**Achieving operational excellence through the lens of Lean and Six Sigma during the Covid-19 pandemic**

**Abstract**

**Purpose:** This article shows operational excellence achieved during the Covid-19 pandemic using the Lean, Six Sigma and Sustainability practices in Small Medium Enterprise (SME) manufacturing firms and its impact on the performance dimensions of efficiency, growth and profit for firms located in the industrial zones of Pakistan.

**Design/methodology/approach:** A quantitative methodology was used and data were collected from a sample of top-level managers from 28 SME manufacturing firms located in the five industrial zones in Pakistan. A total of 62 questionnaires were included in the study.

**Findings:** The findings show that awareness levels of Lean, Six Sigma and Sustainability are emerging and firms are trying to implement these concepts. However, the results show that while Lean and Six Sigma enhance firms’ performance in terms of efficiency, profit and growth, sustainability has no impact on these three performance dimensions.

**Originality/value:** This paper contributes to knowledge in the field by integrating Lean, Six Sigma and Sustainability with firms’ performance during the Covid-19 pandemic by assessing efficiency, growth and profit dimensions where otherwise no empirical research has been undertaken in the Pakistani context.

**Research limitations/implications**: The quantitative data of a sample of 28 manufacturing firms inevitably present limitations on the generalizability of this work. Future research could employ greater quantitative data to explore the topic further. Only one particular country is studied so that future research could be carried out in other countries or regions.

**Practical implications:** This study may have value for policymakers and other stakeholders who need to know more about how Lean, Six Sigma and Sustainability affect a firm’s performance in industrial zones in the context of a developing country.

**Keywords**: Lean; Six Sigma; Sustainability; SME (Manufacturing); Industrial zones; Pakistan

**1. Introduction**

The subject area of Lean and Six Sigma have attracted attention from academics and practitioners, and considerable empirical research has been undertaken to assess the application of Lean and Six Sigma to different manufacturing and services firms around the globe. These methodologies for supply chains and logistics help firms to reduce different types of waste, eliminate functions and processes that do not add value to the products or services, improve cycle times, and produce defect-free and high-quality products and services for their customers (Garza-Reyes, 2015; Gort, 2008; Johansson and Sundin, 2014; MartinezeJurado and MoyanoeFuentes, 2014; Mollenkopf *et al*., 2010). Similarly, sustainability, which is related to an environmentally-friendly environment, also plays a vital role in enhancing a firm’s performance in terms of maximising profit and conserving resources and energy (Garza-Reyes, 2015b; Wong and Wong, 2014). However, there is a potential research gap involving the integration of sustainability with Lean and Six Sigma practices, where little research has been done to explore the overall implications of combining these three concepts (Sustainability, Lean management and Six Sigma). Furthermore, firm or enterprise performance has been measured in the literature of small businesses in different contexts (Chen and Lin, 2021; Sardana *et al*., 2020; Rajapathirana and Hui, 2018). There is a gap in the literature on small firms in the measurement of a firm’s performance based on growth, efficiency and profit using Lean, Six Sigma and Sustainability as independent variables. Thus, this research study seeks to assess the relationship of Lean, Six Sigma and Sustainability with the firm’s performance using the parameters of growth, efficiency and profit (Li *et al*., 2009). These performance indicators are less documented in terms of Lean, Six Sigma and Sustainability in the context of developing countries, where there is a lack of knowledge regarding these methodologies. These concepts are well implemented in developed countries where they have led to lucrative benefits (Tjahjono *et al*., 2010; Chen *et al*., 2021), but more research is needed in developing countries like Pakistan, where there is a lack of fundamental resources like electricity, gas and the infrastructure facilities required by SMEs (manufacturing firms).

In consequence, they struggle to implement these concepts (Kureshi *et al*., 2009; Chen *et al*., 2021). Additionally, there is no adequate research in Pakistan to address the core factors responsible for improving SME performance. Nor, according to Zhang *et al*. (2012), is there proper application of Lean and Six Sigma techniques or managerial styles in Pakistan. The majority of firms in Pakistan are unaware of the benefits of Lean, Six Sigma and environmental sustainability and cannot apply these methodologies effectively (Zeeshan *et al*., 2017; Khan *et al*., 2021).

Focusing on this research gap, this paper identifies the factors that can be effective for enhancing SME performance, particularly for those SMEs located in the industrial zones where the government of Pakistan claims that adequate resources have been provided (UlHaq *et al*., 2015). The key aim of this research is therefore to assess the implementation of Lean, Six Sigma and Sustainability practices in SMEs (manufacturing firms) located in the industrial zones of Pakistan and to discover the relationship of Lean, Six Sigma and Sustainability with firms’ growth using efficiency, profit and growth as the key indicators of business performance (Li *et al*., 2009; Khan *et al*., 2021). In order to achieve this, the following objectives have been developed for this study. These are:

Research objective 1: *To investigate the implementation level of Lean, Six Sigma and Sustainability in manufacturing SMEs located in the industrial zones of Pakistan*

Research objective 2: *To investigate the relationship of Lean, Six Sigma and Sustainability with firm performance based on efficiency, profit and growth*

This research paper contributes to the literature in two ways. First, industrial zones play an important role in economic and entrepreneurship development (Örnek and Danyal, 2015) and are considered the catalyst for innovation (Bababekova, 2020). However, there are huge differences between firms located in industrial zones in developing countries and firms located in industrial zones in developed countries. These differences include the resources and government support that are considered the key antecedents for innovation. Based on the lack of resources in industrial zones in developing countries like Pakistan, this paper measures the implementation level of Lean, Six Sigma and Sustainability in the industrial zones of Pakistan where no empirical research has been undertaken. This paper also adds useful insights to the existing literature on small firms by integrating the key performance indicators of efficiency, profit and growth with Lean, Six Sigma and Sustainability where this has not previously been fully discussed (Cherrafi *et al*., 2016; Khan *et al*., 2021), particularly in the context of Pakistan.

This paper is organised as follows: Section 2 is a literature review that focuses on the theoretical framework and development of hypotheses. Section 3 describes the research methodology covering data collection; section 4 presents our results and analysis; section 5 discusses these results; section 6 offers our conclusions; and section 7 explains the limitations of the research and suggests future study possibilities.

**2. Literature Review**

*2.1 Operational excellence and Covid 19*

The Covid-19 Pandemic has disrupted everything from individual health to the corporate world. An unprecedented crisis should be mirrored by disruptive innovations (Belhadjali and Abbasi, 2020). Governments all over the world imposed lockdowns and social distancing to slow the rapid spread of the virus. However, Covid-19 produced a positive impact on the environment, where the majority of industries were closed due to the lockdowns and environmental damage was reversed during the lockdown period (Verma and Prakash, 2020, Barman *et al*., 2021). Furthermore, recent academic research highlights the need for more efficient corporate innovations to recapture the changed needs of consumers. Social theory highlights the dependency of humans on interactions for survival (He and Harris, 2020), but face-to-face interaction is almost impossible due to social distancing, and the service industry depends on it. Inevitably, academics, industrialists and entrepreneurs are rethinking strategies for the 'new normal' of the pandemic and post-Pandemic eras. There is a desperate need for innovative solutions that borrow from academic theories, including strategic fit business models (Mora *et al*., 2020). In the current global situation, the core challenges our societies encounter are climate change, poverty, clean water, equal education, population growth, pollution, and the increasing cost of energy and resources (Timilsina *et al*., 2020). Firms across the world are under extreme pressure from consumers, regulators and other key stakeholders to organise their operation lines in a more responsible way to improve sustainability and social performance. Therefore, besides achieving financial objectives, businesses are striving to achieve the triple bottom line by focusing on both people and the planet (Elkington, 1997). Bringing sustainable innovation to their products and services will enable them to become responsible enterprises (Chiarini, 2015). In recent years, the use of a new sophisticated management system to resolve global sustainability challenges has been explored (Chiarini, 2015). It is in this context that Lean manufacturing and Six Sigma have emerged as a major part of the answer to sustainability issues (Barman *et al*., 2021). These management styles have earned significant attention from researchers, policymakers and practitioners.

*2.2 Lean*

Lean first became popular in the 1990s when it was adopted by Toyota Production Systems Japan (Ganebnykh *et al*., 2020). *Lean* means to produce goods or services of high quality at the lowest cost and in the least time by reducing waste (Langlotz and Aurich, 2021; Shah and Ward, 2003). In Lean, ‘waste’ is anything other than the minimum amount of equipment, parts, space and time necessary to add value to the product (Mady *et al*., 2020). Waste can occur in different forms, such as overproduction, defective products and unused inventory. These are non-value-adding conditions and impact the performance, cost and quality of products (Leksic *et al*., 2020).

Furthermore, the importance of Lean manufacturing has been explored in other key quality-related elements, including just-in-time production, just-in-time purchasing, productive/preventive maintenance, agile manufacturing, and operational and financial performance (Khalfallah and Lakhal, 2020; Khan *et al*., 2021). However, the most valid Lean manufacturing definition is that the manufacturing/production system is free from waste and unwanted outputs. These are usually expressed in the term ‘losses’, which incorporates excessive production, waiting, time wastage, unnecessary transport or unloading, improper treatments, factory asset increases and unnecessary movement (Mady *et al*., 2020). Different operational goals should be achieved using Lean manufacturing techniques; however, researchers have agreed that the following goals are key: quality improvement, elimination of impurities, reduced time and reduced total costs (Mady *et al*., 2020; Kumar *et al*., 2021). The benefits of Lean are well understood in developed countries, and companies strive to achieve a maximum Lean level to stay competitive (Shrafat and Ismail, 2019; Achanga *et al*., 2006). Lean remains a focal point for researchers and professionals extending their understanding of the concept in different contexts, including small businesses.

*2.3 Six Sigma*

Another approach that helps companies in the manufacturing industry (including both products and services) to reduce errors is the concept of *Six Sigma.* This was first adopted by Motorola in 1986 (Barjakarovic and Jecmenica, 2011). It is used to reduce variations in organisational processes by using a structural method and performance metrics to achieve strategic objectives. Six Sigma aims to improve process performance and achieve a high level of quality by investigating and eliminating the root causes of defects and minimising process and product variability (Ruben *et al*., 2018; Schroeder *et al*., 2008). Six Sigma is a quantitative approach that aims to improve the efficiency and effectiveness of organisations. This improvement focuses on business outputs that are critical to customers (Desai and Patel, 2010; Vinodh *et al*., 2021). In practice, the objective of Six Sigma is not merely to identify and count the defects and quality variations in the product/service but to identify the opportunities to eliminate the causes of quality-related problems before they become defects (Antony, 2006). Six Sigma is a business strategy that seeks to improve customer requirements, business system understanding, productivity and financial outputs (Kwak and Anbari, 2006; Kumar *et al*., 2021). Its implementation has become familiar both at the practical and theoretical levels (Glover *et al*., 2014). Many practitioners and researchers from diverse areas have considered Six Sigma principles and practices and stated numerous reasons for implementing them (Zu *et al*., 2008). In this regard, there is agreement among quality managers and practitioners that Six Sigma improves a firm’s overall effectiveness and enables it to achieve the goal of high performance (Chiarini, 2015; Refaie and Hanayneh, 2014; Tortorella and Fogliatto, 2014; Khan *et al*., 2021).

*2.4 Sustainability*

The complex concept of *sustainability* evolved in the 1970s at a UN conference on the Human Environment (Christer, 2002). Its most oft-quoted definition comes from the UN Brundtland Commission: “Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Keeble, 1988). An alternative definition is “it is not just what we do today but the effect it will have tomorrow” (Chichilnisky, 2011:11). In manufacturing sectors, sustainability aims to create products that use processes and practices that maximise profits, minimise negative environmental effects, conserve natural resources and energy, and are safe for employees, consumers and communities (Silva *et al*., 2011; White *et al*, 2019; Upadhyay *et al*, 2021). Sustainable practices support ecological, human, and economic health and vitality. In the most straightforward terms, sustainability is about our children and grandchildren and the world we will leave them. Sustainability practices are also being adopted in manufacturing firms as manufacturers consider such issues as resource scarcity, consumer awareness of green products/processes, environmental regulations and cost savings (Kumar *et al*., 2021). The goals of sustainable manufacturing are to create and distribute goods with the optimal usage of resources and the removal of preventable process outputs including waste, CO2 emissions, toxic materials, etc. (Raut *et al*., 2019; Upadhyay, 2020; Barman *et al*., 2021).

All three of these management concepts are being implemented in the SME sector in developed countries to achieve business excellence because SMEs play a very important role in the economy of industries all over the world. They contribute significantly to economic growth, innovation and employment generation. Globalisation, rapid technological changes and increased competitive pressure are having a major impact on SMEs around the globe (Humphrey, 2003). SMEs need to upgrade their professional management techniques to achieve economic, social and environmental improvement without large investments or extensive changes. The integration of Lean, Six Sigma and Sustainability is the best response to this challenge (Cherrafi *et al*., 2016; Upadhyay *et al*, 2020). However, there is a lack of knowledge in developing countries like Pakistan on how to implement these management practices in the SME sector (Ali *et al*., 2020).

*2.5 SME Sector in Pakistan*

According to the Small and Medium Enterprises Development Authority (SMEDA) of Pakistan, the importance of SMEs for the development of industry cannot be underestimated. SMEs constitute about 90% of all the enterprises in Pakistan. However, there are still major problems in the SME sector in Pakistan. These include the lack of proper infrastructure, quality control problems, lack of entrepreneurial expertise and a shortage of equity resources (Akram, 2008). As a result, it is difficult for SMEs to sustain their share in the global market, which, in turn, causes unemployment in different major industrial sectors. According to the SMEDA, the increasing input costs and decreasing profit margins increasingly threaten the survival of manufacturing SMEs. Most of the organisations are unable to implement Lean manufacturing techniques due to a lack of resources and poor knowledge regarding Lean concepts (Moeuf *et al*., 2016). The implementation of Lean, Six Sigma and Sustainability by an SME may have a very positive effect on its performance (Valmohammadi, 2011)

The industrialisation trend has attracted significant attention from policymakers in Pakistan because industrialisation is also considered to be a potential source of entrepreneurial spirit (Khan, 1999). Hence, to achieve the development of industry, the government has established industrial estates and has offered lucrative incentives to entrepreneurs. In English-language economic literature, the term ‘industrial zone’ refers to the industrial estate, trading estate, factory estate or employment area (Lofsten and Lindelof, 2002). Furthermore, the term ‘industrial zone’ is defined as a location or area used for industrial development usually situated close to the transportation environment, mainly in cases where several types of transportation are used (Fujita, 2013). The development of industrial zones was mostly based on several core factors that included the allocation of specialised infrastructure to selected areas to decrease cost of building infrastructure, and increasing the capability of a country to attract new investors and enhance entrepreneurial activities to achieve economic growth (Amin and Nigel, 1995). The aim of establishing industrial zones is to facilitate firms in different aspects related to business activities (Gordon and Philip, 2000). Furthermore, firms may cooperate in the exchange of information, provision of product innovation assistance and several other areas due to their proximity to each other. Besides these incentives, firms located in an industrial zone also enhance their links with universities. Industrial zones appear to attract more motivated groups of entrepreneurs when compared to non-industrial zones (Colombo and Delmastro, 2002) and, most importantly, industrial zones promote the economic development of rural and ‘backward’ areas (Sanghvi, 1979; Wong and Tang, 2005). Fortified by this general belief in the efficiency of industrial zones as a powerful catalyst for industrial advancement, a large number of third world countries (e.g., Kenya, Tanzania, Turkey, Yemen etc.) have launched programmes to establish industrial zones (Buckley, 1995).

Pakistan has established several industrial zones in a number of locations. This initiative aims to boost economic development in the country. In the current research, we were interested in examining whether manufacturing SMEs located in these industrial zones focused on Lean, Six Sigma and Sustainability and their level of awareness regarding these concepts. Lean and Six Sigma are very sophisticated and developing countries have less knowledge and fewer resources to implement them appropriately (Albliwi *et al*., 2014). However, there is still a gap in the literature about how firms located in the industrial zones understand these concepts, and even whether Sustainability awareness exists. Based on this research gap we developed the first research objective: *To investigate the implementation level of Lean, Six Sigma and Sustainability in manufacturing SMEs located in the industrial zones of Pakistan.*

*2.6 Relationship between firms’ performance and Lean, Six Sigma and Sustainability*

The integration of Lean, Six Sigma and Sustainability has achieved significant attention in the literature, and researchers have outlined useful implications in different contexts. For example, according to de Freitas *et al*. (2017), Lean Six Sigma (LSS) influences organisational sustainability through their projects and there is a strong relationship between Sustainability and LSS. These findings are supported by Cherrafi *et al*. (2017), who determined that in addition to achieving organisational excellence, Lean Six Sigma and Sustainability make a positive contribution to the economic, social and environmental performance of organisations. Furthermore, Lean Six Sigma has also a positive impact on the environment, as evidenced in the systematic review of the literature performed by Chugani *et al*. (2017). However, the implementation process may be different across organisations.

Research has been conducted in developed, emerging and underdeveloped countries, resulting in more than 118 papers on the integration of Lean, Six Sigma and Sustainability (Cherrafi *et al*., 2016). However, only six papers offer state-of-the-art research into the bridge between Lean, Six Sigma and Sustainability (Cherrafi *et al*., 2016). Moreover, no research discusses in detail the barriers, drivers, benefits and critical success factors for a possible integrated model of Lean, Six Sigma and Sustainability. An extensive body of research exists that explores and measures the impact the integration of Lean and Six Sigma has on the business performance of large organisations (Cherrafi *et al*., 2016; Jaeger *et al*, 2021). However, there is a potential research gap on the integration of Sustainability with Lean and Six Sigma practices, as little research has been documented that explores the overall implications of the combination of these three concepts (Li *et al*., 2009), particularly in the context of developing countries. Only a few studies have been conducted that integrate Lean and Six Sigma with Sustainability. One example investigated the implementation of Lean Six Sigma in developing countries by focusing on the barriers that deter the implementation of the LSS methodology (Mustapha *et al*., 2019); another examined training for the adoption of LSS in Saudi Arabia (Alsmadi *et al*., 2012). However, the most recent study focused on the effect of Covid-19 on Indian manufacturing firms and provided substantial assistance to practitioners by suggesting how manufacturing firms could recover after the pandemic with the help of Lean Six Sigma practices (Singh and Garza-Reyes, 2021). The fact remains, however, that there is a gap in the literature to explore the SME sector of Pakistan in the context of Lean, Six Sigma and Sustainability. Only a few studies highlight the implementation of Lean Six Sigma in the construction sector, its effect on optimising performance levels (Hussain *et al*., 2019; Ullah *et al*., 2017) and the impact it has on environmental sustainability (Ali *et al*., 2020). One shows that the implementation of LSS not only has a positive impact on sustainability but also enhances customer satisfaction, production improvement and reduction in manufacturing lead time (Khanzode *et al*., 2021). Although previous studies have shown the impact of Lean Six Sigma practices on organisational performance, there has until now been nothing to show how Lean, Six Sigma and Sustainability methodologies are being practised in the SMEs located in the industrial zones of Pakistan. Nor has there been an exploration of how these methodologies could assist firms to achieve organisational excellence (growth, efficiency and profit) while maintaining their Sustainability credentials.

According to Venkatraman and Ramanujan (1986), a firm’s performance can be classified into *organisational performance*, *business performance* and *financial performance*. Several performance dimensions can be considered, such as efficiency, growth, profit, size, liquidity, success/failure, market share and leverage, but the most common and significant performance measures are efficiency, growth and profit (Murphy *et al*., 1996). The efficiency dimension includes return on investment, return on equity and return on assets. Growth can be measured in sales growth, employee growth and market share growth. Profit can be measured through return on sales, net profit margin and gross profit margin (Li *et al*., 2009). Based on these dimensions we developed the second research objective: *To investigate the relationship of Lean, Six Sigma and Sustainability with firm performance based on efficiency, profit and growth.*

Therefore, to determine the correlation between Lean, Six Sigma and Sustainability, and firms’ performance dimensions of efficiency, profit and growth, all in the context of a developing country, this study proposes the following hypotheses:

Hypotheses concerning the effects of Lean practices on firms’ performance (efficiency, profit and growth):

*H1: Lean practices have a positive impact on a firm’s efficiency*

*H2: Lean practices have a positive impact on a firm’s profit*

*H3: Lean practices have a positive impact on a firm’s growth*

Hypotheses concerning the effects of Six Sigma practices on firms’ performance (efficiency, profit and growth):

*H4: Six Sigma practices have a positive impact on a firm’s efficiency*

*H5: Six Sigma practices have a positive impact on a firm’s profit*

*H6: Six Sigma practices have a positive impact on a firm’s growth*

Hypotheses concerning the effects of Sustainability practices on firms’ performance (efficiency, profit and growth):

*H7: Sustainability practices have a positive impact on a firm’s efficiency*

*H8: Sustainability practices have a positive impact on a firm’s profit*

*H9: Sustainability practices have a positive impact on a firm’s growth*

**3. Research Methodology**

This study used a quantitative research method to examine the effects of implementing Lean, Six Sigma and Sustainability on business performance based on efficiency, growth and profit, and did so by looking at firms located in the industrial zones in Pakistan. A sample of top-level managers from SMEs was used. First, we developed a questionnaire consisting of 31 questions regarding the implementation of Lean, Six Sigma, and Sustainability and their effect on business performance using the dimensions of efficiency, growth and profit. The questionnaire consisted of five parts. Part A gathered demographic information about the sample: the name of the firm, its sector of activity, the number of employees and the age of the firm. This information was collected to link the firm size with the SME definition in Pakistan. Part B consisted of five items related to Lean and adapted from Gilbert (2008). Part C identified seven items related to Six Sigma, adapted from Antony *et al*. (2007). Part D was related to sustainability and included 10 items adapted from Goodland and Daly (1996) and Hutchins and Sutherland (2008). Part E had nine items related to business performance indicators: three items each for efficiency, growth and profit, adapted for the study from Li *et al*. (2009). Before it was issued, the questionnaire was discussed with other academic experts who were familiar with Lean, Six Sigma, Sustainability and business performance terms. After finalising the questionnaire, we prepared both hard copies and Google docs. All parts except for Part A asked the respondents to answer using the Likert scale from 1 to 5, where 1 indicates “strongly disagree” and 5 indicates “strongly agree”.

The questionnaires were sent to respondents working in companies located in the industrial zones in Gadoon, Peshawar, Islamabad, Lahore and Karachi. The firms in these five industrial zones were contacted with the cooperation of the Chamber of Commerce and Industry. A total of 85 questionnaires were sent to firms in these five industrial zones via Google Docs and personal visits. However, due to physical accessibility constraints, firms located in the industrial zones in Karachi and Lahore were contacted using Google Docs and firms located in industrial zones in Gadoon, Peshawar and Islamabad were contacted through personal visits. Forty-eight (48) questionnaires were sent to the Karachi and Lahore industrial zones using Google Docs, while thirty-seven (37) questionnaires were provided to the respondents through personal visits along with the cover letter. The definitions of Lean, Six Sigma, Sustainability and performance, along with a brief description of the terms, were provided with the questionnaires in Google Docs so that every respondent could understand these terms easily.

Data were collected from the questionnaires that were answered by managers, assistant managers and supervisors of the quality and production/operations departments of SMEs. A total of 62 questionnaires were included in the study. Thirty-two questionnaires (51.62% of the total received) were received from Google Docs and thirty questionnaires (48.38% of the total received) were obtained from personal visits. The data were analysed by using the Statistical Package for the Social Sciences (SPSS) software.

**4. Results and Analysis**

*4.1. Respondents’ positions in their companies*

The positions of respondents within the companies are given in Table 1. The respondents work in different departments like operations, productions and quality. The respondents are directors, quality and operations/production managers, quality and operations/production assistant managers, and supervisors.

**Table 1: Positions of respondents**

|  |  |  |
| --- | --- | --- |
| **Positions of Respondents** | **Frequency** | **Distribution (n=62)** |
| Director | 4 | 9.3 % |
| Quality Manager | 9 | 15.6 % |
| Quality Assistant Manager | 15 | 22.0% |
| Operations/Production Manager | 12 | 18.0 % |
| Operations/Production Assistant Manager | 13 | 19.5 % |
| Supervisors | 9 | 15.6 % |

*4.2. Industry Types*

Companies from different industries were investigated in the survey. Table 2 shows the percentage of responses from different industries.

**Table 2: Areas of industries**

|  |  |  |
| --- | --- | --- |
| **Areas of Industries** | **Frequency** | **Distribution (n=62)** |
| Food | 5 | 9.7 % |
| Packages | 9 | 14.3 % |
| Steel | 3 | 7.0 % |
| Foams | 13 | 17.8 % |
| Chemicals | 12 | 16.5 % |
| Automotive | 2 | 7.5 % |
| Textile | 12 | 16.5 % |
| Checkboard | 6 | 10.7 % |

*4.3. Tests Performed on the data*

The Cronbach’s alpha test was performed on the data to know whether the data were reliable and could be further used for other tests. The value of *Cronbach’s alpha* in *Reliability Statistics* is given in Table 3. The Cronbach’s alpha has a threshold value of 0.7, beyond which the selected items are highly reliable (Nunnally and Bernstein, 1994; DeVellis, 2003). As indicated in Table 3, the Cronbach’s alpha for the constructs ranged from 0.712 to 0.861, which demonstrates the high overall reliability of the model.

**Table 3: Reliability result**

|  |  |
| --- | --- |
| Dimension | Cronbach’s Alpha |
| Lean  | 0.750 |
| Six Sigma | 0.818 |
| Sustainability  | 0.861 |
| Business performance | 0.712 |

*4.4. Comparison of the location of different industrial zones based on the implementation of Lean, Six Sigma and Sustainability*

To analyse the obtained data and to address the first research objective (“To investigate the implementation level of Lean, Six Sigma and Sustainability in manufacturing SMEs located in the industrial zones of Pakistan”), a non-parametric test was used to discover what differences existed between the industrial zones in the implementation levels of Lean, Six Sigma and Sustainability in manufacturing SMEs. Because all variables in this research are nominal and ordinal, parametric tests could not be used as they require at least interval/ratio types of data (see Bryman and Cramer, 2002). Furthermore, according to Bryman and Cramer (2002), the non-parametric test can be used when dealing with psychological and sociological variables, such as practices, views and behaviours that are typically nominal or ordinal. In this research, we asked questions regarding the respondents’ practices and views regarding Lean, Six Sigma and Sustainability. Therefore, non-parametric tests were used.

Several non-parametric tests were used to analyse ordinal data. However, to address the first research objectives, Kruskal-Wallis was used. This test was chosen because it is a non-parametric (distribution-free) test used when the assumptions of one-way ANOVA are not met. Both the Kruskal-Wallis test and one-way ANOVA check for significant differences on a continuous dependent variable by a categorical independent variable (with two or more groups) (Vargha and Delaney, 1998).

**Table 4: Significant differences in terms of Lean, Six Sigma and Sustainability**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Lean Overall Mean** | **Six Sigma Overall Mean** | **Sustainability Overall Mean** |
| Chi-Square | 15.116 | 15.962 | 12.113 |
| Df | 4 | 4 | 4 |
| Asymp. Sig. | .004 | .003 | .017 |

a. Kruskal Wallis Test

b. Grouping Variable: Location of Industry

As shown in Table 4, the Kruskal-Wallis test demonstrates that there is a significant difference among the five industrial zones in terms of Lean, Six Sigma and Sustainability. With the df =4, in all three cases (Lean, Six Sigma and Sustainability) the p < 0.05. The sig value for Lean is 0.004, Six Sigma is 0.003 and sustainability is 0.017. Furthermore, to find out which industrial zone performs better in terms of Lean, Six Sigma and Sustainability they were assessed by finding out the rank-based values.

**Table 5: Rank-based values in terms of Lean, Six Sigma and Sustainability**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Location of Industry** | **Number of Cases (N)** | **Rank based on Lean** | **Rank based on Six Sigma** | **Rank based on sustainability** |
| Gadoon | 22 | 26.82 | 21.32 | 22.70 |
| Peshawar | 21 | 36.21 | 39.52 | 38.57 |
| Lahore | 7 | 13.71 | 25.36 | 26.14 |
| Karachi | 6 | **47.08** | **45.75** | 32.67 |
| Islamabad | 6 | 37.33 | 33.67 | **44.08** |
| Total | 62 |  |  |  |

Table 5 demonstrates that industrial zones located in Karachi perform better in Lean and Six Sigma implementation when compared with other industrial zones in the country, because they have got the highest rank values (47.08 in Lean and 45.75 in Six Sigma). Firms located in the Gadoon industrial zone show the least performance in Lean and Six Sigma implementation. However, an industrial zone located in Islamabad shows the highest rank value for sustainability, at 44.08. Research findings regarding the first research objective show that the implementation levels of Lean, Six Sigma and Sustainability differ according to the level of resources available for these industrial zones.

*4.5 Relationship between Lean, Six Sigma and Sustainability and Firms’ Performance: Hypothesis Testing*

Our second objective is *to investigate the relationship of Lean, Six Sigma and Sustainability with firm performance based on efficiency, profit and growth.* Therefore, to determine the correlation between business performance (efficiency, profit and growth) and Lean, Six Sigma and Sustainability, and to test the hypotheses, the Spearman correlation test was used as it is a nonparametric test. There are two assumptions specific to the use of the Spearman test: first, the variables must be measured on an interval, ratio or ordinal scale. Second, the variables must have a monotonic relationship. Based on these assumptions, the data is ordinal (i.e., the categories are ranked using a Likert scale).

By testing for the Spearman’s Rho, it was found that six out of nine hypotheses were significant, while the remaining three were not, as shown in Table 6. The relationships of Lean (ƿ = 0.594, ƿ < 0.05) with efficiency, Lean (ƿ = 0.616, ƿ < 0.05) with profit and Lean (ƿ = 0.574, ƿ < 0.05) with growth were found to correlate positively to business performance (efficiency, profit and growth.). Similarly, the relationships of Six Sigma (ƿ =0.401, ƿ < 0.05) with efficiency, Six Sigma (ƿ = 0.430, ƿ < 0.05) with profit and Six Sigma (ƿ = 0.445, ƿ < 0.05) with growth positively correlates to business performance (efficiency, profit and growth). However, no positive relationship was found between sustainability and business performance (efficiency, profit and growth). The scale in Table 7 determines the positivity of the correlation between the two variables. In this table, it can be seen that there is a delicate relationship for the coefficient value ranging from 0.00 to 0.19, and a very strong relationship exists for values ranging from 0.80 to 1.00.

**Table 6: Hypothesis Testing**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Hypothesis | Relationship | Sign | Spearman’s rho (ƿ) | Sig (2 tailed) | Result |
| H1 | Lean → (Business performance) efficiency  | + | 0.594\*\* | 0.000 | Supported |
| H2 | Lean → (Business performance) Profit  | + | 0.616\*\* | 0.000 | Supported |
| H3 | Lean → (Business performance) growth  | + | 0.574\*\* | 0.000 | Supported |
| H4 | Six Sigma → (Business performance) Efficiency  | + | 0.401\*\* | 0.000 | Supported |
| H5 | Six Sigma → (Business performance) Profit  | + | 0.430\*\* | 0.000 | Supported |
| H6 | Six Sigma → (Business performance) Growth  | + | 0.445\*\* | 0.000 | Supported |
| H7 | Sustainability → (Business performance) Efficiency  | - | 0.228 | 0.162 | Not Supported |
| H8 | Sustainability → (Business performance) Profit  | - | 0.227 | 0.168 | Not Supported |
| H9 | Sustainability → (Business performance) Growth  | - | 0.225 | 0.169 | Not Supported |

 Spearman’s two-tailed correlation (N=62) Note(s): \*\*Correlation significant at 0.01 level

**Table 7: Interpretation of the relationship of correlation with size**

|  |  |
| --- | --- |
| Correlation Size | Relationship of correlation |
| 0.00 – 0.19 | Very weak relationship |
| 0.20 – 0.39 | Weak relationship |
| 0.40 – 0.59 | Moderate relationship |
| 0.60 – 0.79 | Strong relationship |
| 0.80 – 1.0 | Very strong relationship |

**5. Discussion**

This research paper uncovers interesting findings regarding the quality improvement tools of Lean, Six Sigma and Sustainability and adds new insights to the previous literature in the context of the developing country Pakistan. Our first research objective was *to investigate the implementation level of Lean, Six Sigma and Sustainability in manufacturing SMEs located in the industrial zones of Pakistan* Focusing on this potential gap in the current literature, our findings regarding the first research objective show that the implementation levels of Lean, Six Sigma and Sustainability are currently only at an initial stage in Pakistan. However, our findings reveal that the various industrial zones differ in their awareness of Lean, Six Sigma and Sustainability. For example, firms located in the industrial zone in Karachi have more awareness of Lean and Six Sigma than other industrial zones in the selected sample. Conversely, Gadoon industrial zone has the least awareness of Lean, Six Sigma and Sustainability. Findings related to sustainability show that firms located in the industrial zone in Islamabad have more awareness of it than firms in other industrial zones. It seems that higher educational levels, social connections and environment-related interactions have made them more aware of how sustainability can be applied to other quality-related tools.

Our second research objective was *to investigate the relationship of Lean, Six Sigma and Sustainability with firm performance based on efficiency, profit and growth.* The core purpose of this research objective was to examine the relationship of Lean, Six Sigma and Sustainability on firm performance, using efficiency, profit and growth as key indicators of growth (Li *et al*., 2009; Chen *et al*., 2021). The results revealed that there both Lean and Six Sigma strongly relate to efficiency, profit and growth. However, there is no positive relationship between sustainability and efficiency, profit and growth for firms located in the industrial zones of Pakistan. According to H1, H2 and H3 there is a positive relationship between Lean and efficiency, profit and growth where the p-value is less than 0.05. These results support Ngo (2010), who argues that Lean practices, such as Just-in-time (JIT), are most likely to improve organisational performance (Barman *et al*., 2021). Supporting these previous findings, this research paper shows that Lean practices have a positive relationship with firms’ efficiency, profit and growth in the context of the developing country Pakistan.

Hypotheses H4, H5 and H6 applied to the relationship between Six Sigma practices and firms’ performance as measured by efficiency, profit and growth. Our results show that there is a positive relationship between Six Sigma and firms’ performance in terms of efficiency, profit and growth. Previous findings regarding the relationship between Six Sigma practices and organisational performance showed a negative correlation (Ali *et al*., 2020; Kumar *et al*., 2021). However, our findings are inconsistent with the previous results and instead show that SMEs located in the industrial zones of Pakistan have started Six Sigma practices that have increased their organisational performance (according to the efficiency, profit and growth metrics). These results also show that the competition level in the SME sector in Pakistan has increased significantly. SMEs located in the industrial zones have started the Six Sigma practices to achieve organisational excellence and such practices have increased SMEs’ efficiency, profit and growth. Six Sigma is perhaps an overly sophisticated practice for most of the SMEs in Pakistan that have up to three Sigma performance levels as there is a considerable variation in product quality, defects and other elements. However, firms located in the industrial zones in Pakistan have started Six Sigma practices.

According to H7, H8 and H9, there is no positive relationship between sustainability and firms’ efficiency, profit and growth. Our findings show a p-value greater than 0.05, which indicates that Sustainability practices have little or no effect on the efficiency, profit or growth of Pakistani SMEs in the industrial zones. According to Mahmood *et al*. (2017) and Khan *et al*. (2021), Sustainability practices are weak in Pakistani SMEs and no sustainability report published by any Pakistani SME is to be found in the Global Reporting Initiatives GRI database. This study highlights the lack of training and skills, government regulation, sustainability infrastructure, pressure for sustainability reporting, and resources (Ali, *et al*., 2020). Furthermore, our results indicate that SMEs located in Pakistan’s industrial zones do not consider sustainability practices able to enhance firm performance in terms of efficiency, profit or growth.

The study results provide practitioners and decision-makers with useful insights while also contributing to the theoretical body of knowledge. From a practical point of view, the findings urge practitioners to develop comprehensive measures to further increase the awareness and implementation of Lean, Six Sigma and Sustainability practices for the SMEs located in the industrial zones of Pakistan as well as SMEs located outside the industrial zones. Particularly, policy regarding sustainability practices is needed where these practices do not show positive results for firm performance (as measured by efficiency, profit and growth). This paper adds useful detail to the existing literature regarding SMEs by integrating the key performance indicators of efficiency, profit and growth with Lean, Six Sigma and Sustainability where such integration had not previously occurred (Cherrafi *et al*., 2016; Barman *et al*., 2021; Khan *et al*., 2021), particularly in the context of Pakistan. The study’s findings on how Lean and Six Sigma practices enhance Pakistani SMEs’ performance (in terms of efficiency, profit and growth) offer a benchmark that can be used for research conducted in other developing countries.

**6. Conclusion**

This paper explored the awareness level and implementation of Lean, Six Sigma and Sustainability in SME manufacturing firms located in the industrial zones in Pakistan. These concepts are highly valued for quality improvement and customer satisfaction. We revealed that in developing countries like Pakistan, where there is a lack of resources for SMEs to implement Lean, Six Sigma and Sustainability, firms nevertheless strive to implement Lean, Six Sigma and Sustainability. Knowledge regarding these concepts has captured the attention of individuals functioning in the SME sector. However, more work needs to be done to utilise Lean, Six Sigma and Sustainability in the SME sector appropriately.

Based on our empirical evidence, it was revealed that only Lean and Six Sigma have a positive impact on firms’ performance as measured by efficiency, profit and growth; and, according to these metrics, there is no positive relationship between sustainability and firm performance for firms located in the industrial zones in Pakistan. The findings regarding sustainability reveal that a comprehensive framework must be developed for the SME sector in Pakistan, and that is why sustainability does not show a positive correlation with firm performance.

**7. Limitations of this Study and Possibilities for Future Research**

Although this research paper contributes to previous literature, its research design is not without limitations. First, this research paper has explored only one developing country, Pakistan, and the lack of data from other developing countries affects the generalisations made by the study. Second, only SME manufacturing firms located in the industrial zones were analysed. Third, the research could not capture a large amount of data: only 28 firms were included. To address these limitations, future research could be conducted in different developing countries and different sectors, while greater quantities of data could enrich the existing literature.

The paper also paves the way for future research on the subject of operational excellence, especially in the field of perishable supply-chain performance. Given the recent rapidly changing events, and what is likely to unfold, operations managers for the perishable food and pharmaceutical industries need to consider many things. The bottlenecks in the supply chain need more attention, whether they arise from farming inputs, plant shutdowns in food processing sectors or, most importantly, disruption to air, sea and land freight operations, all of which have a drastic impact on high-value perishable products. The most serious risk for the food supply chain lies not in food availability but in compromising its ability to access consumers. As lockdowns and other Covid-19 restrictions disrupt food supply chains, safety nets and food assistance programs become essential to avoid a global hunger crisis and food insecurity.

Therefore, issues like risk mitigation, organisational partnership strategies (to mitigate risks), network diversification (optimising location advantages), adoption of digital tools (processes and systems) and people strategies (key capabilities) would be major areas upon which future research on this subject could concentrate.

Covid-19 has been a global crisis, yet it is a reality with which every organisation in the world has to grapple before finding appropriate management techniques. The impact of a pandemic on the perishable food supply chain is still unfolding, but many lessons have been learned and new safety nets have emerged. Therefore, certain measures to neutralise the risks, mitigate uncertainties and increase resilience are key factors affecting the supply chain of perishable goods. Any organisation that better adapts these measures for the post-Covid-19 world will surely be ahead of the game, and may be a game-changer.

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