

Implementing lean six sigma in developing operational strategies for industrial companies in Jordan

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ABSTRACT

The objective of this study was to assess the consequences of Lean Six Sigma implementation on the development of operational strategies in Jordanian industrial companies, as perceived by senior management and different divisions. To achieve these objectives, an analytical descriptive approach was used to gather data from 42 industrial companies listed on the Amman Stock Exchange. This approach was used to measure the impact of Lean Six Sigma implementation on the development of operational strategies in these companies, utilizing the appropriate measurement methods., with the distribution of (350) The researcher retrieved (320) questionnaire, and Found that there were (15) invalid questionnaire for the analysis of distributed Questionnaires, where the final number of questionnaires (305), To address the research questions and verify its hypotheses, We utilized suitable statistical tools with SPSS software. The study yielded several important results, the most notable being a significant statistical impact of Lean Six Sigma implementation on the development of operational strategies in industrial companies. The study suggested various initiatives, notably emphasizing the importance for senior management in Jordanian industrial companies to explore Six Sigma support for implementation, along with regular training sessions for staff on quality improvement methods.

Keywords: Lean Six Sigma, Six Sigma, lean Manufacturing, Operations Strategy.

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1. Introduction

In the 1980s, as a result of the increasing intensity of competition, companies were forced to reconsider the concept of operations strategy, and managers realized that they had an urgent need to manage their operations in creative ways. The need also emerged to create a hierarchy that shows the different competitive priorities of the market, focusing on creating a different competitive advantage from the rest. Competitors of speed and reliability of delivery; as a means of excellence in addition to providing products and services of high quality, at reasonable prices [1].

Companies today face an unstable environment fraught with fierce competition, the most demanding customers, given the unstable economic climate in many countries, companies are striving to achieve operational efficiency at lower costs, more quickly, with greater reliability, and with enhanced capability for change and continuous improvement, as this constitutes [2]. The factors were the basis for developing operational strategies, and I decided to follow superior methods of how to compete, see the problem and solve it, this helps improve the efficiency of the entire manufacturing process. This encompasses both workforce in adjacency with the excellency in innovative manufacturing processes. The concept of Lean Six Sigma (LSS) appeared. As a result of merging the lean manufacturing systems and the Six Sigma system [3].

Integrating the two systems together allowed companies to obtain a greater degree of autonomy regarding the processes that occur inside and outside the company, This strengthens the foundation of continuous improvement and enables companies to attain improved performance through the use of tools that facilitate continuous improvement efforts [4, 5], and developing processes that It helps achieve the goals set in the company's strategy, urging various industrial companies to adopt quality tools and concepts in order to achieve better product quality, lower lead times, and reduce costs, thus framing various quality management concepts at all levels of the company. Therefore, this study aimed to investigate how Lean Six Sigma impacts the development of operations strategy in industrial companies [4]. To effectively manage operations by maximizing resource utilization, the operations strategy formulates policies and plans to sustain its long-term competitive strategy [6]. Operations management is responsible for effectively overseeing the resources needed for the production of goods and services, in addition to the integration that appears as a result of employing management tools [7]. With the review of the Lean Six Sigma methodology in developing operations strategy, studies have indicated its contribution in providing many alternatives [8], including solving problems related to operations strategy, as it provides a flexible mechanism within models that suit existing problems, and addressing them in creative ways to reach the degree of freedom from defects and the ability to compete in the market, not to mention the urgent need to adopt the Lean Six Sigma methodology, and its contribution to gradually raising the level of quality, Improving product quality and process reliability. The problem of the study is that it addresses waste processes, reduces variation and standard deviations, and also works to simplify operations. The researcher noted through her review that industrial companies are located within a highly competitive environment, which leads to deviations and variation in the company's operations and activities. It is worth mentioning that the Lean is implemented successfully not only in manufacturing but in many industries including hospitals, higher education, etc. [9]. Therefore, the goal of the study involves identifying Lean Six Sigma tools and methodologies, and examining how their application affects industrial companies in Jordan.

2. Literature review

Lean Six Sigma serves as a statistical metric for assessing process variability and is a business and activity management strategy developed by Motorola in 1986; To increase quality, eliminate the causes of defects, and reduce variation and errors in manufacturing processes. It also aims to improve the competitive position and increase the company's value as perceived by the customer. Ben Naylor et al (1999) believes that Lean Six Sigma has received the attention of researchers in several fields, as ideas and opinions have varied regarding it [10].

According to [5], Lean Six Sigma is described as a structured tool that effectively reduces variation in managing company operations, which leads to stability and predictability of results. It is an organized administrative structure. Integrating lean manufacturing and Six Sigma, when implemented effectively, constitutes a potent force in executing and overseeing company operations [11]. It can also help companies achieve very significant improvements in quality levels, reduce defects, and lower their costs. Assarlind et al (2013) agreed with him, he described Lean Six Sigma as a methodology that merges lean manufacturing and Six Sigma, two concepts in quality management, aiming to broaden operational scope and amplify improvement outcomes through their integration [12]. The studies in [13, 14], emphasized that Lean Six Sigma constitutes a fully integrated system that amalgamates the tools of lean manufacturing and Six Sigma. The studies in [15, 16], highlighted that it is an integrated methodology that merges the strengths of lean manufacturing with the precision of Six Sigma, effectively eliminating the weaknesses and inefficiencies of each individual concept to create a more robust approach. Pepper and Spedding (2010) considered it a tool for detecting deviations, discrepancies, or dispersion, with the aim of developing and continuously improving a company's activities [17]. They also noted its flexibility in reducing costs, ensuring quality at all levels, and underscoring the importance of continuous improvement across the organization. The authors of [18] stated that Lean Six Sigma focuses on eliminating errors, reducing lead times and wasted time in work preparation, enhancing productivity, increasing system flexibility, thereby reducing inventory levels and lowering costs.

Based on the information presented, it is clear that Lean Six Sigma constitutes a comprehensive framework that includes a variety of tools suitable for effective application across various fields and sectors., Lean Six Sigma, with a central emphasis on customer satisfaction [19], aims to achieve continuous improvement in both production and services. Its aim is to minimize defects and eliminate non-value-added activities, thereby bolstering companies' capacity to meet evolving customer demands and stay abreast of technological advancements [20]. Researchers in the studies [10, 12, 15, 21], concur that Lean Six Sigma endeavors to

achieve perfection and minimize defects. Furthermore, the researcher argues that Lean Six Sigma is a comprehensive methodology aimed at optimizing processes and organizational activities, improve quality, identify and control problems, and reduce waste.

Applying Lean Six Sigma improves the mechanism of collecting ideas, raises the efficiency of operations, and reduces the waste of resources in the company [22]. Because it works on a comprehensive vision of the company's operations, and precise and organized detail at all levels, its goal is to achieve perfection and mastery in products and services, and customer satisfaction [23]. The authors of [12, 15, 17], identified were the six core principles of the Agile Six Sigma methodology, encapsulating essential concepts that should be upheld:

- Working for the client and focusing on it: The primary goal of any change that companies want to implement is to achieve the highest possible benefit for the customer, and to set clear standards of quality early on, which is determined by the requirements and desires of the customer or the market, and what they expect from them [24]. The concept of customers expands to include investors and beneficiaries of the good or service provided by companies, and lean Six Sigma improvements occur through their impact on customer satisfaction, knowledge of their requirements, and raising managers' awareness of them [25, 26].
- Focus on processes and activities that constitute value: Companies seek superior performance by reconsidering the structure of their activities and focusing on processes and activities that create value for the company [27]. There was a need to improve operations; To increase its efficiency by knowing the current state of the process before examining which processes create added value, making improvements to activities, and controlling them [15]. Undoubtedly, the effectiveness of Lean Six Sigma principles hinges on identifying the processes that create value, and also how companies visualize all the steps in a particular process, and highlight the processes in which waste occurs, by tracking the process starting with the first step all the way to the final product [12].
- Find the problem and focus on that: Using Lean Six Sigma tools in developing the company's operations and activities strategy contributes to the ease of finding the required changes [28]. Therefore, we must focus on the initial problem, collect the data that emerges through analyzing the problem, and focus on reconsidering the problem and how to solve it. This would create a change in the company in general or change the product. Failure to focus on the problem leads to making Six Sigma agile tools ineffective. The goal of these tools is to detect where the problems lie, identify them, and prevent them from occurring in the future [16].
- Eliminate errors and deviations: Once the problem is identified, efforts are directed towards minimizing defect probabilities and eliminating non-value-added activities [18]. These vulnerabilities often manifest as lengthy and intricate processes that are prone to errors and resource wastage. Simplifying or eliminating these functions is an excellent way; To achieve quality control and efficiency of activities, companies become able to measure defects, eliminate them, and reduce errors until they approach the point of being free of defects [14, 29].
- Maintaining business continuity: Business continuity is not a plan to be implemented when needed; Rather, it refers to the daily actions and activities that ensure the continuous maintenance of the company's performance [30]. The basis for maintaining business continuity is the presence of clear and comprehensive standards and directives, Business plans encompassing all company activities, alongside the development of supporting programs and policies. To maintain uninterrupted workflow regardless of circumstances or negative events [23, 31].
- Creating a culture of change and flexibility: Implementing Lean Six Sigma necessitates substantial change. It involves fostering an organizational environment conducive to change and encouraging employees to embrace and adapt to it, and work to embrace cultural change [13]. Companies should always be looking for new ways to simplify the process, eliminate defects, keep an eye on the primary goal, and constantly adjust processes. This is the basis of the Lean Six Sigma methodology, as it emphasizes improvement continuously and forever [32].

Lean Six Sigma, a methodology aimed at streamlining processes and improving efficiency, is comprised of four key dimensions, as highlighted by researchers such as [33]:

Removing Waste: The core of Lean Six Sigma lies in waste elimination. Using statistical tools and methods effectively, companies identify and remove activities that do not enhance the process's value [10]. This involves scrutinizing the entire process flow to pinpoint inefficiencies and redundancies. By closely monitoring resource utilization and prioritizing critical processes, organizations can streamline operations, reduce costs, and boost overall productivity [17]. Examples of waste include unnecessary movement of materials, overproduction, excess inventory, waiting times, unnecessary processing steps, and defects [21, 34].

Reducing Variation: Reducing Variability: Consistency in operational processes is very important to achieve the sustainable development that companies strive to achieve. Reducing the variability resulting from fluctuations in the course of operations requires many continuous audits, examinations and measurements that the company is required to carry out. Companies delve into the root causes of discrepancies. To detect these cases of discrepancy or deviation in data and processes, the company uses techniques such as root cause analysis and statistical process control; to maintain the stability of the process and ensure its course [24, 35]. Therefore, bridging the gap between the performance of planned operations and their actual performance requires reducing the variance to the lowest level, and this in turn will certainly be reflected in enhancing customer satisfaction and raising the level of organizational effectiveness. These variations in operations lead to instability and consistency in the service or product, and lead to longer lead times, thus leading to higher operating costs [33].

Reducing Non-Value-Added Activities: Process improvement is based on examining activities that do not add any value to the company's products or services. These non-value-added activities consume available resources without any benefit, which must be eliminated and removed to enhance the productive efficiency of the company's operations [36]. Hence, the Lean Six Sigma tool is considered the first aid for companies to get rid of processes that do not add any value to them, and this in turn gives companies the ability to simplify the path of their operations and achieve the highest quality. This includes measuring every process and step that takes place within the company to reach activities that do not constitute any benefit and work to remove them and improve the efficiency of operations, as this type of activity reduces customer satisfaction and works to inefficient achievement of organizational goals. In summary, by eliminating these activities and restructuring operations so that they are devoid of any activity or task that is of no benefit, companies can reach their goals with minimal effort and a record period of time [11, 20].

Continuous Improvement: Continuous improvement forms the cornerstone of Lean Six Sigma philosophy. It emphasizes an ongoing commitment to enhancing processes and delivering superior value to customers. Companies foster a culture of continual learning and adaptation, urging employees at every level to identify opportunities for improvement [25]. This iterative approach involves setting measurable goals, implementing changes, and monitoring outcomes to drive continuous enhancement. Embracing a continuous improvement mindset enables organizations to remain agile, respond effectively to evolving market dynamics, and sustain a competitive edge [19].

The concept of operations strategy is of interest to many writers and researchers in many fields. According to [38], operations strategy involves creating a long-term plan to align the company's key resources effectively with its overarching strategic goals. According to [37], the operations strategy tackles broad questions on how these critical resources are structured to achieve the company's established goals, fully integrating operations strategy with the overarching company strategy. Thus, operations strategy is formulated to define policies and plan the resources that are used to support the competitive strategy for the company in the long term (Field and Sroufe, 2007).

Akkermans and Van Aken (1992) view operations strategy as the mechanism through which the functional capabilities of operations are leveraged to develop and consolidate the desired competitive advantage of the business unit. This strategy also involves integrating these capabilities with other functions to ensure cohesive and comprehensive business performance [39].

Díaz Garrido et al. (2007), operations strategy encompasses the comprehensive set of decisions that shape a company's long-term operational capabilities across all functions. It involves continuously integrating market demands with the company's resources to contribute effectively to the overall strategic objectives. (Brown et al., 2009). All companies have markets and possess resources, so all companies are concerned with raising their operations to the strategic level [40].

Barnes and Rowbotham (2003) observed that operations strategy involves the strategic decisions and actions that delineate the role, objectives, and activities of operations. The term "pattern" is used to denote the consistency between these decisions and strategic actions over time [41].

Sarmiento et al (2018) emphasized that operations strategy combines strategic decisions that have a long-term impact and focus on the company's mission and goal, and operational decisions that have a short-term impact and are related to operations, activities and problems that occur on a daily basis [42].

Kennedy (1992) described operations strategy as the main force in creating and sustaining competitive advantage, and the growing role of competitive strategy adopted by companies, which he defined in three strategies: cost leadership, differentiation, and focus [43].

Liu and Liang (2014) assert that operations strategy is crucial for enhancing the overall performance of companies by focusing on operational strategic objectives such as speed, cost reduction, quality, and flexibility [44]. This strategy is essential for ensuring company success, increasing competitiveness in global markets, addressing weaknesses, emphasizing strengths, and investing in operations to achieve a competitive advantage. The researcher concurs with [39,41], that operations strategy is an organized plan for the long-term utilization of a company's resources, with the goal of improving performance and creating integration between operations and the company's overall strategy [45].

The researcher posits that operations strategy constitutes a vision and plan for managing operations, aimed at determining the overall direction. It serves as the fundamental driving force behind decision-making, and this vision must be integrated with the company's overarching strategy and business strategy. To achieve a competitive advantage, operations strategy should expedite the completion of operations, reduce costs, and ensure optimal quality [38, 40, 46].

Operations strategy was not important until 1970. Until that time, American companies were engaged in mass production at relatively high prices, and at that time there was little international competition. In the 1970s and even 1980s, all this changed as Japanese companies began to offer high-quality products at a lower cost [47]. Less, and thus American companies lost their market share compared to Japanese companies. American companies sought to imitate the Japanese approach, but unfortunately the imitation was often unsuccessful. It became evident that Japanese companies gained a competitive edge through their operations strategy, which aligns all resources to support the company's overarching strategic plan [48, 49, 50]. Porter (1991) - a professor at Harvard Business School - highlighted that companies frequently fail to distinguish between operations strategy and operational strategy., as operational strategy stipulates the ability of companies to perform daily tasks and activities more efficiently than competitors, while operations strategy is a long-term plan. To compete through optimal use of resources [51, 52, 53].

The process of developing an operations strategy determines the company's long-term direction and scope, by achieving a competitive advantage in light of changing environments through the efficient and effective use of resources in order to achieve the expectations of stakeholders [51]. This includes developing the operations strategy at the three levels, as mentioned below [54]:

Corporate level strategy: It embodies the pinnacle of strategic planning, defining the long-term direction and scope of the entire company [55]. The company usually includes many business units, and the role of strategy at the corporate level is to determine what these businesses should be, and how to allocate resources among them. The procedures that are implemented at this level are related to the acquisition of new business areas, adding production lines, or liquidating business units and stations. Production lines that do not add value or enter into joint projects with other companies in new fields [54]. Companies frequently articulate their strategy through a mission or vision statement, which outlines the company's direction regarding growth trends, management of diverse activities, product lines, and strategies for maintaining a balanced portfolio of investments or products.

Business level strategy: Business-level strategy focuses primarily on how a specific business unit competes within its industry and defines its strategic goals [56]. It concerns each business unit or production line in the company, and the strategic decision in this type of strategy is related to the size of the advertisement, the direction, the scope of research, changing the product, developing new products, and expanding or contracting the production lines depending on the overall strategy of the company, and the strategy at the business level is considered complementary to the strategy. At the company level [47, 50 57, 58].

Functional level strategy: This strategy concerns the main functional departments within the business units, and is linked to all the main practical functions, which include (operations, marketing, finance, etc.) (Baines et al., 2009). It focuses on how each function contributes to the business strategy, defines its strategic objectives, and outlines resource management necessary to achieve those objectives. The strategy at this level is less extensive compared to the strategy at the company level as a whole or at the business level, but what remains important is having the ability to implement the strategies taken at the company level or business units, develop functional strategies (individuals, finance, production, marketing) and create a situation Integration between tasks and work within a single function [53, 56, 59, 60].

3. Methodology

The study included directors of various departments, branches and divisions in industrial companies listed on the Amman Stock Exchange in Jordan, which numbered (55) listed companies. A purposive sample was taken from the study population of companies that adopt Lean Six Sigma, and their number reached (45) companies. Then, a paper questionnaire was distributed that included Arabic and English to make it easier for the study sample to understand, and it was deliberately distributed to the directors of departments, divisions, branches, and divisions in listed industrial companies. The number of questionnaires distributed was (350) to members of the study population. (320) questionnaires were retrieved, and after examination, it was found that there were (15) questionnaires that were not suitable for analysis. From the questionnaires distributed to the study sample, 305 questionnaires were collected suitable for analysis. Table 1 shows how the sample members are distributed across demographic variables.

The sample comprised 1,957 Portuguese companies that participated in the survey. Among the respondents, the majority were male (62.1%, $n = 1,216$) with ages ranging from 20 to 85 years and an average age of approximately 46 years ($SD = 10.35$). Regarding their roles within their companies, 33.3% ($n = 652$) were managing partners, 26.3% ($n = 514$) held administrative positions, 23.2% ($n = 455$) were administrators or managers, and 17.2% ($n = 336$) were directors. On average, these companies had been operating for approximately 25 years ($SD = 19.36$), with 50% of them operating for 21 years or less.

Table 1. Characterization of the Population and Sample

Variables	Categories	n	%
Gender	Male	80.3	245
	Female	19.7	60
Age	Less than 30 years old	6.6	20
	From 30 and under 40 years old	50.8	155
	From 40 and less than 50 years old	29.8	91
	50 years and over	12.8	39
Educational level	High School diploma	0	0
	Bachelor's	1.6	5
	Postgraduate	85.9	262
Years of Experience	Less than 5 years	12.5	38
	5 years and less than 10 years	13.1	40
	More than 10 years	58.0	177
Professional level	Manager	28.9	88
	Department manager	6.2	19
	Branch Manager	47.9	146
	Division head	33.4	102
		12.5	38

Table 1 reveals various demographic characteristics. The gender distribution indicates that 80.3% of the study sample was male, with 19.7% being female. This suggests a male predominance in industries characterized by dynamic and challenging environments.

Regarding age, the highest percentage of individuals, at 50.8%, fell within the 30 to less than 40 years category, with the lowest percentage, 6.6%, in the under 30 years category. This pattern is attributed to industrial companies typically favoring mid-career individuals for managerial roles.

In terms of educational attainment, the majority of participants, at 85.9%, held a Bachelor's degree, while none possessed a high school diploma. This underscores industrial companies' preference for candidates with higher education qualifications, particularly for administrative positions.

Concerning years of experience, 58% of participants had between 5 and less than 10 years of experience, with only 13.1% having less than 5 years of experience. This reflects the career progression opportunities associated with accumulated experience, enabling individuals to advance across organizational levels.

Regarding job roles, 47.9% of the sample held department manager positions, whereas only 6.2% occupied director-level roles. This discrepancy is attributed to the relative scarcity of director positions and the challenges associated with reaching them within organizational hierarchies. The study tool consists of three main parts as follows:

The first part includes demographic variables such as gender, age group, educational level, number of years of experience, and job level. The second part contains the independent variable, which is represented by the lean Six Sigma approach in its multiple dimensions: eliminating waste, reducing variation, reducing non-added value, and continuous improvement. The third section encompasses the dependent variable, operational strategy, assessed through indicators such as quality, cost, speed, and flexibility. The study hypotheses were tested using a five-point Likert scale to analyze data, ranging from a score of (1) that expresses categorical rejection, to a score of (5), which expresses categorical approval, with one score in the middle expressing neutrality.

The principal components factor analysis method was used to analyze sample members' responses to Lean Six Sigma items. The saturation values (Loadings) and commonality values (Communalities) were calculated for each factor extracted from the field and rotated using the Varimax method, respectively. And they were evaluated utilizing the Kaiser-Meyer-Olkin (K.M.O) test. Table (2) displays the findings of the factor analysis for the Lean Six Sigma field.

Table 2. Loadings values and Communalities values for each extracted factor from the field, rotated using the Varimax technique and tested using K.M.O.

Dimension 1: Eliminating Waste (EW)				Dimension 2: Reducing Variation (RV)			
The percentage of variance explained (74%) and the value of the test (K.M.O = 0.718) with statistical significance (0.00)				The percentage of variance explained (56.667%) and the value of the test (K.M.O = 0.562) with statistical significance (0.00)			
Values of communism	Saturation	Paragraph	No	Values of communism	Saturation	Paragraph	No
0.40	0.54	1		0.71	0.68	1	
0.73	0.70	2		0.46	0.67	2	
0.81	0.82	3		0.72	0.25	3	
0.74	0.81	4		0.46	0.63	4	
0.83	0.82	5		0.56	0.57	5	
0.80	0.75	6		0.46	0.60	6	
Dimension 3: reducing non-added value (RNAV)				Dimension 4: continuous improvement (CI)			
The percentage of variance explained (85.16%) and the value of the test (K.M.O = 0.93) with statistical significance (0.00)				The percentage of variance explained (91.8%) and the value of the test (K.M.O = 0.76) with statistical significance (0.00)			
Values of communism	Saturation	Paragraph	No	Values of communism	Saturation	Paragraph	No
0.93	0.86	1		0.76	0.92	1	
0.94	0.89	2		0.77	0.94	2	
0.93	0.86	3		0.74	0.92	3	
0.91	0.82	4		0.74	0.89	4	
0.93	0.86	5		0.77	0.92	5	
0.90	0.82	6					

The table displays the results of factor analysis for Lean Six Sigma dimensions, showing loadings and communalities for each extracted factor. Rotation of factors employs the Varimax technique and assesses them

using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. Here's a detailed commentary on the table from a statistical perspective:

For Dimension 1: Eliminating Waste (EW), the percentage of variance explained by this dimension is 74%, with a KMO value of 0.718, which is statistically significant (p -value = 0.00). This indicates a strong factor structure for this dimension. The loadings (saturation values) for the six items range from 0.54 to 0.84, showing that each item has a strong association with the eliminating waste dimension. Community values range from 0.40 to 0.83, reflecting the proportion of each variable's variance that can be explained by the factor.

Dimension 2: Reducing Variation (RV) explains 56.667% of the variance, with a KMO value of 0.562 and statistical significance (p -value = 0.00), indicating an adequate factor structure. The loadings for the six items vary from 0.25 to 0.68, suggesting moderate to strong relationships with the reducing variation dimension. Community values are between 0.46 and 0.71, indicating that a reasonable proportion of the variance of each variable is explained by the factor.

For Dimension 3: Reducing Non-Added Value (RNAV), this dimension explains 85.16% of the variance, with a KMO value of 0.93 and statistical significance (p -value = 0.00), indicating an excellent factor structure. The loadings for the six items range from 0.82 to 0.89, demonstrating very strong associations with the reducing non-added value dimension. Community values range between 0.91 and 0.94, suggesting that a substantial amount of each variable's variance is accounted for by the factor.

Dimension 4: Continuous Improvement (CI) explains 91.8% of the variance, with a KMO value of 0.76, also statistically significant (p -value = 0.00). This indicates a very strong factor structure. The loadings for the five items range from 0.74 to 0.92, showing strong associations with the continuous improvement dimension. The community values range from 0.77 to 0.92, indicating that a substantial proportion of each variable's variance is explained by the factor.

General Observations: The KMO values for all dimensions are above the acceptable threshold (0.5), with particularly high values for dimensions 3 and 4, indicating the adequacy of the sample for factor analysis. The high percentage of variance explained for each dimension signifies that the factors derived are robust and significant in explaining the variability in the data. The loadings and communalities demonstrate that the items are well-correlated with their respective factors, confirming the validity of the instrument used for measuring Lean Six Sigma dimensions.

Instrument validity pertains to how effectively it measures the intended purpose for which it was designed. . To achieve this, the tool was presented to 31 judges to evaluate the linguistic clarity and comprehensiveness of the paragraphs. Based on their feedback, the tool was modified to ensure that it covered all aspects of the topic clearly and concisely. Instrument stability means that the results are stable and consistent when the test is repeated under similar conditions. The Cronbach's alpha test was employed to gauge internal consistency, with reliability coefficient values spanning from (0.71 to 0.96), and achieving an alpha value of (0.92), which is considered good for generalizing the results of the study. Acceptable values are usually 0.60 or higher.

Table 3. Reliability coefficients (Cronbach alpha) for all items of the dimensions of study and performance as a whole

Field	Dimension	Coefficient (Cronbach Alpha)
Lean Six Sigma	Eliminating Waste	0.85
	Reducing Variation	0.71
	Reducing Non-Value-Added Activities	0.73
	Continuous Improvement	0.96
	Lean Six Sigma Domain as a Whole	0.87
Operations strategy	Quality	0.92
	Speed	0.78
	Flexibility	0.83
	Cost	0.94
	Operational Strategy Domain as a Whole	0.88

The researcher used a set of statistical methods to analyze the data collected from the study sample. Then the researcher processed it statistically using the Statistical Package for the Social Sciences (SPSS). As shown in the results section.

4. Results and discussion

After analyzing the data for the first question, the arithmetic averages and standard deviations were calculated for the answers of the study sample members regarding the dimensions of the “Lean Six Sigma” field. Table (4-7) shows the following:

Table 4. Descriptive Statistics for Dimension 1 (Eliminating Waste)

Factors	n	M	SD	Score
The organization uses contemporary technology to monitor its operations and activities.	305	3.92	0.85	High
The organization implements measures to minimize interruption and waste in operations and activities.	305	3.88	0.88	High
To reduce waste throughout the production process, the organization employs an analytical method.	305	3.77	0.72	High
The firm is engaged in decreasing waste using innovative technologies.	305	3.62	0.75	Medium
Production machines and equipment are modern and readily available.	305	3.45	0.61	Medium
Controlling the usage of raw and packaging resources.	305	3.33	0.63	Medium
Dimension 1 (Eliminating Waste)	305	3.66	0.74	Medium

Table 4 shows that the arithmetic averages of the sample members' answers to the paragraphs after “eliminating waste” ranged between (3.92-3.33), the highest of which was paragraph (1) “The organization uses contemporary technology to monitor its operations and activities” with a high rating. While the lowest is for paragraph (6) “Controlling the usage of raw and packaging resources” with a medium rating. As shown in Table 4, The responses of the study sample members exhibited standard deviations ranging from 0.61 to 0.88, suggesting minimal variability around the arithmetic mean, suggesting a convergence of opinions regarding the level of waste elimination in industrial companies listed on the Amman Stock Exchange in Jordan..

Table 5. Descriptive Statistics for Dimension 2 (Reducing Variation)

Factors	n	M	SD	Score
There are systems for controlling inspection and measurement equipment and tools.	305	4.12	0.84	High
Providing solutions for managing industrial processes.	305	4.05	0.79	High
Every period, the firm measures the variance rates.	305	3.55	0.65	Medium
The firm is implementing a strategy plan to decrease variability.	305	3.41	0.62	Medium
The organization offers strategies to decrease variations in operations and activities.	305	3.21	0.65	Medium
Designing the company's operating systems based on this dimension.	305	2.77	0.65	Medium
Dimension 2 (Reducing Variation)	305	3.51	0.68	Medium

Table 5 shows that the arithmetic averages of the sample members' answers to items after “reducing variance” ranged between (4.12-2.77), the highest being paragraph (1) “There are systems for controlling inspection and measurement equipment and tools” with a high rating, while The lowest is for paragraph (5): “Designing the company's operating systems based on this dimension” with a medium rating. Table (5) illustrates that the standard deviations of the study sample members' responses varied from 0.84 to 0.55, indicating a low level of dispersion from the arithmetic mean, indicating convergence in their opinions regarding the level of variation reduction in industrial companies listed on the Amman Stock Exchange in Jordan.

Table 6. Descriptive Statistics for Dimension 3 (Reducing Non-Value-Added Activities)

Factors	n	M	SD	Score
The corporation differentiates between activities that provide value and operations that do not contribute value.	305	3.63	0.90	Medium
Reformulating a new concept to decrease processes that do not provide value to the organization.	305	3.52	0.76	Medium

Factors	n	M	SD	Score
The firm offers processes for reducing non-added value in operations and activities.	305	3.47	0.66	Medium
The firm examines activities to determine their success using contemporary methods.	305	3.45	0.63	Medium
The firm attempts to streamline processes by removing those that do not provide value.	305	3.23	0.67	Medium
Dimension 3 (Reducing Non-Value-Added Activities)	305	3.46	0.72	Medium

Table 6 shows that the arithmetic averages of the sample members' answers to the items after "reducing non-added value" ranged between (3.63-3.23), the highest of which was paragraph (1) "The corporation differentiates between activities that provide value and operations that do not contribute value." It adds value with a "medium rating," while the lowest for paragraph (5) is "The firm attempts to streamline processes by removing those that do not provide value. Table (6) indicates that the standard deviations of responses from the study sample members ranged between 0.90 and 0.63, suggesting little variation from the arithmetic mean. Indicating consensus in their opinions regarding the level of value reduction not added in industrial companies listed on the Amman Stock Exchange in Jordan.

Table 7. Descriptive Statistics for Dimension 4 (Continuous Improvement)

Factors	n	M	SD	Score
Systems are in place to control inspection and measurement devices and tools for continuous improvement.	305	3.67	0.69	High
Provides systems to control production processes and work to improve them continuously.	305	3.57	0.76	Medium
Changing the company culture to suit this dimension.	305	3.50	0.64	Medium
The company works to continuously improve by using modern systems.	305	3.43	0.65	Medium
Designing the company's operations systems in accordance with the dimension of continuous improvement.	305	3.34	0.69	Medium
The company follows procedures that contribute to continuous improvement in processes and activities.	305	3.31	0.62	Medium
Dimension 4 (Continuous Improvement)	305	3.47	0.67	Medium

Table 7 shows that the arithmetic averages of the sample members' answers to items on the "continuous improvement" dimension ranged between (3.67-3.31), the highest of which was item (1) "Systems are in place to control inspection and measurement devices and tools for continuous improvement." With a high rating, while the lowest for paragraph (6) "The Company follows procedures that contribute to continuous improvement in processes and activities. As Table 7 illustrates that the standard deviations of responses from the study sample members varied between 0.76 and 0.64, indicating little deviation from the arithmetic mean. This suggests agreement among the study sample members regarding the extent of continuous improvement in industrial companies listed on the Amman Stock Exchange in Jordan.

To address the second question, arithmetic averages were calculated for the responses of the study sample members to the items regarding the dimensions of "operations strategy development." Table 8 presents these averages:

Table 8. Descriptive Statistics for Dimension 1 (Quality)

Factors	n	M	SD	Score
The company seeks to continuously audit and evaluate quality plans.	305	4.17	0.75	High
The company has clear criteria for evaluating the company's operations and activities.	305	4.02	0.89	High
The company focuses on quality and modernization of operations	305	3.73	0.77	High
The company monitors operations and activities through modern systems.	305	3.90	0.67	High
Preparing a strategic plan to improve the quality level in the company.	305	3.41	0.50	Medium
Descriptive Statistics for Dimension 1 (Quality)	305	3.8	0.71	High

Table 8 shows that the arithmetic averages of the sample members' answers to paragraphs after "eliminating waste" ranged between (4.17-3.41), the highest being paragraph (1) "The company seeks to continuously audit

and evaluate quality plans” with a high rating, while the lowest was for paragraph (1). (5) “Preparing a strategic plan to improve the quality level in the company” with a moderate rating. Table (8) displays that the standard deviations of responses from the study sample members varied between 0.89 and 0.50, suggesting little deviation from the arithmetic mean, suggesting consensus in their opinions regarding the level of quality in industrial companies listed on the Amman Stock Exchange in Jordan.

Table 9. Descriptive statistics for Dimension 2 (Speed)

Factors	n	M	SD	Score
The company aims to simplify its operations to ensure rapid delivery.	30	3.82	0.87	High
The company is interested in increasing the reliability of its operations.	30	3.70	0.74	High
Operations and activities are completed on time by the company.	30	3.50	0.61	Medium
The company enjoys the confidence of its customers through the speed of completion of operations.	30	3.41	0.63	Medium
The company is keen to meet market demands at the appropriate speed.	30	3.31	0.67	Medium
Descriptive Statistics for Dimension 2 (Speed)	30	3.54	0.62	Medium

Table 9 shows that the arithmetic averages of the sample members’ answers to the items after “Speed” ranged between (3.82-3.31), the highest of which was item (1) “The company aims to simplify its operations to ensure rapid delivery.” With a high rating, while the lowest is for paragraph (5): “The company is keen to meet market demands at the appropriate speed,” With an average rating. As Table (9) shows, the standard deviations for the answers of the study sample members ranged between (0.87-0.61), There is a narrow range of variation among the study sample members' responses from the arithmetic mean, indicating agreement in their opinions regarding the level of speed in industrial companies listed on the Amman Stock Exchange in Jordan.

Table 10. Descriptive statistics for Dimension 3 (Cost)

Factors	n	M	SD	Score
Reducing the cost of operations at the company level as a whole is one of the company's priority goals.	305	3.77	0.81	High
There is cooperation between the administrative and technical bodies in achieving a mechanism to reduce the costs of the company's operations.	305	3.66	0.67	Medium
The company is interested in achieving optimal use of its resources in order to reduce costs.	305	3.57	0.78	Medium
Production capacity is utilized efficiently.	305	3.45	0.67	Medium
The company supports research and development activities in order to reduce the costs of the company's operations.	305	3.32	0.61	Medium
The company's operations systems are designed in accordance with this dimension.	305	3.27	0.62	Medium
Descriptive Statistics for Dimension 3 (Cost)	305	3.50	0.61	Medium

Table 10 illustrates that the arithmetic means for the sample members' responses on the items related to the "Reducing Non-Value-Added Activities" dimension ranged from 3.77 to 3.27. The highest mean was for item (1) "Reducing the cost of operations at the company level as a whole is one of the company's priority goals," with a high evaluation score. The lowest mean was for item (6) "The company's operations systems are designed in accordance with this dimension," with a medium evaluation score. Furthermore, Table (10) indicates that the standard deviations for the responses of the study sample ranged between (0.81-0.61), reflecting a low degree of dispersion around the arithmetic mean. This minimal dispersion indicates an elevated degree of cohesion among the study sample members regarding the cost levels in industrial companies listed on the Amman Stock Exchange in Jordan.

Table 11. Descriptive statistics for Dimension 4 (Flexibility)

Factors	n	M	SD	Score
Company's operations respond to market requirements flexibly.	305	3.61	0.78	Medium

The company has the ability to change and reshape operations.	305	3.58	0.79	Medium
Offering a wide range of products to meet customer requirements and achieve the greatest flexibility.	305	3.49	0.68	Medium
The company's ability to adapt its operations within available resources.	305	3.32	0.66	Medium
The company can shift its operations from old line products to new line products.	305	3.31	0.71	Medium
Descriptive Statistics for Dimension 4 (Flexibility)	305	3.46	0.62	Medium

Table 11 displays that the arithmetic means for the responses of the sample members on the items of the "Flexibility" dimension varied between (3.61-3.31). The highest mean was observed for item (1) "Company's operations respond to market requirements flexibly," indicating a moderate evaluation score. The lowest average score was noted for item (5). "The company can shift its operations from old line products to new line products", also with a medium evaluation score. Additionally, Table (11) shows that the standard deviations of responses from the study sample varied between 0.79 and 0.66, indicating little dispersion around the arithmetic mean. This low dispersion suggests that there is an elevated degree of agreement among the study sample members regarding the level of flexibility in industrial companies listed on the Amman Stock Exchange in Jordan.

To examine how each facet of Lean Six Sigma implementation influences industrial companies in Jordan, multiple linear regression analysis was employed. This analysis aimed to determine if there is an effect of the independent variables at a statistical significance level of ($\alpha \leq 0.05$). Before applying the regression analysis to test the study's sub-hypotheses, it was necessary to verify the suitability of the data for multiple regression assumptions through several statistical tests. This included testing the normality of each variable in the study (the independent variable and the dependent variable), after which the importance was evaluated and the explanatory power of the multiple linear regression model used was measured.

A linear correlation test was conducted: the researcher used a linear correlation test to ensure that there was no statistically significant relationship between the independent variables. This test included performing a variance inflation factor (VIF) test and a tolerance test for each independent variable as well, To ensure that all data of the independent variables in the model are interconnected. That is, the VIF value must be less than 10, and the tolerance value must exceed 0.05. Looking at Table 11, it displays the results of these criteria for all independent variables.

Table 12. Variance inflation factor test, and allowable variance test for study variables

Dimension	(VIF)	(Tolerance)
Eliminating Waste	1.59	0.63
Reducing Variation	1.44	0.70
Reducing Non-Value-Added Activities)	1.24	0.81
Continuous Improvement	1.05	0.95

Table 12 shows that the Variance Inflation Factor (VIF) values for all independent variables are less than 10, ranging between 1.05 and 1.59. The Tolerance values for all independent variables are greater than 0.05, ranging between 0.63 and 0.95. Therefore, it can be concluded that there is no issue of high multicollinearity among the independent variables, which supports the feasibility of using all of them in the model. Following the inclusion of independent variables in the multiple linear regression analysis, the study sought to determine which of these variables significantly influenced the dependent variable, and its percentage of influence, if applicable. To validate the primary hypothesis and its associated sub-hypotheses, the multiple regression equation was employed to assess how Lean Six Sigma implementation affects the development of operational strategy in Jordanian industrial companies. Table 12 illustrates these findings.

Table 13. The results from applying the multiple regression equation revealed the impact of independent variables on the dependent variable.

Dimension	β	t	Sig	R ² Adjusted	R ²	R	Sig
Eliminating Waste	0.47	11.70	0.00				
Reducing Variation	00.5	1.31	0.19				

Dimension		β	t	Sig	R ² Adjusted	R ²	R	Sig
Reducing Activities)	Non-Value-Added	0.16	4.70	0.00	168.7	0.69	0.687	0.83
Continuous Improvement		0.45	11.71	0.00				

Table 13 shows the impact of the Lean Six Sigma dimensions on industrial companies in Jordan. The correlation coefficient (R) is 0.83, These results show a statistically significant correlation between the collective independent variables and the dependent variable, resulting in an R-square value of 0.687. This statistically explains how Lean Six Sigma implementation enhances operational strategy in Jordanian industrial companies. This means that Lean Six Sigma implementation accounts for 70% of the variance in operational strategy. The F-test value is 168.7 with a statistical significance of 0.00, which is statistically significant at the 0.05 level ($\alpha \geq 0.05$). This indicates a variance in the ability of the independent variables and a statistically significant impact of Lean Six Sigma implementation on industrial companies' operational strategy at the 0.05 significance level. The first sub-hypothesis posits that "Waste elimination does not show a statistically significant impact, at the $\alpha \leq 0.05$ significance level, on operational strategy development in Jordanian industrial companies from the perspective of managers." The findings indicated a significant statistical impact, at the $\alpha \leq 0.05$ significance level, of waste elimination on the development of operational strategies in industrial companies listed on the Amman Stock Exchange. The values of (β , t) were (0.47, 11.70), respectively, indicating statistically significant results. Therefore, the first hypothesis was accepted.

The second sub-hypothesis posits that "From the managers' perspective, reducing variation does not show a statistically significant effect on the development of operational strategy in Jordanian industrial companies at the significance level ($\alpha \leq 0.05$)." According to the findings, the null hypothesis was rejected because reducing variation did not have a statistically significant effect, at the significance level ($\alpha \leq 0.05$), on the development of operational strategies in industrial companies listed on the Amman Stock Exchange. The values of (β , t) were (0.05, 1.31), respectively, which are statistically significant values. Consequently, the second hypothesis was rejected.

The third sub-hypothesis asserts that "From the managers' perspective in Jordanian industrial companies, reducing non-value-added activities does not demonstrate a statistically significant effect on the development of operational strategy at the significance level ($\alpha \leq 0.05$)." The results revealed a statistically significant effect, at the significance level ($\alpha \leq 0.05$), of reducing non-value-added activities in developing operational strategies in industrial companies listed on the Amman Stock Exchange. The values of (β , t) were (0.16, 4.70), respectively, indicating statistically significant values. Therefore, the third hypothesis was accepted.

The fourth sub-hypothesis posits that "From the perspective of managers in industrial companies in Jordan, continuous improvement does not show a statistically significant effect on the development of operational strategy at the significance level ($\alpha \leq 0.05$)".

The results revealed a significant statistical impact of continuous improvement on the development of operational strategies in industrial companies listed on the Amman Stock Exchange, at the significance level ($\alpha \leq 0.05$). The values of (β , t) were (0.45, 11.71), respectively, indicating significant statistical outcomes. Therefore, the fourth hypothesis was validated.

5. Conclusions

According to the results, the adoption of Lean Six Sigma in industrial companies listed on the Amman Stock Exchange had a moderate impact on the development of operational strategy from the viewpoints of senior management, department heads, branches, and divisions. This is because industrial companies in Jordan aim to enhance their business reputation by obtaining certifications that demonstrate their dedication to best practices and methodologies in their industry through its application. Furthermore, they aim to gain recognized accreditation within international standards and specifications.

The results also indicated that the level of awareness among industrial companies is acceptable regarding the importance of applying Lean Six Sigma to develop operational strategy. They acknowledge its positive reflections on the performance of the industrial companies that apply it, through increased productivity, improved profit margins, and the ability to streamline operations, leading to cost reduction and improved current performance. Additionally, there is an increased awareness of the culture of change and the adoption of methods that enhance their competitive capability.

These findings are attributed to industrial companies' perception of Lean Six Sigma as a contemporary management approach that emphasizes modern managerial concepts and methods, particularly those centered on prioritizing customer satisfaction. This philosophy combines innovative efforts and creative means to elevate the company to a distinguished performance level and a strong competitive position. This result aligns with the study by [24], which emphasized that modern managerial methods like Lean Six Sigma enable companies to face challenges and obstacles effectively. Additionally, Habidin & Yusof (2012) noted that Lean Six Sigma increases the flexibility of company operations, simplifies processes and activities, and enhances the quality to achieve near perfection.

The researcher attributes the suboptimal level of Lean Six Sigma implementation to several factors. Firstly, the implementation process of Lean Six Sigma starts with establishing a strategic future vision, defined by long-term objectives that are objective and based on organized plans and strategic policies. These policies are intended to coordinate efforts to achieve integration among all principles and pillars to reach the desired goals. However, the Lean Six Sigma implementation process is not without strategic and other obstacles. Additionally, the management's inability to envision long-term ownership and the weakness of their management in this aspect, along with the lack of strategies that enhance their ability to adopt modern methods in the long run, are significant issues. Cost and profit metrics continue to dominate the entire management process more than important issues like quality improvements. Furthermore, some industrial companies in Jordan lack strategies for developing skills and competencies that contribute to quality enhancement.

This finding highlighted the need for management to provide essential requirements for the optimal implementation of Lean Six Sigma. These include the management's ability to appreciate the importance of Lean Six Sigma and its critical role in achieving efficiency for companies that adopt it. The findings in this area suggest that the level of operational strategy development in industrial companies listed on the Amman Stock Exchange was moderate from the viewpoint of senior management, department heads, branches, and divisions. The researcher attributes this outcome to the fact that industrial companies in Jordan focus on developing their operational strategies. The importance of operational strategy necessitates its enhancement and attention, which in turn improves the strategic capacity of their operations, making them more distinctive. Industrial companies view their success and continuity as dependent on the strength and efficiency of their performance.

The researcher also attributes this result to the companies' awareness of the concept of operational strategy and its development through methods and activities that aid in its advancement across all managerial levels. These companies commit to using real indicators such as the annual profit rate, production rate, and waste reduction percentage, adhering to internationally recognized standards and specifications.

The researcher explains this result by highlighting the desire of the industrial companies in the study sample to progress and achieve the highest levels of production efficiency. They aim to ensure the necessary flexibility in their operations and activities, enhancing their ability to make quick adjustments to their processes in response to changes. Furthermore, the industrial companies in Jordan aim to achieve cost leadership to generate higher returns on their investments and increase their sales.

The industrial companies focusing on cost leadership achieve higher returns than others in the same industry by adopting strategies that enhance and support their market position. Similarly an operational strategy elevates companies to excellence, enhancing their operations and boosting their capacity to follow innovative approaches due to the flexibility and adaptability of their processes to changing business environment conditions.

In conclusion, adopting Lean Six Sigma methodologies is important for improving the operational efficiency of the company's operations and thus inevitably leads to customer satisfaction, which is what any senior management in any industrial company seeks to achieve. In view of this study, its results have achieved a tangible impact on the application of the Lean Six Sigma methodology in calculating operational processes in industrial companies listed on the Amman Stock Exchange. The study recommends the need to provide the necessary support to implement this methodology, which contributes significantly to improving the company's operational efficiencies, reduces the waste of resources, and works to remove unimportant activities and thus improves quality.

Declaration of competing interest

The authors declare that they have no any known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution statement

Hanan Al-Edwan contributed to the study's conceptualization, methodology design, data collection, and manuscript drafting. Mohamad Al-Edwan assisted with the conceptual framework, data analysis, and manuscript revision. Both authors approved the final version of the manuscript and are accountable for its content.

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