DEVELOPING A CONCEPTUAL MODEL FOR MEISURING LEAN TOOLS IN THE MANUFACTURING SECTORS AND ITS IMPACT ON SUSTAINABLE PERFORMANCE IN SRI LANKA: WITH SPECIAL REFERENCE TO THE APPAREL INDUSTRY.

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Abstract

For today's enterprises to sustain the market over the long term, a lean manufacturing system is an advanced instrument and strategy. The lean manufacturing system's primary element is a set of lean tools that foster corporate growth and generate value while driving innovation and industry development. The variables extracted are namely the value stream mapping, 5Ss, just in time, and continuous improvement. These variables are considered the basis of a production technique called lean manufacturing, which is founded on the idea of boosting output while cutting waste in a manufacturing process. According to the lean view everything that does not provide value that customers are ready to pay for is waste. Many organizations are using lean manufacturing principles to cut waste, optimize processes, reduce costs, foster innovation, and accelerate time to market in today's quick-paced, turbulent, and ever-changing global economy. Sustainable performance evaluation is based on three key areas called Economic sustainability, Environmental sustainability, and Social sustainability. The proposed conceptual model can be used to test hypotheses, concerning the impact of each lean tool on sustainability performance dimensions in a large sample quantitative study.

Keywords: Lean Manufacturing, Sustainable Performance, Economic Performance, Environmental Performance, Social Performance

Introduction

Lean Manufacturing (LM) has been described in a variety of ways by authors throughout the lean evolution process (Bhamu and Singh Sangwan, 2014) and Abul Bashar, (2020), noted that there are five guiding principles of lean production that were identified by Womack and Jones (1996) as follows: describe a value, map the value stream, create flow, develop pull, and pursue perfection. 2020's Chaochao Liu. Generally speaking, the majority of authors have emphasized Lean Manufacturing as a route to wasteless production (Bhamu & Singh Sangwan, 2014). It reduces waste, allowing the organization to be more responsive, adaptable, and lean (Wilson, 2010). Lean Manufacturing gives manufacturers a competitive advantage by enhancing output and quality while cutting costs (Sisson & Elshennawy, 2015). The lean notion was stated by Pettersen (2009) from a philosophical and practical perspective.

Lean production's guiding concepts and objectives are described philosophically, while a collection of lean tools and techniques are described practically (Shah & Ward, 2007). Abul Bashar, (2020); Shah and Ward (2007) noted a discrepancy between the two viewpoints and noted that many authors are still unsure of how lean principles contributed to organizational change (Caldera et al., 2017). A performance measurement tool based on lean tools and practices has been proposed by Shah and Ward (2007) as the foundation for lean production research (Valente et al., 2019).

Many of the manufacturing companies in Sri Lanka have faced losses through COVID. Some have even closed down. The problem that has been identified is attributional to the manufacturing skill gap. Skilled workers were scarce during COVID. This was also due to the poor inventory and supply chain management, where stocks were not delivered to the quality, quantity or consistency demanded. There was also a gap in the management of stocks through the supply chain. Many companies used a manual system due to the cost of investment in an Enterprise Resource Planning (ERP) system. Hence, many of manufacturing companies are looking at the option of lean manufacturing to improve efficiency, reduce waste and increase productivity. Thus, the researcher has undertaken qualitative research on the impact of lean tools on sustainable performance within the manufacturing sector in Sri Lanka.

According to previous researches, the majority of lean tools support the accomplishment of sustainable goals. But such studies only focused on the few traditional tools and did not consider the newest tools. Hence there is a wide research gap in the field of lean manufacturing practices and sustainable performance. This study aims to fill that research gap by focusing on the newest lean tools.

1.1 Objectives

- To understand the impact of value stream mapping tool on sustainable performance
- To understand the impact of 5s tool on sustainable performance
- To understand the impact of the kaizen tool on sustainable performance
- To understand the impact of the JIT tool on sustainable performance

Lean Tools

Gupta, and Jain, (2013), claim that because lean tools are the most crucial element of lean manufacturing, the focus of lean literature has always been on them. However, existing literature offers a diversity of definitions and descriptions for these tools due to how lean tools have grown in different industries and departments. In conjunction with the research's primary goal and literature study, 4 exemplary lean tools were found.

Value Stream Mapping

Value stream mapping is a method of lean management that allows the company to visualize and improve the steps in a product or service delivery process. This mapping uses flowcharts to show, evaluate, and improve the procedures involved in providing a good or a service. Value Stream Mapping (VSM), a crucial component of the lean methodology, examines the information and process flow from point of origin to point of customer delivery. It uses a system of symbols to represent different work activities and information flows, just like other forms of flowcharts. Value Stream Mapping is very helpful for locating and eliminating waste. To identify products that do not contribute value, items are mapped as either adding or subtracting value from the customer's perspective (Singh, et al, 2011).

Value stream mapping, which can be used in any process—not just manufacturing—is an effective way to find waste. That is its main objective. It describes each important process step in detail and assess if it adds value from the customer's perspective or not. The company is able to compete most successfully in the market because the analysis is kept focused on value. Lean practitioners can effectively use VSM to provide the most value for the client in the most efficient manner whether anticipating or dealing with any competitive threat. It can and ought to be utilized continuously for process improvement, bringing ever-better stages online. Value Stream Mapping enables one to view the source or cause of the problem in addition to the waste (Solding, and Gullander, 2009).

Like other great visualizations, value stream mapping is a powerful tool for collaboration, communication, and even culture change. The current state of the process and the locations of waste are easily visible to decision-makers. They are able to observe concerns like inventory problems, excessive downtime, and process delays.

5-S Tools

The 5S technique consists of five processes for creating an orderly workplace: separating, organizing, cleaning and shining, standardizing, and maintaining the workspace. An operation is safer, more productive, and more efficient when the workplace is well-organized. It guarantees ongoing housekeeping improvement, which leads to a healthier environment and higher safety standards (Liker, 2004).

The five steps of the 5S process are Sort, Straighten, Shine, Standardize, and Sustain to create a more orderly and effective workstation. The 5S technique serves as a foundation for more sophisticated lean manufacturing technologies and processes. The fundamental lean tool is 5S, and it is a great approach to assist the business cut waste and increase revenues. Japan is where the 5S idea originated. Visual control systems are about enhancing value-added flow, and 5S is a tool in the Transaction Processing System (TPS) that may be used to help make problems visible and be a part of the visual control process of a well-planned lean system (Warwood, & Knowles, 2004).

5S includes five primary practices. They are as follows.

Table1: 5S principles

Japanese Term	American Term	Definition
Seiri	Sort	Sort through materials, keeping only the necessary items required to complete tasks. (This process involves going through every content of a workspace to decide what is needed and what may be removed. Everything that is not utilized to complete a work operation or process must be removed from the workspace.)
Seiton	Set in Order	Ensure all items are managed and every item has a designated place. Manage all remaining items in the workplace logically so that they are easy for employees to complete. That usually involves setting things in ergonomic locations that do not require people to bend or make different movements to get them.
Seiso	Shine	Take proactive steps to keep workplaces clean and orderly to guarantee goal-oriented work. That means cleaning as well as maintaining the newly managed workspace. It may include general tasks such as cleaning, dusting, or maintenance of tools, machinery, and other equipment.
Seiketsu	Standardize	Make a set of standards for both processes and organization. In essence, the organization takes the first three S's and lays down the rules for how and when to perform these tasks. Those standards may include schedules, lists, charts, etc.
Shitsuke	Sustain	Maintain discipline by maintaining new practices and executing audits. This suggests that the prior four Ss' should be maintained over time. This is accomplished through instilling self-discipline in workers who will engage in 5S.(Gupta, & Jain, 2013).

Continuous Improvement (Kaizen) Tool

Continuous improvement, also known as kaizen, is commonly referred to be the "basis" of all lean manufacturing practices. In order to reduce waste, boost efficiency, and achieve long-term improvement in a company's particular operations and procedures, the Japanese idea of kaizen is used. Continuous improvement, or kaizen, is at the core of lean production. This perspective holds that small, gradual changes done frequently and maintained over time have significant positive effects. The kaizen strategy aims to unite workers from all levels and divisions of the company to solve an issue or enhance a process (Gupta, & Jain, 2013).

Kaizen is an approach to building continuous modification based on the opinion that small, continuous positive changes may lead to substantial enhancement. In general, it is based on cooperation and commitment instead of methods that utilize radical or top-down transformations to reach transformation. Also, Kaizen is fundamental to lean production and the Toyota Way. (Sundar, et al, 2014). It was developed to reduce defects in the production sector, increase productivity, eliminate waste, encourage employee accountability and goal, and promote innovation (Bhamu, & Sangwan, 2014).

Furthermore, it has been embraced in numerous industries, including healthcare, as a vast concept with numerous interpretations. It may apply to any business sector and even at the individual level. Kaizen may use several tools and approaches, like value stream mapping. It is a management model that documents, studies, and enhances the data and material flows required to manufacture a product and service and incorporates total quality management. It focuses on quality improvement among all employees. Regardless of the method, in a corporate setting, the successful utilization of Kaizen depends on gaining assistance for the approach throughout the firm and from the CEO. (Gupta, & Jain, 2013).

Just-In-Time (JIT)

Just in time in manufacturing is a production model that is created to meet the demand that is not created in surplus or in advance of the need. The organization accommodates a JIT approach when they want to increase their efficiency while reducing cost and speeding up product delivery (Goyal, & Deshmukh, 1992). Just In Time is also

considered a workflow methodology that helps with the reduction of flow time within the production system. Thereby, the response time from suppliers and customers is enhanced. In order to achieve the goal of adapting to JIT, the company must eliminate the types of waste that are typically associated with manufacturing (Voss, & Robinson, 1987).

The JIT methodology, also known as the lean production model is associated with manufacturing in post-World War II in Japan. At that time the country was faced with a lack of working capital. They lacked in natural resources as well (Cheng, & Podolsky, 1996).

Hence this situation has led Japanese companies to incorporate lean, efficient business practices. This adoption helped enhance the manufacturing process. This meant building smaller factories. At times they enjoyed economies of scale. The production items were in smaller batches. Yet, they paid close attention to the efficiency of their production process. Following a JIT process requires discipline, structure and explicit processes. There were strict limitations on inventory. The JIT process paid attention to details eliminate defects. It set up reduction and flexible changeover approaches. There was always a balanced flow actively managing small-sized batches. There was skill diversification. There was prominence given to the designing of the process (Goyal, & Deshmukh, 1992).

Toyota was at the forefront of the JIT effort in Japan. The company was able to implement JIT practices successfully and the company's approach became well known. It was called Toyota Production System (Bhamu, & Sangwan, 2014). The Toyota Production System philosophy shares seven types of waste namely overproduction which means that there are more products than the customer needs, waiting means time taken to complete the production, and inventory where there is more inventory at hand that requires extra storage. (Sundar, et al, 2014). Then there is transportation where goods are transported unnecessarily during the production process. There are inefficiencies in processing that resulted in unnecessary effort. The JIT process also considers workers' inefficiency and unnecessary work during production. There could also be defects that result in a waste of time, material and effort that will eventually affect the company's reputation (Cheng, & Podolsky, 1996).

Lean in the Manufacturing, Sustainable Performance and Conceptual Model

Organizations may embrace Lean Manufacturing to enhance their business process. After reviewing the literature, it appears that the Lean Manufacturing process is still quite new. But the use and execution of almost all Lean techniques and tools can be seen to have increased annually (Pettersen, 2009). According to the literature review, this appears to be because most companies have reached the early execution stage rather than staying in the planning phase. Manufacturing sectors are ahead in executing lean techniques and tools compared to other sectors. Paper and allied items, textile mill items, stone-clay-glass items, petroleum items, printing, and metal manufacturing are industries that are lagging in executing lean production concepts (Silva, et al, 2012). Lean manufacturing focuses on minimizing waste within the manufacturing system while maximizing productivity. Waste in manufacturing is an area that the customer does not believe would add value and is not willing to pay for.

Furthermore, the use of lean tools depends on the industry's nature, the plant's size, and the country's technical abilities. Many industries tend to execute 5S and different visual management tools. American manufacturing industries utilize Six Sigma methodologies somewhat significantly heavier than other countries. Canadian and USA industries utilize Value Stream Mapping (VSM) considerably more than small-scale Indian industries. Surprisingly, Australian firms do not utilize Kaizen. Group Technology (GT) and Kanban as in other countries. Instead, they depend on total quality management (TQM). Therefore, 5S, Just-In-Time (JIT), Kaizen, as well as standardized tasks are the most valuable and famous for the printing industry in America (Gupta, & Jain, 2013).

The United Kingdom (UK) furniture manufacturing industry uses many tools to some extent. The most used tools are those that may easily change the visible shop floor and may affect the organization's financial position significantly. Single Minute Exchange of Die (SMED) is not very popular because of the belief that it requires massive investment in new machinery or tools to improve the changes (Gupta, & Jain, 2013). But China's computer industry is quite ahead in applying Lean practices (Sundar, et al, 2014). On the other hand, small firms that engage in contract production tools, such as cellular manufacturing, face challenges because they have diverse customers and constantly changing schedules. There is not enough consistency to process the cells. It may be that backsliding is one of the primary obstacles to executing Lean around the world. Lack of knowledge and middle management resistance is the following influencing factors. In all the above-analyzed countries, there is very little senior management resistance to

Lean execution (Gamage, et al, 2022). Budget constraint is another aspect for small businesses compared to medium and large businesses. Furthermore, the analysis supplies robust support for the impact of plant size on lean execution, while the impact of plant age and unionization are less influential (Bhamu, & Sangwan, 2014). Reviewing the local background Lean Manufacturing is fairly new to Sri Lanka. Few manufacturing companies have executed Lean in Sri Lanka.

The sustainable performance of an organization is harmonious with the environment and the financial objectives in ensuring that the company is able to deliver on its core business while its business activities help maximize value (Chardine-Baumann, & Botta-Genoulaz, 2014). The shared commitment to environmental sustainability is usually driven by the management of the organization. It is the investment and operating expertise that create value and provide superior business performance. There is greater interest vested by such ventures in the stakeholder and the community. As a result, the shared commitment does not lose focus on the discipline as well as the fundamentals that are needed to balance the capital needs, the risk management as well as the growth of the company. Therefore, sustainability can also be considered a process of eliminating risk, and sustaining profitable growth while understanding the long-term mindset that helps engage in rapid but efficient change, economically, environmentally and socially (Spreitzer, & Porath, 2012).

Hence economic sustainability is considered by way of growth, development and productivity. There are market allocations that bring sustained levels of growth and are consumption dependent on the natural resources available to the company. With a sound economic pillar, most companies feel that they are on firm ground. To sustain a business, it must have profit. Profit must be earned in compliance, adherence to proper governance and risk management. The economic pillar can be called the governance pillar as well. Thereby, the Board of Directors and the management aligned the company's interest with that of the shareholder's interest. The investors must feel certain that the company uses accurate and transparent accounting methods. The company needs to be assured that the management does not share a conflict of interest among Board Members. It is with the economic pillar that the company establishes a sustainable strategy (Henao, et al, 2019).

The social pillar is supported by the stakeholders and the community. Hence, it comes down to the manner in which the employees and the management are treated. The company can focus on retaining the talented. The company can enhance its engagement strategy. The company can incorporate more responsive benefits like family benefits, and flexible work hours. In the same light, the company can look for the many options available to give back to the community. Such social activities can come in the form of fundraisers and sponsorships (Henao, et al, 2019).

The environmental pillar gets the most affected. Many of companies focus on the reduction of their carbon footprint. They also concentrate on the packaging of waste, water usage and other activities that damage the environment. Hence, there are certain companies that believe in the importance of helping the planet which in turn has a positive financial impact. For example, reducing packaging material usage will reduce spending and improve the efficiency of fuel. There are certain companies that have zero tolerance for waste but may be difficult with a manufacturing company (Chardine-Baumann, & Botta-Genoulaz, 2014).

One of the main challenges in the environmental aspect is that a business impact may not be fully costed. This is because there are certain externalities that do not reflect consumer pricing. Sometimes the cost of wastewater, and carbon dioxide is hard to calculate. Hence, these companies practice benchmarks that quantify these externalities helping them to track the progress better (Spreitzer, & Porath, 2012).

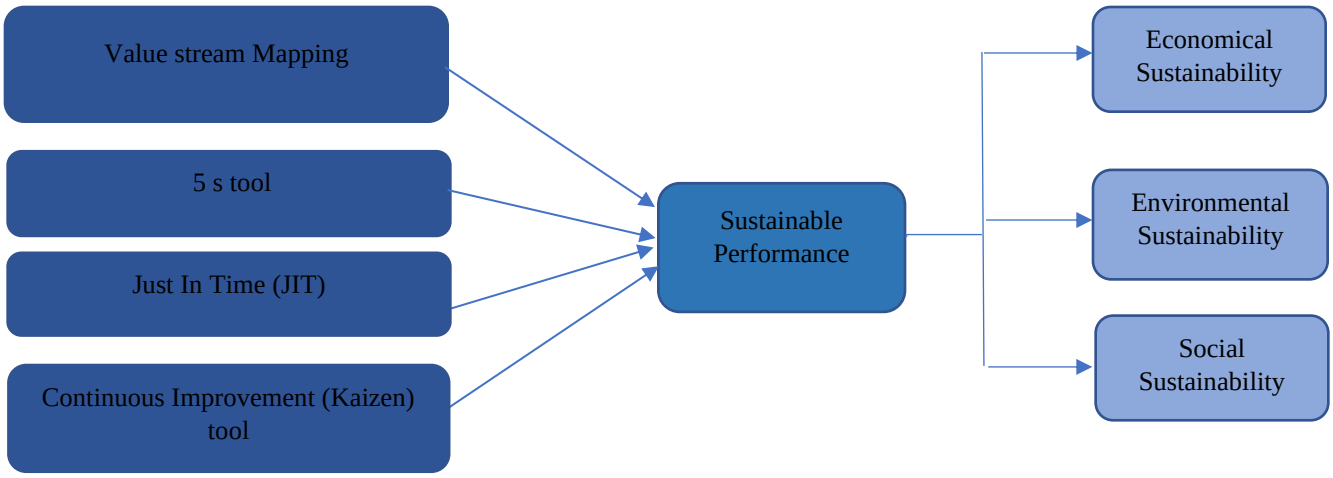

Figure 1: Conceptual model for the effect of lean tools on sustainable performance

This study follows the *Figure 1* model to identify the relationship between the Lean Manufacturing tool and the sustainable performance parameters.

Limitations and Future Research

This research has developed a conceptual model to assess the impact of lean tools on sustainable performance. The four commonly used Lean Manufacturing practices in Sri Lanka namely, value stream mapping, 5Ss, JIT and continuous improvement have been selected for the model.

A leanness evaluation metric was created by Karim et al. (2013) using continuous performance measurement (CPM) that leads to sustainable performance. There, they used production efficiency and effectiveness as measures of an entity's performance. Therefore, it is clear that prior research supports the idea that using lean methodologies directly correlates with improved sustainable performance for manufacturing businesses (Kumarasiri, 2017). However, empirical evidence for the impact of specific tools on three sustainability dimensions; economic, environmental and social performance is almost unavailable.

In addition, this study has not considered other Lean tools such as bottleneck analysis, Plan-Do-Check-Act (PDCA) cycle, and SMED that can also lead to improves sustainability performance of manufacturing firms. The research is mainly based on literature reviews. Hence where extensive contribution can be made with the information gathered in quantitative research to be conducted in the future.

Conclusion

Based on the independent variables that have been chosen the author has developed a conceptual framework to understand the effect of four Lean practices namely, value stream mapping, 5Ss, JIT, and continuous improvement. The conceptual framework can be used to test hypotheses, in future quantitative research. According to the literature, a positive relationship between Lean Manufacturing tools and some sustainable performances are evident. The proposed model will particularly be useful in exploring the impact of selected LM tools on economic, environmental, and social performance, which are the three pillars of sustainability performance.

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