoka ('autonomation' or automation with human intelligence) and aims at achieving the highest quality, shortest lead time, and lowest cost (Bhamu & Singh Sangwan, 2014; Jasti & Kodali, 2015; Lean Enterprise Institute, 2022a; Shah & Ward, 2007).

Lean is generally described as a way of thinking ('lean thinking') about guiding principles and overarching goals, and as a practice ('toolbox lean' or 'lean practice') that relies on a set of management practices, tools, or techniques (Lean Enterprise Institute, 2022b; Petersen, 2009; Shah & Ward, 2007; Womack et al., 1990). Bhamu and Singh Sangwan (2014) summarize that lean may be understood as a way, a process, a set of principles, a set of tools and techniques, an approach, a concept, a philosophy, a practice, a system, a programme, a manufacturing paradigm, or a model aimed at reducing costs and time to delivery, levelling the production schedule, improving quality at low cost, removing waste from the system, maximizing capacity and minimizing inventory, improving productivity and quality, achieving agility, etc.

There have been several important attempts to define lean. Shah and Ward (2007) define lean as "an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability". Hopp and Spearman (2021) broadly describe lean as efficiency management and offer four narrower definitions to describe four lenses through which lean can be viewed: process (pursuit of waste elimination), flow (minimizing the cost of excess inventory, capacity, or time), network (a systematic process of reducing the cost of waste), and organization (an organizational culture that encourages the continual reduction of the cost of waste). Lean is studied mostly in the fields of operations and general management (Ahlstrom et al., 2021), psychology (Balzer et al., 2019), accounting (Maskell & Kennedy, 2007), and information technology (Mrugalska & Wyrwicka, 2017), etc.

2.1. Benefits and factors of lean implementation

In recent decades an increasing number of manufacturing and service companies have embraced lean principles as a way to improve performance. Lean is seen as a business method that promotes efficiency and elimination of waste, as well as focusing on customer needs (Bhamu & Singh Sangwan, 2014; Shah & Ward, 2007). It is seen as an instrument to improve product development processes and reduce the time to market of new products with better quality and manufacturability. Lean can also help a company develop a competitive advantage (Hartini & Cipromulyono, 2015; Kosky et al., 2021; Natarajan et al., 2017; Shah & Ward, 2003, 2007; Swank 2003; Wood et al., 2004). Lean can be implemented in companies of all types, sizes, and industries that strive to improve their competitive advantage, operations, and profits in regional and global markets (Alkhoraif et al., 2019). Lean is expected to contribute to the development of a positive and fulfilling work environment through employee involvement in and ownership of problem-solving and improvement activities (Bocquet et al., 2019; Neirotti, 2018).

Lean manufacturing relies on empowering employees (Todorović & Čupić, 2017). Vidal (2007) argues that employees' empowerment increases their responsibilities and abilities and increases their job satisfaction and performance. Employees' ideas regarding changes and improvements create a competitive advantage that is more sustainable (Robinson & Schroeder, 2006). This is especially important for companies in transition economies like Serbia's, which in addition to a lack of motivation and resistance to change faces a problematic low level of employee involvement in the processes of continuous improvement. The low level of awareness about the need to present ideas and opinions is the consequence of a specific socio-economic pre-transition period, with passive employees, collective responsibility, and strict adherence to hierarchy (Janjić et. al., 2020). It is therefore necessary to ensure continuous communication of the objectives and significance of lean implementation; i.e., it is necessary to prepare and motivate people (Antony, 2014). The failure of many companies' change programmes can be attributed directly to employees' resistance to change (Allaoui & Benmoussa, 2019). That is why it is important to understand why employees adopt/accept change, i.e., lean initiative (Keyser et al., 2016).

Companies have difficulties sustaining lean over time for several reasons. One of the most important reasons is that managers lack a real understanding of lean principles and therefore focus on the short-term application of isolated tools rather than on deeper changes. The various lean techniques are very effective for achieving short-term improvements, but after a few years many companies' lean programmes no longer meet expectations (Dombrowski & Mielke, 2014). For many companies, the kaizen[1] event has become the primary and, in some cases, the exclusive vehicle for lean improvement (Nicholas & Soni, 2005). Veech (2004) notes that up to 90% of the benefits of kaizen events disappear within six months. Another reason for lean failure is a lack of focus on developing the capabilities of employees that make them progressively better at doing lean, and on creating a learning environment that supports a lean culture. A continuous learning process and building lean culture are key assumptions for achieving long-term sustainable results (Jorgensen et al., 2007). Another main reason for lean failure is inadequate management of the change process during the lean transformation (Nordin et al., 2012).

2.2. Management accounting and performance measurement

The efficiency and effectiveness of lean management are determined by many factors, but one of the most important is the performance measurement system which allows evaluating processes and the impact of new concepts or changes on process efficiency. Cherrafi et al. (2019) argue that performance measurement permits organizations to identify process issues, evaluate the effectiveness of an action plan, and monitor progress towards goals. Some studies (Norreklit & Mitchell, 2007; Searcy, 2009) analyse the existence of the time lag between early operational improvements and delayed financial results, which can be misinterpreted as an indication of lean failure. Searcy (2009) notes that this

1 Kaizen (Continuous Improvement) is a strategy where employees at all levels of a company work together proactively to achieve regular, incremental improvements to the manufacturing process.

misinterpretation reflects “the overemphasis on costs early in a lean implementation and the disregard of the time lag inherent in the financial results”.

Jorgensen et al. (2007) stress that assessment tools are critical to successful lean implementation and that lean assessment tools must include a technical perspective that reflects performance, methods, and tools related to the company's strategic scope, and an organizational perspective which reflects management, organizational, and human capabilities, culture, and learning. Changes to performance measurement, management accounting, and management reporting systems are often found to be necessary for lean sustainability (Searcy, 2009; Kaplan & Anderson, 2007; Nordin et al., 2012; Norreklit & Mitchell, 2007; Todorović & Čupić, 2017). Lean sustainability also requires the use of different financial and non-financial performance measures. Fullerton and Wempe (2009) find that managers who implement lean manufacturing without utilizing supportive non-financial manufacturing performance measures may experience disappointing financial results.

There are many studies investigating the importance of management accounting and cost accounting for performance measurement and management reporting in the context of continuous improvement programme implementation (Kaličanin & Knežević, 2013; Kaplan & Anderson, 2007; Nordin et al., 2012; Todorović & Čupić, 2017). The choice of an adequate methodological approach for cost accounting is very important. The most common choices in the context of lean implementation are Value Stream Accounting (VCA) and Activity Based Costing (ABC). Leading authors in the field of management accounting argue that Time-Driven Activity Based Costing (TDABC) can be beneficial for lean implementation (Kaplan & Anderson, 2007). TDABC can contribute to lean management, especially when it comes to waste identification, selection of appropriate measures for waste elimination, and application of corrective measures to improve efficiency (Demeere et al. 2009; Everaert et al., 2012; Hoozee & Bruggeman, 2010; Kaplan & Anderson, 2007).

Todorović (2013) finds that 19.4% of accountants in a sample of Serbian companies are familiar with the lean concept, while only 5.6% of companies apply lean. She also finds that as many as 80.5% of accountants are unfamiliar with

TDABC, while only 8.33% of accountants are familiar with both lean and TDABC and only 1.39% of accountants implement lean and know TDABC. In a study of the effects of 5S implementation on the operational and financial performance indicators of one Serbian company, Todorović and Čupić (2017) find that the implementation of 5S only contributes to the performance of an organization in the short and medium term. They also point to the importance of management accounting system improvements after implementation of the continuous improvement programme.

3. RESEARCH METHODOLOGY

3.1. Research method and instruments

We use a multiple case study method to examine the motives behind, barriers to, and effects of lean implementation and to investigate the changes in management accounting and performance measurement systems after lean implementation. The case study method is often used to illustrate an emerging theory (Keating, 1995). It is also used to research unknown subjects (Bogićević Milikić & Janićijević, 2009) and to get an in-depth and first-hand understanding of a particular situation (Yin, 2014). The case study is widely used because it can offer insights that might not be achieved with other approaches (Rowley, 2002). Yin (2014) defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between the phenomenon and the context are not evident, using multiple sources of evidence. Eisenhardt (1989) points out that case studies are an excellent research method for generating creative, testable, and empirically valid theories.

Unlike single case studies, multiple case studies permit replication and extension between individual cases, which helps researchers to more easily understand patterns, to eliminate chance associations, and to form a better theoretical structure. Multiple case studies depend on proper case selection. While there is no ideal number of cases, a number between four and ten usually works (Eisenhardt, 1989). We analyse four large companies which have experience with lean. Like Chen and Guliang (2009) and Kennerly and Neely (2002), to introduce diversity into our sample we intentionally choose companies from different industries and with different competitive and organizational characteristics.

The multiple case method has been used in several studies on operations management, management accounting, corporate governance, and performance measurement (Bogićević Milikić & Janićijević, 2009; Chen & Guliang, 2009; Everaert et al., 2012; Kennerly & Neely, 2002; Stancic et al., 2012). Scapens (2006) emphasises that a case study method can be used "to understand how accounting practices which are in use have emerged in specific organisations". He further explains that "the organisations do not have to be representative of some population; simply organisations in which management accounting practices are changing".

Akkermans and Helden (2002) point out that the case study method can pose problems ensuring rigour and reliability, given that the conclusions can be based on accidental circumstances and researchers' own biases, instead of on careful observations of reality. Following Akkermans and Helden (2002), we take steps to limit our personal biases by using several independent perspectives and data sources. Independent perspectives were obtained by sending the questionnaire to members of the sample companies with different backgrounds: PR manager, Chief Financial Officer (CFO), and production manager. We also interviewed them to supplement the information gathered from the questionnaires that they completed. We used additional sources of data, including company and official institutions reports, to cross-check and supplement the data and information collected from the questionnaire and interviews. Following Everaert et al. (2012), we support the reliability of our conclusions by combining qualitative data from the interview with data from different sources.

Our questionnaire comprises three groups of questions. The first group aims to identify implemented lean techniques, the process of and the key barriers to lean implementation, and the motivation behind and expectations and effects of lean implementation. The second group of questions aims to determine the implications of implemented lean techniques on management accounting and cost accounting; i.e., to determine changes in the cost accounting methodology and performance measurement system. The third group of questions aims to identify the implications of the implemented lean techniques for the company's organization, production, and overall business processes.

3.2. Sample

Our sample consists of the four companies presented in Table 1. The success of the implementation of any particular management practice frequently depends on organizational characteristics, and not all companies can or should implement the same set of practices. All companies in our sample are publicly traded and large, according to the Serbian Law on Accounting of 2019. Large companies generally have better access to the capital and human resources necessary for the adoption and implementation of lean practices (Dombrowski et al., 2010; Bhamu & Singh Sangwan, 2014). The sample companies are from different industries and they all have foreign capital in the ownership structure. They implemented different lean techniques, but they all implemented 5S as one of the best-known and most widely used. Companies A, B, and C implemented the Quality Management System (QMS), the Environmental Management System (EMS), and the Occupational Health and Safety Advisory Service (OHSAS) as integral parts of the Integrated Management System (IMS). Companies A and B implemented ISO-22000, while company A also has a HALAL certificate.

Table 1: Features of selected companies

Company	Primary activity	Implemented lean techniques	Implemented standards
A	Production of bakery products and pasta	Total Productive Maintenance (TPM), Single-Minute Exchange of Die (SMED), 5S	Integrated Management System (IMS) based on ISO-9001 (QMS), ISO-14001 (EMS), ISO-18001 (OHSAS), and ISO-22000 (HACCP); HALAL
B	Production of tobacco	5S, Visual Management	ISO 22000 (HACCP)
C	Production of footwear	TPM, SMED, 5S, Six Sigma	IMS based on ISO-9001 (QMS), ISO-14001 (EMS), and ISO-18001 (OHSAS)
D	Production of drinks	TPM, SMED, 5S, Six Sigma, Visual Management	IMS based on ISO-9001 (QMS), ISO-14001 (EMS), and ISO-18001 (OHSAS).

The Serbian economic environment is specific. Serbia is a developing and transition economy in the process of accession to the European Union (EU). One of the consequences of this process is the continuous intensification of competition due to market liberalization. This is especially important, given that about 80% of company A's revenues and over 60% of company D's revenues are realized in the domestic market. Company C holds about a 75% market share in Serbia, and exports more than 60% of its products to the EU, the United States, and Canada. The level of competition, especially price competition, in the European markets is very high and the producers are forced to focus on production costs. Strong competition is also an important factor in companies' efforts to implement continuous improvements and eliminate waste. The sample companies implemented lean as one of the solutions to these problems.

4. ANALYSIS OF THE LEAN IMPLEMENTATION

4.1. Understanding of lean and motives for its implementation

Table 2 presents the understanding of lean and motives for its implementation in the sample companies. An adequate understanding of lean and avoiding focusing on short-term lean techniques is crucial for its sustainability (Dombrowski & Mielke, 2014). Companies B and D have formalized their commitment to lean implementation and understand lean in the broadest sense, as a business philosophy and concept. These companies do not focus only on lean techniques. Company D treats lean as an integral part of the corporate culture. On the other hand, companies A and C focus only on individual lean techniques, meaning that lean is understood more narrowly.

Table 2: The understanding of lean and motives for its implementation

Company	Understanding of lean	Motives of lean implementation
A	- Little experience - Focus on lean techniques - There is no formal commitment to lean principles	- Increasing process efficiency - Cost reduction - Higher employee motivation and participation - Elimination of non-value-adding work
B	- There is a formal project to introduce lean	- Sales increase and cost reduction - Better product quality - Reduction of unproductive work - Strengthening staff motivation and development - Encouraging teamwork
C	- Focus on techniques, not on lean concept	- Cost reduction and productivity increase - Reduction of delivery time - Improving process efficiency - Better customer satisfaction
D	- Formal corporate decision on lean implementation	- Cost reduction and productivity growth - Reducing the number of complaints - Strengthening employee motivation and development

Table 2 shows that the most common motives for lean implementation are cost reduction, greater employee development and participation, and improved customer satisfaction. Similar to previous studies, we find that lean is associated with the creation of a positive work environment and greater employee participation and involvement (Bocquet et al., 2019; Neirotti, 2018). Lean is also expected to reduce costs, shorten lead times, and provide the best staff safety and highest morale (Jainury et al., 2012; Shah & Ward, 2003, 2007; Wood et al., 2004). Although the sample companies understand lean differently, there is a significant degree of similarity regarding their motives. The question is whether the companies' expectations regarding lean will be met, given their different approaches to lean understanding.

4.2. The phases of and barriers to lean implementation

Table 3 presents the phases of and barriers to lean implementation in the sample companies. The vision, mission, and objectives of company A indicate that the lean principles are accepted (Table 3 and Table 4). Company B uses a project approach to lean implementation, meaning that lean implementation is an organized, coordinated, structured, and managed process. There is no formal project of lean implementation in company C; however, the promoted core values indicate that this company informally accepts lean principles. Company D started to implement lean after a corporate decision to improve processes and employees. When asked how long the implementation process took, one of the managers of this company answered:

> "*Lean implementation is an ongoing process. It cannot be said how long this process will take. The process is still ongoing.*"

Employees in company D who underwent training abroad were the leaders of lean implementation. Employees in the department that has already implemented lean train the employees in the department where the implementation is just beginning. Monitoring is of great importance for project sustainability in company D. It involves continuous control and regular follow-ups on the current situation and its development towards the defined aims. Follow-up 1 involves verification of the lean effects. One of the managers stated:

> *"The purpose of follow-up 1 is not just in the monitoring of quantitative performance, given that significant improvements are still expected. Follow up 1 should instead enable the analysis of business processes and check if they are implemented in an intended way."*

Follow-up 2 and all other follow-ups aim to ensure lean sustainability. Company D emphasises that to ensure the success of its implementation, lean needs to become part of the corporate culture. This requires time, continuous work, and top management's absolute support, commitment, and understanding of lean. Top management should be supported by special teams whose basic task is continuous improvement. Other factors are employees, continuous investment in employees, and the development of a culture of process and employee improvement.

Table 3: Issues relevant to lean implementation

Company	Phases of lean Implementation	Barriers to lean implementation
A	- Reviewing the situation - Employee training - Monitoring implementation - Organizational changes to comply with lean principles - Communication of objectives and significance of lean implementation	- Lack of employee knowledge, skills, and competencies - Employees' resistance to and distrust of the results, usually caused by the time lag between implementation and results
B	- Project approach to implementation	- Employee inertia and resistance to change
C	- Defining and planning improvements in the plant, equipment, and employees - Measuring and analysing implemented changes to achieve defined objectives - Launching production after the implementation of improvements - Continuous control of the implemented improvements and taking corrective action when needed	- Seasonal workforce with lower levels of competency - Conflict between management at different hierarchical levels - Lack of defined business policies and procedures related to implementation
D	- Reviewing the actual situation - Defining the future situation with a top-down approach (when targets are set by top management) or a bottom-up approach (when areas where improvements are needed are first identified and then targets are defined) - Development of activity plan and project management - Implementation - Follow up at multiple levels and stages	- Duration (improvement process is a continuous process) - Difficulties in accepting change, especially due to job rotation

One of company D's objectives is to increase employees' motivation. To achieve this, different methods of measuring employee motivation and engagement are developed, including the ratio of the number of reported problems to the number of ideas for improvement suggested by employees, and the ratio of the number of employees who suggest ideas to the total number of employees. The purpose of encouraging initiatives and ideas from employees is to implement them as simply as possible with the employees' support.

It can be concluded that employees at all levels of the hierarchy are a critical success factor in lean implementation and sustainability in the sample companies. The human factor is the critical success factor of lean implementation (Janjić & Todorović, 2019), but it is often also the reason for its failure, due to a lack of real understanding of lean principles and a focus on the short-term application of lean tools (Nordin et al., 2012), a lack of employee involvement (Bocquet et al., 2019; Neirotti, 2018), a lack of focus on developing employees' lean capabilities (Jorgensen et al., 2007), and an inappropriate style of governance (Hoozee & Bruggeman, 2010). Our study also indicates that the most common problems in lean implementation related to employees are lack of knowledge, skills, and competencies; inertia; resistance to change; and management conflict at different hierarchical levels. Resistance to change is usually found to be due to low commitment and inadequate training (Nordin et al., 2012), weak support from top management (Tiwari et al., 2020), and lack of communication and participant involvement during change (Canning & Found, 2015).

Ford et al. (2008) argue that resistance to change is usually caused by the actions or inactions of change agents. Top management and change agents of companies implementing lean sustainability need to continuously work on improving employees, encouraging their participation, and building a supportive work environment. AlManei et al. (2018) find that one of the major challenges of lean implementation is managing the changes in structure, system, process, and employees, as defined in the implementation plan. They add that lean implementation is not a one-off project but a continuous process affecting processes and people. Top management and strong leadership styles and an effective change-agent system are critical aspects of lean implementation. Nordin et al. (2012) argue that the role of a lean-change agent is very important in implementing behavioural and mindset changes, given that the employees are often not familiar with the lean work environment. Ahlstrom et al. (2021) argue that future studies should examine the roles of different hierarchical levels in sustainable lean implementation, as well as the deeper emotional, change-management side of lean implementation, including the psychological hurdles of continuous improvement and behavioural change.

4.3. The effects of lean implementation

Table 4 presents the business characteristics after lean implementation and the financial and non-financial benefits of lean implementation in the sample companies. Company A introduced 160 new products over the three years following lean implementation. The production of such a large number of new products requires the organization of flexible production in small batches, which in turn requires well-trained employees and flexible equipment allowing frequent tool changes and more frequent cleaning of the production line. Food quality and consumers' health and safety are ensured through the implementation of HACCP and HALAL for over 80 products. Company A focuses on identifying defective products at each stage of production and at at least two workplaces before the final packaging. Employees should identify, mark, and inform the management about defects, but also eliminate defects. Company A productivity, measured as the ratio of total production volume to hours spent per worker, increased by 2% in the first year and by 40% over the five years after lean implementation.

Employee innovations are constantly encouraged in company B: employees are expected to identify problems and present ideas for improvements directly to their superiors or at regular meetings related to continuous improvements. After the implementation of 5S, impressive results were achieved. In just one year, the number of unnecessary elements per department was drastically reduced – from 179 to 31 in factory 1, from 85 to 14 in factory 2, and from 56 to 0 in factory 3. In addition, significant water savings were achieved: over a period of three years, water consumption was reduced by more than 70%. The reject ratio, as a percentage of discarded products or components in relation to the total number of processed products, was reduced from 3.8 to 1.6 in four years. Implemented continuous improvement techniques resulted in productivity growth of 52% and a decrease in scrap of 57%.

Table 4: Effects of lean implementation

Company	Business characteristics after lean implementation	Benefits of lean implementation
A	- Creating value for customers - Flexible production in small batches - Focus on quality assurance	- Development of 160 new products - Productivity growth by 40% over five years after lean implementation
B	- Focus on continuous improvements - Increasing employee participation, responsibility, and innovation - Commitment to quality	- Productivity growth by 52% - Waste reduction by 43%, where scrap is reduced by 57% and water consumption by more than 70% - Technical efficiency growth
C	- Greater investments - Job rotation and employee empowerment	- Cost reduction - 150 new products
D	- Innovations and investments in production - Investments in employees (3% of profits are invested in employees' education) - Work in small groups - Job rotation and employees' safety	- Cost reduction - Reduced number of defective products - Reduced number of injuries at work

Company C invests in the development of new products and new and alternative materials to improve product performance. More than 150 products were developed over the three years after lean implementation. They strive to optimize the cost of goods sold through productivity growth. Monthly production plans are prepared according to sales requirements; i.e., production is realized in accordance with defined monthly plans, total stocks of finished products, and available preproduction stocks. The company applies job rotation according to process requirements, resulting in highly qualified and skilled employees.

Employees of company D work in small groups, which increases the level of employees' complex knowledge, the creation of rotation opportunities, and the responsibility and flexibility of employees. The rotation of employees and management is carried out every 1 to 2 years, which improves the flexibility of the employee structure and understanding of the entire business. Visual management involves setting up boards to present problems and new ideas, visual instructions, and machinery operation. As a result, company D has improved the transparency of monitoring machinery operation, improved internal communication between shifts, reduced the number of errors, and facilitated monitoring of reported problems. The innovations in company D led to productivity improvements and employee development and education. Investments in human resources or soft capital proved to be extremely profitable, given their very quick payback.

In summary, the sample companies increased investments in new technology, production, and new products. They invest in the education and development of employees; they also rotate employees and increase their flexibility. Teamwork, participation, and increased accountability lead to increased motivation. Employees are encouraged to present problems resulting from and ideas for continuous improvements. The companies pay great attention to the safety and protection of employees, and they all have similar objectives regarding quality assurance. The common characteristics of the sample companies are investment and innovation, education, and product quality.

5. ANALYSIS OF CHANGES IN THE PERFORMANCE MEASUREMENT SYSTEM

In the second part of our research we analyse changes in the performance measurement system and management reporting after lean implementation. We analyse the measurement process itself, and not the results of that process. Company B considered these issues to be a business secret and is therefore not included in the analysis.

The accounting information system (AIS) organization, accounting methodology, and performance measurement system of company A did not change significantly after lean implementation. The company uses absorption costing, where overhead costs (about 40% of the total) are allocated according to the value of the work order. Given that company A has experience in monitoring and measuring time, and the fact that TDABC relies on time measurement, changes in the accounting system could include TDABC implementation. This is especially important given that the managers of lean companies usually have greater information needs and require performance measures based on time.

The implementation of lean techniques in company A required the introduction of the following performance measures: mean time between failures (MTBF) and mean time between repairs (MTBR). MTBF represents the time between failures during system operation. It can be calculated as a statistical mean; i.e., average time. However, its definition depends on how the failures are defined or understood. Failures are most often those conditions and unforeseen circumstances that put the system out of operation. MTBR reflects the average time between repairs. Company A also relies on the Overall Equipment Effectiveness (OEE) index to measure production effectiveness. This indicator is considered crucial for lean production and is determined by production capacity availability, results, and quality. Each of these OEE elements can be improved. Capacity availability is measured as the ratio of the actually available work time to the maximum possible time. The results are measured in several ways; for example, as the ratio of the actual number of products produced to the maximum possible number of products, and the ratio of the ideal cycle time to the quotient of the time actually spent and the number of products produced. Quality is measured as the ratio of the number of products whose production has been completed to the number of products whose production has started or as the ratio of the number of valid products to the total number of products.

Company C has radically changed its accounting methodology. It uses time-driven activity-based costing (TDABC) for cost accounting, which allows creating information and reports important and useful for efficient decision making and control after the lean implementation. It also allows detailed analysis of the efficiency and capacity utilization of business processes and the introduction of production productivity and efficiency measures. Implementation and utilization of TDABC make possible a more precise allocation of indirect costs (about 15% of the total) based on the time needed for the production of one unit of product. Productivity is measured as the ratio of production volume to the number of employees, while efficiency is measured as the degree of capacity utilization or by using the productivity index (ratio of labour productivity in the current compared to the previous period).

Company D applies traditional cost accounting approaches but has made significant methodological improvements. Different types of costs are calculated and monitored in relation to the time variable. There are no significant changes in the performance measurement system. The OEE index is considered to be very important. It is used in production, and with certain modifications in other parts of the company. Cycle time is also important. It reflects the total time from the beginning to the end of the process. The cycle-time ratio is calculated as the ratio of standard to actual cycle time. To measure quality assurance and control, the rejection rate is calculated. The reject ratio is calculated as the ratio of the number of products rejected to the total number of products.

Based on the results of the analysis, we draw several conclusions. First, a lean environment changes the management's information needs, the performance measurement system, and management reporting. These changes are a prerequisite for ensuring lean sustainability. However, the scope and depth of changes in the sample companies differ as a consequence of their different understanding of lean. Second, no changes in financial reporting were identified, but there were organizational and methodological changes in the management accounting system. Third, lean implementation increases the importance of measuring productivity and efficiency. Fourth, the importance of non-financial performance measures, especially those related to the environment and environmental costs, is growing. Fifth, time measurement has become more important and is included in various calculations. Instead of partial use of time, possible further improvements for companies A and D include the implementation of TDABC as one of the most effective instruments for valorising lean effects (Kaplan & Anderson, 2007; Everaert et al., 2012).

6. CONCLUSIONS

In this paper we have identified and analysed the key success factors of sustainable lean implementation and investigated the changes in management accounting and performance measurement after lean implementation. Lean sustainability means that the momentum of improvement is maintained after the initial implementation steps are completed. Jorgensen et al. (2007) argue that lean sustainability involves the continuous development of lean implementation capabilities among employees and requires a focus on both performance improvement and capability development. The company is not lean when it uses some lean techniques, but when it establishes a culture of continuous improvement of processes and employees.

The human factor is often found to be a key success factor in lean implementation. It is often also the reason why lean fails. In the sample companies we identified several barriers to lean implementation related to employees: lack of knowledge, skills, and competencies; inertia; resistance to change; and management conflict at different levels of the hierarchy. These are the reasons why the sample companies pay great attention to employees and continuous employee improvement. They all invest heavily in employee education and development and encourage employee initiatives and innovations. Working in small groups and employee rotation increase employees' level of complex knowledge, the flexibility of employee structure, and employees' understanding of the entire business process.

In the sample companies the employees are invited to present ideas and suggest improvements. The sample companies also tend to create a supportive work environment where employees feel empowered and have the necessary tools to own the product and process. The work environment should encourage change and transformation. An integral element of such an environment is dedicated, professional, and supportive management at all hierarchical levels. Management is also responsible for a good relationship with employees and the development of the concept of "respect for people" (Natarajan et al., 2017).

The sample companies improved their performance measurement and management accounting systems. They all measure and monitor time in different contexts. One sample company has implemented time-driven activity-based costing (TDABC) to create the information and reports important for decision-making and control in a lean environment. The other two companies still need to work on improving their accounting methodology. The performance measurement system should allow continuous monitoring of the implemented changes. This is especially important because of the time lag between lean implementation and performance (Alkhoraif et al., 2019). One of the sample companies emphasises the existence of a time lag in performance and the importance of monitoring.

Our paper has significant theoretical and practical implications related to the theoretical background, literature review, and results. We have identified, analysed, and emphasised barriers to sustainable lean implementation as well as its key success factors. Our results suggest that some of the key success factors of sustainable lean implementation are the continuous communication of the objectives and importance of the lean project, the continuous improvement of soft skills, the development of teamwork and employee motivation, a dedicated management, a supportive work environment, and continuous monitoring of the implemented changes and results. Our results contribute to raising management awareness of the need to identify and manage these factors. Management should be supported by specialist teams whose task is continuous improvement. Finally, change management and lean transformation should become part of the corporate culture. Lean is just one continuous improvement programme, but the results of this study can also be used to improve the sustainability of other programmes. We therefore expect that our study will contribute to a wider application of the lean concept, more efficient lean implementation, and the achievement of long-term sustainable results.

Finally, our paper has several limitations. The multiple case study method has limitations stemming from the fact that the analysed cases may be unusual and therefore cannot be used to draw general conclusions. It is a data-driven rather than theory-driven approach and it does not allow the use of statistical or econometrical analyses. Some data on the sample companies (e.g., understanding lean and lean effects) cannot be compared using statistical methods. The sample is small and the data are qualitative. However, we limit our personal biases by using several independent perspectives and data sources and believe our study offers useful insights into lean implementation and its effects.

The paper has introduced some questions and dilemmas for the consideration of future researchers. The key question is how to build a lean accounting model. A larger sample and the use of quantitative data should enable the application of advanced statistical methodology.

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