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Benefits of Using Data-Driven Lean Manufacturing in Textile and Apparel Manufacturing Units in Pakistan

Ahras Rashid *, Adeel Shah, Hafiza Noor Ul Ain, Sherbaz Khan, Afzal Adamjee

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Ahras Rashid is currently affiliated with Institute of Business Management Sciences, University of Agriculture, Faisalabad, Pakistan.
Email: ahrasrashid@hotmail.com

Adeel Shah is currently affiliated with Department of Supply Chain, Institute of Business Management, Karachi, Pakistan.
Email: adeel.shah@iobm.edu.pk

Hafiza Noor Ul Ain is currently affiliated Jinnah University for Women Karachi, Pakistan.
Email: noorhanif70@gmail.com

Sherbaz Khan is currently affiliated with Department of Business Administration, Jinnah University for Women, Karachi, Pakistan.
Email: analyzeus@gmail.com

Afzal Adamjee is currently affiliated with Management Department, Textile Institute of Pakistan, Karachi Pakistan.
Email: afzal.adamjee@tip.edu.pk

Corresponding Author*

Abstract

The objective of the present study is to investigate the advantages of lean manufacturing in textile and apparel manufacturing facilities in Pakistan. This study examines the influence of lean manufacturing on the time-saving, process efficiency, and industry improvement. Modern organizations are employing lean manufacturing as a critical concept in their operations. There are numerous advantages to employing lean manufacturing; consequently, the textile industry is also transitioning to this methodology. The quantitative methodology employed in this investigation is employed to investigate the current subject matter. The study's data is gathered from the customers and employees of textile and apparel manufacturing units in Pakistan. In order to accumulate data from the respondents of the investigation, questionnaires were implemented. The study's findings suggest that lean manufacturing is significantly positively correlated with industry improvement, process efficiency, and time savings. These three factors are also essential for the success of an organization. This investigation also encompasses practical and managerial implications, future direction, and limitations.

Keywords: Lean manufacturing, time saving, industry improvement and process efficiency.

INTRODUCTION

This research primarily aims to shed light on lean manufacturing and all of its advantages. Lean manufacturing tools have been investigated by many researchers. Numerous industries are reaping benefits from implementing lean manufacturing practices, according to literature on the subject. In developed nations like the United States, Japan, Germany, the United Kingdom, and Italy, the majority of research has linked lean manufacturing to a company's success. Lean manufacturing has so far only been implemented in industrialized nations, with very little impact in developing nations

(Naeanir et al., 2013). Pakistani textile and apparel units have not been the subject of any studies investigating the impact of lean manufacturing. Pakistani textile and apparel units have never before been the subject of an effort to quantify the effects of lean manufacturing.

BACKGROUND OF THE STUDY

Applying lean manufacturing principles to the textile industry, particularly the regular production sector, is the main focus of this study. Japanese manufacturers faced difficulties following WWII due to a lack of fabric, economic resources, and human capital, especially in the automotive industry. Eiji Toyoda and Taiichi Ohno of the Toyota Motor Company in Japan were the first to propose the Toyota production system, which is now known as "lean manufacturing" in the US. Waste reduction is the main focus of this paradigm. Anything that doesn't help bring about the client's desired end result is considered wasteful. Supporting manufacturers in improving their company operations and attaining greater efficiency through the implementation of various lean manufacturing tools and techniques is the primary objective of lean manufacturing. Numerous organizations, especially those in the US, quickly adopted lean production after its successful implementation in Japan. According to Womack and Jones (1994), "lean" refers to a framework that uses a lot less resources (including all inputs) to get the same results as a traditional large-scale manufacturing system, but has more options for the customer.

The Lean methodology emphasizes meeting customer demands by creating just what they need, when they need it, and in the quantities they want. The goal of streamlining the assembly process was to reduce the amount of time, effort, and floor space needed to transport the finished products. At most times, it is also carried out at the most affordable prices while maintaining the greatest standards of quality. In order to stay afloat in the new global competitive landscape, many well-known organizations in Pakistan and around the world have been trying to launch innovative business projects. Lean manufacturing is an approach to production that seeks to minimize waste by doing away with steps that do not directly contribute to the final product's value. The manufacturing industry widely used lean manufacturing technologies and methodologies after the introduction of the original Toyota production system. Efficiency in production has been a common goal in many fields, including manufacturing, electronics, and the automotive industry. Among these methods are production tuning, comprehensive maintenance, time-sensitive instrumentation, cell fabrication, and real-time material exchange.

The continuous cycle sector has been slow to adopt lean manufacturing practices. Most people think these companies are naturally effective and don't need much help with organizational development. The traditional manufacturing industry's supervisors have been hesitant to implement lean manufacturing tools and techniques because of issues like the high volume and low variety of products, large-scale production processes, and the long business cycle lead times. As an example, the widespread and immobile nature of existing equipment makes it very difficult to incorporate the idea of telephone generation into a communication workplace. Clearly, some lean manufacturing techniques present difficulties when applied to the manufacturing sector, while others do not. Research at an interaction office by Cook and Rogowski (1996) and Billesbach (1994)

used a rigorous methodology, leading to significant results. The lack of intentional research into the implementation of lean tools and strategies in a continuous manufacturing setting is largely attributable to the widespread belief that the two contexts are fundamentally different, despite the fact that analysts and specialists in the manufacturing industry frequently use fit manufacturing tools. In today's cutthroat global market, companies in the persistent interaction industry need to think outside the box to stay ahead of the competition.

The purpose of this research is to find out what textile and garment factories in Pakistan can gain by adopting lean manufacturing techniques. Lean manufacturing's capacity to rapidly improve organizational efficiency and effectiveness has led to its widespread acceptance and use across a wide range of industries around the world. Investigating the impact of lean manufacturing on improving industry performance, optimizing process efficiency, and reducing time consumption is the goal of this research-based study. Because of the positive results that have been seen in lean manufacturing, this study will not only contribute significantly but also encourage other industries and companies in Pakistan to adopt this approach. Examining the possible benefits of adopting lean manufacturing practices in Pakistani textile and apparel factories is the main aim of the study.

- How the use of lean manufacturing contributes towards the industry improvement?
- How lean manufacturing contribute to the process efficiency of textile and apparel manufacturing units?
- How lean manufacturing contribute to the time saving in textile and apparel manufacturing units?

LITERATURE REVIEW

Significant shortages in textile, manufacturing, and labor resources posed serious problems for Eastern nations after the global battle ended. Distinct from their Western counterparts, producers in the eastern region face unique challenges. As a result of these factors, the idea of "lean" manufacturing came into being. Toyoda, as CEO of Toyota Motor Company, noticed that American car companies were producing higher-quality vehicles than their Japanese competitors. American businesses in the 1940s had a tenfold competitive advantage over their Japanese rivals. For the sake of advancement, early Japanese innovators like Toyoda Kiichiro, Shigeo Shingo, and Taiichi O'Hono came up with a new, method-oriented framework called the "Toyota production system" or "lean manufacturing." Of these trailblazers, Taiichi O'Hono is generally considered the main force behind this framework (Junaid et al., 2023).

Ohno borrowed some concepts from the West, most notably from Henry Ford's seminal work "Nowadays and the Next Day." Ohno took design cues for the Toyota manufacturing machine from Ford's groundbreaking mechanical production machine, which could knit cloth indefinitely (Niazi et al., 2023). In the years between 1945 and 1970, the Toyota manufacturing system was refined and developed through a process of experimentation. Up to the current day, it has undergone and is undergoing continuous evolution. Limiting the use of assets that improve an object is the core idea behind this framework. The modern market is so cutthroat that producers have realized they need

to change their traditional view of mass production to align with the revolutionary ideas of lean manufacturing (Nazir & Yu, 2023). "The Machine That Changed the Industry" (Womack, Jones, & Ross, 1990) details how American manufacturers achieved great success thanks to an in-depth analysis carried out at the Massachusetts Institute of Technology. The analysis focused on the shift from mass production to lean manufacturing. The evaluation highlighted the significant difference between the Western and Japanese car industries and highlighted Toyota's notable accomplishment at Nummi (New United Motor Production Inc.). Reduced human effort, capital investment, floor space, equipment, materials, time, and cost were all outcomes of American businesses adopting Japanese practices (Womack et al., 1990). Lean is a popular concept in many different academic disciplines, but its meaning can vary depending on the researcher due to their varied backgrounds, experiences, viewpoints, and ways of thinking (Bhamu and Singh Sangwan, 2014).

According to Vamsi Krishna Jasti and Kodali (2014), the term "lean" describes the process of producing goods or services with minimal waste. Inclination has been proposed by most specialists as a practical method for trash disposal. According to Shah and Ward (2003), incline is a method that uses human intervention and intentional design features to maximize customer value by efficiently managing waste. Negligible buffering charges, waste elimination across a product's value chain, and the connection between waste identification and supply chain value flow are some of the definitions put forth in the literature (Hopp and Spearman, 2004; Shah and Ward, 2007; Karim and Arif-uz-Zaman, 2013). One alternative way to describe lean methodology is in terms of the reasons behind or advantages of using it (Melton, 2005). As an example, incline is described by Hallgren et al. (2009) as a methodology that seeks to improve process tasks and business management sustainability by increasing task efficiency, identifying value and waste, generating information, and fostering a culture of continuous improvement.

According to Erdil et al. (2018), experts who follow the principles of lean methodology will become more conscious of sustainability if they reduce the use of unnecessary materials and energy during the improvement process. A collaborative framework for creating outcomes is what the lean methodology is described as (Chay et al., 2015). Furthermore, Toyota's production rationale is broadened through the implementation of lean assembly (Holweg, 2007). Further, lean is an all-encompassing methodology that includes the following principles: Just-in-Time (JIT) production, cell layout, streamlined operations, TQM, HRM, and a robust quality system. These principles have a significant impact on productivity and competitive performance. The sources referenced are Taj and Morosan (2011) and Ravani and Al-Ashraf (2012).

Following extensive deliberation, Samuel et al. (2015) proved that analysts do not agree on a single, all-encompassing definition of lean. The lean definition was born out of these discussions. Despite the need for separate areas, this shortcoming has given specialists a chance to study a sophisticated lean estimation system. Thus, lean can be seen as a methodology that seeks to improve operational efficiency, data quality, and waste reduction by utilizing lean tools. Still, word of lean methodology's merits has spread far and wide for more than 30 years. Please consult Pearce et al. (2018a). The four pillars of effective performance—customer satisfaction, lead time performance, adaptability performance, and cost performance—are strongly correlated with lean practices, as stated by Khanchanapong et al. (2014). In order to improve operational efficiency,

decrease expenses, optimize inventory management, streamline supply chain processes, and increase sports performance, lean methodology has been found to be an effective approach (Nawaniret al., 2013). Marodin et al. (2016) looked at multiple cases of intentional and unintentional lean practice implementation. Lead time, inventory, and turnover metrics were all executed proficiently by those who adopted high relaxation practices, according to the findings. But Nazir et al. (2023) found that they weren't as good at making sure the delivery was on time. According to several studies, including those by Nawanir et al. (2013), Yang et al. (2011), Charrafi et al. (2016), Henao et al. (2019), and the Green Manufacturing Community (2018), as well as by Huo et al. (2019) and Nayha (2019), lean manufacturing is a great way to boost business performance. Jabbour et al. (2013) also looked at how 75 Brazilian organizations fared operationally after implementing natural management practices.

The study's authors concluded that efficient environmental management is positively correlated with the use of lean principles. The function of lean implementation in improving the operational efficiency of corporate organizations was the subject of an extensive literature review by Caldera et al. (2017) and Dieste et al. (2019). Lean Manufacturing (LM) has been shown to have many documented benefits for organizations that have used it. However, there is also a lot of evidence from many different organizations that shows the drawbacks of LM (Henao et al., 2019). Companies have been slow to embrace lean manufacturing (LM) because there aren't enough readily available frameworks to help them implement LM procedures (Jadhav et al., 2014). A study carried out in the United States revealed that about a third of large-scale manufacturing (LM) companies realized the expected benefits in the early phases of project implementation (Gandhi et al., 2018). Organizations implementing LM encounter substantial obstacles, as demonstrated by the low achievement rate of 25% within the Unified Realm (Hofer et al., 2012; Ramesh and Kodali, 2012; Bhasin, 2013).

One possible explanation for this phenomenon could be that the existing reception structures were designed for larger organizations (Alhuraish et al., 2017). Still, more small and medium-sized businesses (SMEs) than large corporations are clearly present. It is clear that there needs to be extensive research and development done to help small and medium-sized businesses (SMEs) better implement LM systems. Having said that, it's worth mentioning that recently, implementation has only been shown by a small percentage of SME industry leaders (Helleno et al., 2017). The unfavorable reception of LM was largely caused by the negative perception of LM drivers, as stated by Moyano-Fuentes and Sacristán-Díaz (2012). A structured conversation with an engaging facilitator is required for an effective reception of LM. As a result of its low labor expenses and advantageous combination of low manufacturing costs, China has recently become a world leader in re-sourcing (Anvari et al., 2014; Ramos et al., 2018).

In recent years, China's electronic product innovation has been unparalleled. They are seen as pioneers in creating cost-effective models of electronic products, say Farias et al. (2019). As LM practices have shown to be especially beneficial in organizations involved in mass production of goods, their widespread adoption has allowed for their effective implementation. Experts in the field, like Caldera et al. (2019). According to research by Storch and Lim (1999), cutting two or three seconds off the production cycle can lead to substantial savings in investment capital. This has led to the LM practices becoming very popular in Chinese business settings. In any case, research shows that

other developing country organizations have had a much harder time adopting LM. Learning Management (LM) has been around since the 1960s, but many companies still haven't figured out how to put it into practice. Luxury goods (LM) have a far higher reception rate in developed economies than in developing ones, according to the research. The existence of numerous large-scale enterprises in developed economies is a key factor in this phenomenon, as they provide excellent opportunities for LM implementation. However, there are ongoing difficulties in implementing learning management in developing economies with a high concentration of SMEs and weak educational and infrastructure systems (Khan, Zaman, Shah, et al., 2023).

Consequently, training for the implementation of Lean Manufacturing (LM) in SMEs located in developing countries is crucial, as is the establishment of a driver-centric framework. When properly implemented, Lean Manufacturing (LM) has the ability to boost performance in organizations by making better use of energy and materials, leading to higher quality products and safer working conditions for employees. Nevertheless, without conducting contextual investigations or utilizing Multi Rules Navigation (MCDM) approaches to validate the significance of the developed structure, establishing a supporting system alone will not yield significant benefits. According to Belekoukias et al. (2014), while there are a few LM systems out there, even fewer have been thoroughly tested in real-world organizational contexts using empirical methodologies. Despite the fact that MCDM offers a variety of methodologies that Learning Management (LM) analysts can use, as well as flexibility in validating the system that has been developed, many researchers have focused solely on developing theoretical and practical models for LM implementation.

The low success rate of LM implementation in SMEs is due, in part, to the fact that these models need approval (Khan, Zaman, & Mubarik, 2023). Even though there have been a few big companies that have successfully used LM, SMEs still have a hard time doing the same (Panwar et al., 2015). Many contextual analyses in the Indian context have found that SMEs have been disappointed with the results of implementing learning management (LM), according to Thanki and Thakkar (2014). According to these results, the Indian context is not ready to completely adopt and successfully apply LM just yet. Experts in the field have long stressed the critical importance of providing SMEs with clear recommendations for what they can do to improve their company's performance through the use of learning management (LM). While some scholars have created LM reception setups, Ramesh and Kodali (2012) note that no one has looked into how much these drivers contribute to successful LM reception. Hence, studies documenting the drivers' traits, capacities, and interconnections are key.

According to Womack, Jones, and Roos (1990) and Holweg (2007), the idea of lean manufacturing is currently the most popular paradigm in the manufacturing industry. For example, in Vietnam, a study by Nguyen et al. (2020) found that SMEs in the textile industry faced significant challenges in implementing lean manufacturing due to limited access to technology and trained personnel. However, the study also found that with the support of government initiatives and training programs, SMEs were able to overcome these challenges and achieve significant improvements in productivity and quality. Lean manufacturing practices have been shown to improve production costs and quality, increase adaptability, decrease lead times, and make manufacturing organizations more responsive (Bhamu and Sangwan, 2014; Chauhan and Singh, 2012; James-Moore

and Gibbons, 1997). Nevertheless, many organizations still encounter difficulties in effectively adopting lean practices, even though lean manufacturing has helped many reduce waste and improve performance in specific areas (Jadhav, Mantha, and Rane 2014). A number of companies try to apply lean methodologies in inappropriate contexts without first considering the basic difficulties of doing so (Azadegan et al., 2013). Some people may think that the lean manufacturing foundational methodologies aren't enough and don't match up with what the company needs for operations (Kolberg and Zühlke, 2015). And many businesses struggle to keep the lean project's core momentum going, even after the initial implementation seems to have gone well (Netland, 2016). Investigating the protocols made possible by ICT is pertinent to addressing these concerns. Lean manufacturing, in its purest form, has its roots in the Toyota Production Framework of the 1950s and can function perfectly well without the use of any kind of ICT.

The growing sophistication of ICT systems, however, has shifted the emphasis of research toward the possibility of a partnership between lean manufacturing and ICT for the purpose of enhancing performance. Among the many works that make up a thorough assessment of the literature in this area are those of Houy (2005), Ward and Zhou (2006), Riezebos, Klingenberg, and Hicks (2009), Powell (2013), and Maguire (2015). It has been found through industry research that companies can create hybrid solutions that merge the best of lean manufacturing with ICT systems. Using this method, businesses can implement ERP systems, or enterprise resource planning. Cowtyn et al. (2011) and Riezebos, Klingenberg, and Hicks (2009) are the references mentioned. Many manufacturing performance frameworks have been developed to examine the connection between ICT and lean manufacturing; however, very little has been done to investigate the possibilities offered by Industry 4.0, or smart manufacturing (Kang et al., 2016). Few studies have looked at how lean manufacturing and other well-established management practices could be affected by the introduction of Industry 4.0, or how these practices could in turn affect the implementation of Industry 4.0. Lean manufacturing and Industry 4.0 use different approaches, but they share a common goal of increased flexibility and efficiency (Forthcoming, 2014).

An essential part of Industry 4.0, digital physical systems (CPS) integrate with the Internet of Things (IoT), allowing for distributed processing and autonomy that is usually lacking in conventional integrated information and communication technology (ICT) systems. This is in line with the tenets of classic lean thinking, which place an emphasis on distributed systems with simple, compact modules. Based on recent studies (Thoben et al., 2014; Schneider, 2015; Kolberg and Zühlke, 2015), this research aims to analyze the dynamics of the connection between Industry 4.0 and lean manufacturing. An essential part of this paper is that it lays out the essential parts and introduces the suggested connections between them. This article goes above and beyond by presenting major academic findings in four separate areas of study. In light of the foregoing, we present a suggested examination agenda for upcoming exams. Lean endeavor design advocates viewing all stakeholders—including experts, managers, vendors, and consumers—as valuable assets to any given business (Sherbaz Khan, Imran Zaman, et al., 2022). Supervisors have come to realize that fundamental processes, rather than specific abilities or departments, are more important in fostering customer loyalty and guaranteeing the delivery of high-quality products. The two primary goals of these cycles should inform their design. The

primary goal is to establish credibility as a reliable product supplier; secondary is to showcase a selling point that will bring in customers (Dimancescu et al., 1997). In order to achieve this goal, organizations and their leaders should stop fixating on the performance of individuals, capabilities, and departments and start concentrating on improving the enterprise's overall performance. Lean manufacturing is the foundation upon which the idea of lean endeavor rests. But lean methodology broadens its scope to include the company, its workers, its partners, and its suppliers in an effort to provide value to the customer from their point of view. The goal of the lean methodology is to organize and control the value creation and transfer processes for a final product or service in a systematic way. Any other product or service's lifecycle—from ideation to launch, from request to delivery, and from raw materials to finished product—can be streamlined with the help of the methodologies that this undertaking intends to thoroughly examine.

By including all relevant parties, the methods can be refined to perfection (Khan & Sajjad, 2013). The client's metrics of significant value are consistently used to evaluate all cycles, and wasteful and non-value-added activities are allocated effectively and intentionally. According to Marksberry (2011), an assortment of quality management practices have been examined by various experts to ascertain their applicability to LM. These practices include 5S (Seiri, Seiten, Seiso, Seiketsu, Shitsuke), value stream planning, waste analysis, total quality management, and overall operational maintenance. The term "5S" is often used to describe well-supported, standardised procedures in housekeeping, according to Jadhav et al. (2014). There are five separate parts to this framework: sort, assemble, sparkle, normalize, and support. All of these parts work together to make sure the system runs well (Bhasin, 2011b). In addition, value stream planning is a way to strategically plan ongoing activities to create a current status guide that highlights problem areas and non-value adding processes. Dismantling processes that don't add value to production systems is what this method is all about (Mangla et al., 2019).

Whatever the case may be, thorough maintenance includes actions taken in advance to reduce the likelihood of failure and maximize the efficiency with which tasks are carried out in the production system (Vocalist and Becker, 2013). Key elements for successful lean manufacturing execution include work standardization, continuous improvement, visual management, technology management, and cell manufacturing (Chiarini, 2011). Strategic planning of comparative activities, development of product families, and establishment of the work cell are all steps in the phone manufacturing process. In contrast, visual management is defined as the practice of utilizing visual data systems and visual guides to identify activities for quantifiable waste (Manzouri et al., 2013). Nonetheless, demand fluctuations were identified and systematically standardized in order to establish the cycle center and improve operational procedures (Shamah, 2013b).

It is the duty of the executives in charge of innovation management to introduce groundbreaking innovations that could cut costs on lead instances and do away with non-value adding tasks (Arya and Jain, 2014). According to Hasle et al. (2012), kaizen is a technique that is systematically applied as part of the continuous development approach. Its main focus is to consistently identify the critical areas that need improvement. Developing and maintaining a productive workforce is facilitated by implementing effective assessment systems and offering strong incentives to efficient

project personnel (Pavnaskar et al., 2003; Marodin and Saurin, 2013; Pakdil and Leonard, 2014). Machado and Tavares (2008) and McDonald et al. (2009) both highlight the significance of workforce training and the educational system in providing comprehensive training and education to improve understanding of LM exercises. One way to make workers more versatile and responsive to new demands in the workplace is to help them develop their "representative capability" (Machado and Leitner, 2010; Upadhye et al., 2010). By empowering representatives in labor market projects to actively collaborate and take on substantial responsibilities, we can improve the strength and association of the labor force (Yadav et al., 2018). There are three fantastic types of exercise that are present in almost every organization (Monden, 1998)

- **Value adding exercises**: The concept of value in lean manufacturing encompasses all the activities that the client perceives as significant, whether implemented in a product or as a form of assistance. In the context of the automotive industry, for example, this may involve the transformation of iron metal into various components, the fabrication of raw materials, and the application of paint to the exterior of a vehicle. To assess the value inherent in an action, it is necessary to consider whether a customer would be willing to pay for said action.
- **Lean manufacturing process efficiency**: These exercises, as perceived by the final client, do not attribute greater significance to a product or service, but rather are essential within the existing operational context. Rapidly eliminating such waste poses significant challenges and should be prioritized for sustainable transformation. Models inherently involve traversing considerable distances in order to retrieve components or unloading vendor containers. The removal of these items can be achieved through the modification of the existing line format or the coordination of seller-related shipments for unloading purposes.
- **Lean manufacturing process for time saving**: These encompass all the activities that the client perceives as insignificant, whether in a product or as a service, and are also excessive given the prevailing circumstances. These exercises are considered hazardous waste and should be prioritized for effective fire evacuation. Modelling encompasses the concepts of waiting time, item stacking, and two-way exchanges.

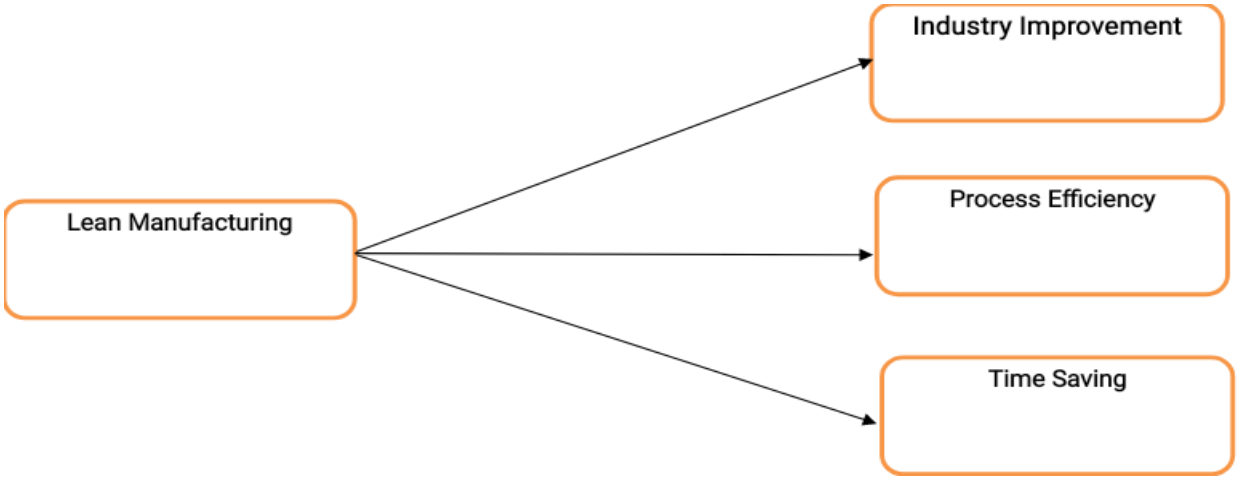
A significant number of companies are currently implementing lean manufacturing practices. Nevertheless, a significant number of these domains lack a comprehensive understanding of the central concepts, resulting in a tendency to dominate the notion (Khan, Rashid, et al., 2023). The perception may arise that companies lacking the necessary capabilities for lean manufacturing should not be expected to meet the requirements of a lean project. In their argument, Womack and Jones assert that in order for an individual within the supply chain to maintain its strength, it is imperative that all components of the chain are coordinated. This implies that assuming one part becomes lean different individuals from the worth stream won't share the advantages except if they all partake all the while (Womack et al., 1994). So, we hypothesize that

H1: Lean manufacturing is significant positive associated with industry improvement.

H2: Lean manufacturing is significant positive associated with process efficiency**.**

H3: Lean manufacturing is significant positive associated with time saving**.**

RESEARCH MODEL



RESEARCH METHODOLOGY

Research Philosophy

The field of research philosophy is grounded in three fundamental paradigms: positivist, interpretivism, and critical research paradigms. A paradigm comprises four fundamental assumptions, namely ontology, epistemology, methodology, and the research study method. The present research challenge is grounded in a positivist scientific paradigm or employs a quantitative methodology. The researcher underscores the existence of reality within the purview of the positivist paradigm, which is grounded in ontological assumptions. Organizational personnel are experiencing emotional distress due to a perceived absence of fairness. Epistemological arguments are grounded in the premise that researchers engage in the acquisition and examination of specific facts or phenomena that necessitate investigation. The third premise of the positivist approach posits that methodology is employed to elucidate the researcher's intended plan and course of action, while methods refer to the specific manner or technique that the researcher intends to employ. The present investigation employs a deductive approach to data analysis, followed by an inductive approach for result interpretation (Sherbaz Khan et al., 2022).

The present study employs the positivist paradigm methodology. The utilization of quantitative experiments and surveys is frequently linked to deductive research methodologies. The primary method employed for data collection in this study is a questionnaire survey. The research methodology utilized in this study was cross-sectional quantitative research, which involves examining a single point in time. Additionally, a comprehensive study was conducted to elucidate existing relationships and phenomena. The proposed study will employ primary data, as indicated in the literature review, as well as primary data obtained from a local brand's practitioners of electronic marketing (EM). The research methodology will involve the administration of interviews and questionnaires to individual consumers of the brand. This research study includes 14 quantitative questions. 14 items of the quantitative research were examined by using the SPSS. The purpose of this questionnaire is to systematically investigate inquiries that aim to distinguish between sales generated through traditional marketing methods and sales

generated through experiential marketing strategies (Khan, Qabool, et al., 2023). Subsequently, following the data collection process, it is imperative to identify any potential errors made by the respondents and extract viable responses that can be utilized for conducting the tests. In this study, the statistical technique of T-test will be utilized to determine the significance or lack thereof of the relationships between the variables. Following the completion of the tests, the obtained results will be systematically organized and examined in conjunction with the conducted interviews. Subsequently, comprehensive deliberations and recommendations will be formulated, taking into account the limitations inherent in the studies.

The scope of the study

This research will primarily examine variables such as independent and dependent factors, specifically lean manufacturing, which is closely linked to enhancing industry performance, optimizing process efficiency, and reducing time consumption. The study will be conducted on local and international brands, specifically their branches located in Karachi, with the aim of investigating how lean manufacturing contributes to enhancing industry development, process efficiency, and time management.

The relevance of the study

The primary objective of the present study is to examine the advantages of implementing lean manufacturing in textile and apparel facilities in Pakistan. In the present-day business landscape, lean manufacturing has emerged as a formidable challenge for contemporary enterprises, prompting a widespread adoption of this approach owing to its numerous advantages. All apparel manufacturing units in Pakistan are making concerted efforts to implement lean manufacturing practices in order to enhance customer acquisition and retention. All attempts are being made, however, only a subset of apparel manufacturing units have achieved success by implementing lean manufacturing practices.

Variables of the study

This study is grounded in the examination of lean manufacturing practices within apparel manufacturing units, which serves as the independent variable in this research. The implementation of lean manufacturing has resulted in significant improvements in industry, process efficiency, and time savings. Therefore, the study focuses on the dependent variables of industry improvement, process efficiency, and time saving.

Population Framework

The sample population for the present study comprises individuals who are customers and employees of textile and apparel manufacturing facilities located in Pakistan.

Social demographics

The demographic variables assessed in this study included gender, marital status, age, and education.

Research Framework

The scope of this study was limited to the garment and textile sector in Karachi, as Karachi is the largest city in Pakistan and is home to a significant concentration of garment and textile plants.

Target Population

The focus population for the current research investigation comprises the private textile and garments industry in Karachi. The rationale behind selecting the textile sector stems from its favorable reputation and the trustworthiness of its stakeholders, who are known for their exemplary practices in serving both internal and external customers. The present study aims to assess the influence of advanced manufacturing technology, supplier responsiveness, logistic responsiveness, and resilience on sustainability within the textile and garment sector.

Unit of Analysis

The focal unit of analysis for this research study pertains to individuals, and data was gathered from both customers and employees within the textile and garment industry. The respondents selected for this study consist of both customers and employees, as they possess a comprehensive understanding of the firm's practices and policies.

Sample Size, Sampling Technique

The sample size of the present study comprises 213 customers employed in the textile and garment industry. Perceptions regarding a specific brand were assessed through the collection of quantitative data from the respondents. Our study employed non-probability sampling techniques, specifically convenience sampling, to gather responses from the participants.

Instrument development

We gather statistics via structuring a questionnaire using five-point Likert scale (strongly disagree 1, Disagree 2, Neutral 3, Agree 4 and Strongly Agree 5). This questionnaire is consistent of the well thought Questions, with the total 40 items sliced into 5 parts:

- Part 1 consists of lean manufacturing.
- Part 2 considering of industry improvement.
- Part 3 focused on process efficiency.
- Part 4 focused on time saving.

Data Analysis Tool

The data collected from the study respondents can be classified into two distinct types. A dataset consisting of quantitative data was obtained from customers within the textile and garment sector, which was subsequently analyzed using SPSS 26. According to a majority of researchers, SPSS is the software that is most extensively utilized and thus highly recommended. The present study employs descriptive analysis, reliability analysis, correlation evaluation, and regression evaluation to ascertain the relationship between

observed variables. Hence, the present study employs regression analysis as its primary objective is to examine the influence of lean manufacturing on enhancing industry performance, optimizing process efficiency, and reducing time consumption.

RESULTS

The questionnaire utilized for data analysis in this study comprises two distinct sections. The first section comprises inquiries regarding demographic variables, while the second section encompasses study variables. Both sections are administered in a closed-ended format and are analyzed using SPSS.

Reliability Analysis

Table1.
Reliability Analysis

Variable	Cronbach's Alpha	No. of Items
Lean Manufacturing	0.844	05
Industry Improvement	0.782	03
Process efficiency	0.747	03
Time Saving	0.707	03

The table presented above displays the Cronbach Alpha reliability analysis conducted on the variables under study. The table illustrates that all the variables examined in the present study, namely lean manufacturing, industry improvement, process efficiency, and time saving, exhibit Cronbach alpha reliability levels surpassing the established threshold of 0.7. The data presented in the tables indicates that lean manufacturing is assessed using a 5-item scale, which demonstrates a Cronbach alpha reliability coefficient of 0.741. Similarly, industry improvement is evaluated using a 3-item scale, yielding a Cronbach alpha reliability coefficient of 0.782. Process efficiency is assessed using a 3-item scale, resulting in a Cronbach alpha reliability coefficient of 0.747. Lastly, time saving is evaluated using a 3-item scale, yielding a coefficient of 0.707. This indicates that all the variables under investigation exhibit satisfactory Cronbach alpha values, thereby enabling us to proceed with subsequent statistical analysis on the collected data.

Correlation Analysis

Table 2.
Correlations

Variables	1	2	3	4
Lean Manufacturing	1			
Industry Improvement	.267**	1		
Process efficiency	.350**	.400**	1	
Time Saving	.223**	.347**	.716**	1

The study's variables' correlation analysis is displayed in this table. There is a strong positive correlation between all of the study variables, as shown in the table. The table demonstrates that there is a strong positive correlation between lean manufacturing and enhancing industry performance (r=.267, p<.01), improving process efficiency (r=.350, p<.01), and saving time (r=.223, p<.01). There is a strong positive correlation between process efficiency (r=.400, p<.01) and time saving (r=.347, p<.01) and industry

improvement, as shown in the table. Time savings is positively associated with process efficiency, as shown in the table (r=.716, p<.01).

Regression Analysis

Table 3.
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.267	.071	.067	.72863

This table shows the model summary of the hypothesized research model. Table shows that R square of the model is .07 which shows that 7% change in industry improvement is due to lean manufacturing.

Table 4.
Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.471	.238		1.367	.646
Lean Manufacturing	.303	.075	.267	4.028	.000

The regression coefficients of the proposed research model are displayed in this table. All of the variables' t-statistics are greater than the 2 threshold, indicating a good fit, as shown in the table. The correlation between lean manufacturing and industry improvement is positive (B=.303) and statistically significant (p<.01), as shown in the table. This study's findings provide credence to the null hypothesis that lean manufacturing has no positive association with industry improvement.

Table 5.
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.350	.122	.118	.87415

This table shows the model summary of the hypothesized research model. Table shows that R square of the model is .12 which shows that 12% change in process efficiency is due to lean manufacturing.

Table 6.
Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.605	.286		1.612	.446
Lean Manufacturing	.489	.090	.350	5.420	.000

The predicted research model's regression coefficients are displayed in this table. According to the table, all of the variables' t-statistics are greater than 2, indicating a good fit. A positive correlation (B=.489) and statistically significant relationship (p<.01)

between lean manufacturing and process efficiency are shown in the table. We can conclude from the results that lean manufacturing is positively associated with process efficiency, lending credence to the second hypothesis of the study.

Table 7.
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.223	.050	.045	.90871

This table shows the model summary of the hypothesized research model. Table shows that R square of the model is .05 which shows that 5% change in sustainability is due to advanced manufacturing technology, supplier responsiveness, logistic responsiveness and resilience.

Table 8.
Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2149	.297		7.230	.445
Lean Manufacturing	.312	.094	.223	3.325	.01

This table shows the regression coefficients of the hypothesized research model. Table shows that t statistics for all the variables is above the standard of 2, this shows the good fit. Table shows that lean manufacturing is significant ($p<.01$) and positive ($B=.312$) relation with time saving. So H3 of the study that lean manufacturing is significant positive associated with time saving is being supported by the data of this study.

Table 9.
Hypotheses Summary

Hypothesis	Supported/ Not Supported
H1: Lean manufacturing is significant positive relationship with industry improvement.	**Supported**
H2: Lean manufacturing is significant positive relationship with process efficiency.	**Supported**
H3: Lean manufacturing is significant positive relationship with time saving.	**Supported**

DISCUSSION AND CONCLUSION

This project is conducted to examine the impact of lean manufacturing on industry improvement, process efficiency and time saving of apparel manufacturing units in Pakistan. Lean manufacturing an important factor that is considered to be critical for each organization and industry as well. The success of an organization purely depends upon its lean manufacturing (Khan et al., 2023). Therefore, this specific study is conducted to explore the role of lean manufacturing on industry improvement, process efficiency and time saving of apparel manufacturing units in Pakistan. This study is conducted to explore the benefits that an organization can achieve through the usage of lean manufacturing in textile and apparel industry of Pakistan. This research study includes 14 quantitative questions. 14 items of the quantitative research were examined by using the SPSS. The consequences of the current research indicate that lean manufacturing is significant positive associated with industry improvement, process efficiency and time

saving. Results of this study indicates that lean manufacturing contributes towards industry improvement, process efficiency and time saving. This study is all about the benefits that apparel and textile can achieve through by using lean manufacturing. This study is also an important because results of the study shows that 40% change in industry improvement, process efficiency and time saving is due to the lean manufacturing. Industry improvement helps overall industry and that also set a standard on which all the organizations of particular industry can work. In the same manner all the textile and apparel manufacturing firms strive to improve their process because it's the process that makes an organization better than the others, competitive advantages can only be attain through process improvement and process efficiency. Time saving is also a critical success factor for contemporary organizations (Khan et al., 2022). Organization that takes lesser time to convert input into output are successful in the world. So, the concept of time saving should be also an important function for any sort of textile and apparel manufacturing unit. Therefore, the current study acknowledges the importance of these three-factor named as industry improvement, process efficiency and time saving because these play a vital role in the success of an organization. This study also proves that lean manufacturing is the phenomena that helps to improve industry, process efficiency and time saving in context of textile and apparel manufacturing unit.

THEORETICAL CONTRIBUTION

This research study has many theoretical contributions as this study explore the role of lean manufacturing on industry improvement, process efficiency and time saving. Lean manufacturing is the most discussed topic in the world now a days and most of the organizations are entirely shifting their trends to use lean manufacturing but its application in Pakistan is limited and little research but that study provides comprehensive platform for the researchers especially for apparel manufacturing units of Pakistan. The study elaborates that lean manufacturing is important concept that contributes to industry improvement, process efficiency and time saving in textile and apparel manufacturing units of Pakistan. In theory that will advance the literature and open new dimension to disclose other variables like mediators and moderators in the current framework.

PRACTICAL IMPLICATIONS

The outcomes of the present study are also had important applied inferences as the managers and owners of the textile and garments firms can focus on the lean manufacturing due to its direct association with industry improvement, process efficiency and time saving. That will improve their sales and so due to increase in sales the resources of organization can be best utilize to gain maximum benefits out of that. Lean manufacturing is widely used by different sectors and organizations around the world but its application is limited to textile and apparel manufacturing units in Pakistan. So, this study will provide foundation for the mangers to use this lean manufacturing due to its multiple long-term benefits for an organization. Therefore, the current research tends to explore the factors that will defiantly help the organizations to improve industry, process efficiency and time saving. The current study explores that textile and apparel manufacturing brand must consider lean manufacturing to boost industry improvement, process efficiency and time saving. So, this is an important practical implication for the managers of textile and apparel manufacturing units to use lean manufacturing to boost

industry improvement, process efficiency and time saving of apparel and textile units in Pakistan.

LIMITATION AND FUTURE DIRECTIONS

It is imperative for future researchers to acknowledge and address the limitations inherent in each research study, as they should strive to mitigate these constraints. One primary limitation of the current study is the relatively small sample size. The research study employed a sample size of 174 quantitative respondents, which is considered to be a relatively small sample size. In order to ensure the generalizability of research findings, it is imperative that future investigations on stress incorporate substantial sample sizes. As a consequence of the constrained time frame, the generalizability of the findings from the present research study is limited, thereby constituting a significant limitation of the study. One additional limitation of the current research study pertains to the method of data collection.

Specifically, all data was collected simultaneously, employing a cross-sectional research design. Future investigations on a similar topic should incorporate a longitudinal research design, which involves examining the same data at different time points. This approach has demonstrated that situational factors also play a role in shaping responses and findings among respondents. In subsequent studies, it is plausible to extend the applicability of this research model to additional sectors such as telecommunication, banking, and education. Therefore, the findings of the research can be extrapolated to various other industries.

A significant constraint of the present study pertains to the respondents' comprehension level, as a considerable proportion of participants exhibited limited ability to comprehend and respond to the questions posed due to their limited educational background. In light of this, we engage in verbal translation with the respondents and solicit their perspectives on the posed inquiries. Furthermore, it is imperative to consider the translation of the questionnaire into Urdu in order to ensure that all respondents are able to provide responses to the questions.

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