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Surman Journal for Science and Technology
ISSN: Online (2790-5721) - Print (2790-5713)
مجلة صرمان للعلوم والتقنية
Vol5, No.1, Mar. 2023
Pages: 056 ~ 071

Mediating Effects of Process Improvement between Lean Manufacturing and Financial Performance

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Abstract

In today's competitive business environment, companies aim to boost financial performance (FP) through effective strategies. Lean Manufacturing (LM) optimizes resources while delivering customer value. Although LM's impact on FP is recognized, the mediating role of Process Improvement (PI) remains an area of interest. This study investigates the relationships among LM, PI, and FP within Libyan manufacturing companies.

The primary objective is to explore the dynamics among Lean Manufacturing (LM), Process Improvement (PI), and Financial Performance (FP) within the context of Libyan manufacturing. By enhancing comprehension of these interrelationships, this research aims to provide insights for manufacturing entities.

An empirical survey was conducted across various Libyan manufacturing firms to achieve this goal. The survey included dimensions related to LM, PI, and FP. Collected data underwent multivariate techniques, structural equation modeling, and measurement model validation for comprehensive analysis.

Results confirm a positive correlation between LM and PI, signifying the effectiveness of incorporating lean practices for process efficiency. However, a notable finding suggests a lack of significant impact of PI on FP, challenging the notion that process improvement directly leads to better financial outcomes. Additionally, the hypothesized mediating role of PI in the LM-FP connection lacks empirical support, implying a more complex relationship.

In conclusion, this study highlights the complex interplay of LM, PI, and FP in Libyan manufacturing, emphasizing nuanced strategies for financial optimization. Further research is needed to validate and expand these context-specific insights, offering empirical guidance to organizations navigating lean practices and financial performance.

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Keywords: *Lean Manufacturing- Process Improvement- Financial Performance- Libyan Manufacturing Companies*

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الملخص:

تهدف الشركات إلى تعزيز الأداء المالي (FP) من خلال استراتيجيات عملية في بيئة الأعمال التنافسية اليوم. يعمل التصنيع الخالي من الهدر (LM) على تحسين الموارد مع تقديم القيمة للعملاء. على الرغم من الاعتراف بتأثير LM علىFP ، إلا أن دور الوساطة لتحسين العملية (PI) يظل مجالًا مثيرًا للاهتمام. تبحث هذه الدراسة في العلاقات بين LMو PI و FP داخل شركات التصنيع الليبية.

الهدف الأساسي هو استكشاف الديناميكيات بين التصنيع الخالي من الهدر(LM) ، وتحسين العمليات (PI) ، والأداء المالي (FP) في سياق التصنيع الليبي. ومن خلال تعزيز فهم هذه العلاقات المتبادلة، يهدف هذا البحث إلى تقديم رؤى للكيانات الصناعية.

تم إجراء دراسة تجريبية عبر مختلف شركات التصنيع الليبية لتحقيق هذا الهدف. تضمن المسح الأبعاد المتعلقة بـ LM و PIو .FPخضعت البيانات المجمعة لتقنيات متعددة المتغيرات، ونمذجة المعادلات الهيكلية، والتحقق من صحة نموذج القياس لإجراء تحليل شامل.

تؤكد النتائج وجود علاقة إيجابية بين LM وPI، مما يدل على فعالية دمج الممارسات الهزيلة لكفاءة العملية. ومع ذلك، تشير إحدى النتائج الملحوظة إلى عدم وجود تأثير كبير لل PIعلى FP، مما يتحدى فكرة أن تحسين العملية يؤدي بشكل مباشر إلى نتائج مالية أفضل. بالإضافة إلى ذلك، يفتقر دور الوساطة المفترض لـ PI في اتصال LM-FP إلى الدعم التجريبي، مما يعني وجود علاقة أكثر تعقيدًا .

في الختام، تسلط هذه الدراسة الضوء على التفاعل المعقد بين LM وPI وFP في التصنيع الليبي، مع التركيز على الاستراتيجيات الدقيقة لتحسين الأداء المالي. هناك حاجة إلى مزيد من البحث للتحقق من صحة هذه الرؤى الخاصة بالسياق وتوسيع نطاقها، وتقديم إرشادات تجريبية للمؤسسات التي تتنقل في الممارسات الخالية من الهدر والأداء المالي.

الكلمات المفتاحية: التصنيع الخالي من الهدر- تحسين العملية - الأداء المالي- شركات التصنيع الليبية

1. Introduction

In today's competitive business landscape, companies strive to enter the market and enhance their financial performance (FP). This holds true for both service and manufacturing industries, where the ability to effectively introduce and adapt to changes plays a crucial role in gaining a competitive advantage. Continuous improvement of products and services is essential for companies to remain competitive, as highlighted by [1]. Lean manufacturing (LM), as defined by Womack and colleagues, refers to a system that achieves the same outputs as traditional mass production while utilizing fewer resources, ultimately leading to increased customer value [2]. Other terms such as just-in-time manufacturing, synchronous manufacturing, world-class manufacturing, and continuous flow are often used interchangeably with LM. The underlying principle of LM is to continuously improve processes, reduce costs, and maximize profits [3];[4]. However, most studies on LM have focused on developed countries, neglecting its implementation in developing nations. [5] Found that the relationship between lean manufacturing and performance is contingent on the national context. Therefore, this study aims to provide a comprehensive understanding of lean manufacturing by examining its relationship with financial performance in the context of Libyan manufacturing companies.

This study considers various dimensions to investigate the relationships between lean manufacturing, process improvement, and financial performance. The term "process improvement" encompasses practices such as problem-solving, genchi genbutsu (go and

see), and other relevant factors. These dimensions are crucial for enhancing operational efficiency and ultimately influencing financial performance [6, 7] Achieving process improvement involves eliminating errors, optimizing asset utilization, minimizing waiting time, ensuring user-friendliness, meeting customer preferences, gaining competitive advantages, and reducing costs. Numerous success stories have emerged from companies implementing process improvement strategies [8-10], although challenges and obstacles may arise during the implementation phase [11]. By focusing on continuous improvement activities, such as, long-term goal setting, and problem-solving, companies can embrace the essence of process improvement [12] ;[13].

In this study, the aim is to examine the impact of process improvement on lean manufacturing and financial performance, while also investigating the dominance of specific process improvement dimensions in relation to lean manufacturing outcomes. Unlike previous studies, our research treats process improvement as a comprehensive construct and explore its mediating role between lean manufacturing and financial performance. The study collected data from various manufacturing companies in Libya, including iron and steel, aluminum, metals, engineering, cement, and chemical industries.

By examining the relationships between lean manufacturing, process improvement, and financial performance, this study contributes to a better understanding of how these factors interrelate within the Libyan manufacturing context. The findings will shed light on the mediating role of process improvement and provide valuable insights for companies seeking to enhance their operational efficiency and overall financial performance.

2. Theoretical background and model development

Numerous studies have explored the relationship between lean manufacturing (LM) and financial performance (FP) [14];[15];[16]. However, this study distinguishes itself by employing different measurement approaches and examining the influence of various factors on FP. It aims to fill the gaps in the existing literature by testing these relationships using different methods.

Several preceding studies carried out within the Malaysian setting have predominantly assessed lean production (LEAN) by focusing on two key dimensions: Just-In-Time (JIT) and technology and innovation [17]. The findings underscore a robust and statistically significant positive correlation between elevated JIT levels, technology, innovation, and financial metrics such as return on sales (ROS) and return on investment (ROI). This suggests a compelling argument that enterprises with well-established JIT and technology and innovation capabilities are inclined to attain superior financial performance.

Büyüközkan, Kayakutlu [18] explored the combined financial and non-financial outcomes resulting from implementing diverse sets of lean techniques in the realm of family planning. Employing a Bayesian Belief Network, the study analyzes the influence of various factors on performance indicators across changing conditions. The findings emphasize significant enhancements in overall performance, contributing to heightened productivity, flexibility,

operational seamlessness, and service excellence. The study's conclusions accentuate the alignment between the implementation of lean principles and improvements in capacity utilization, reduction of idle time, and optimized resource allocation. Departing from earlier research primarily focused on waste reduction and tool identification through value stream mapping, this study adopts a comprehensive perspective, investigating the intricate interplay between lean manufacturing, financial performance (FP), and process improvement (PI) as a mediating catalyst.

With a dearth of extensive research concerning the implementation of lean manufacturing, [19] embarked on enhancing the existing understanding in this realm. He underscored the significance of an all-encompassing embrace of agile practices to attain peak performance, accentuating their intrinsic interconnection. Within this context, the study accentuates the concurrent assimilation of all Lean manufacturing practices, harmoniously aligning with the tenets of integration theory.

Moori [20] investigated the relationship between lean manufacturing management, competitive skills, and financial performance among Brazilian companies. The results, considering competitive skills as a mediating variable, revealed a positive relationship between lean manufacturing and financial performance. However, the study also highlighted managers' lack of awareness regarding the importance of competitive skills for enhancing financial performance. The theoretical model for this study is shown in Figure 1 that the variable of process improvement (PI) is a mediating factor in the relationship between lean manufacturing and financial performance in Libyan manufacturing companies, which has not been previously explored. Previous literature examining this relationship has yielded mixed results when looking at the direct relationship between lean manufacturing and financial performance. However, these studies did not investigate the indirect effect by introducing the mediating variable, namely process improvement. The theoretical model for this study is depicted in Figure 1.

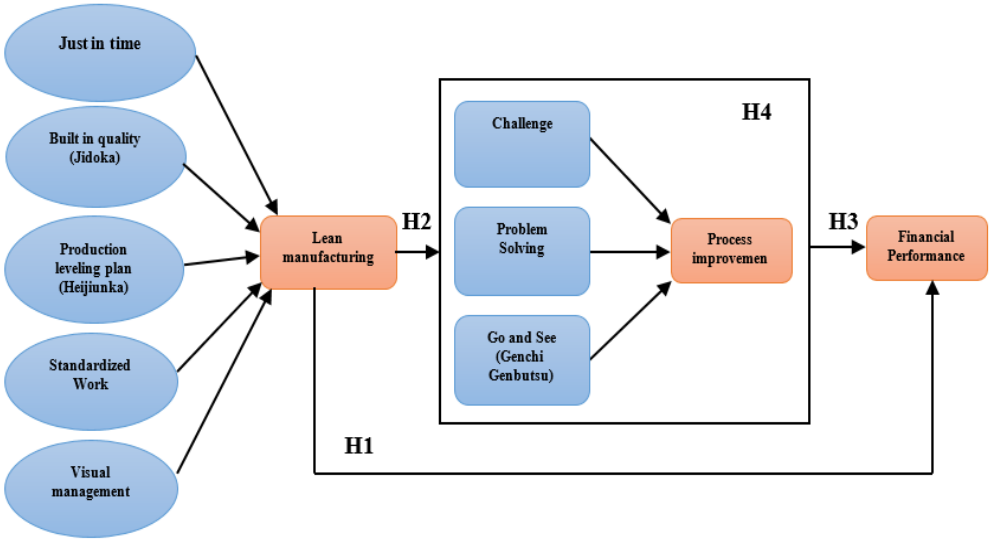

Figure 1. Proposed research framework

Accordingly, the following hypotheses are proposed.

The finding of this study goes in line with the many previous studies of Hussain, Stewart [21], Zokaei and Simons [22], Bateman [23], Mahmood and Shevtshenko [24], Nahmens and Ikuma [25] they found that the PI is vital in order to implement LM. In contrast, other studies show that Lean practices and the use of Lean tools does not directly impact process improvement or customer effectiveness performance [26]. Accordingly, the author proposes that:

H1: Lean Manufacturing (LM) has significant impact on Process Improvement (PI)

Many firms found that even dramatic levels of PI often do not translate into better FP; in addition, many companies have consequently found it hard to sustain the effects of process improvement over time [23, 27, 28]. Other studies are indicated that top management does not drive changes and support PI, and do not believe in PI. Comprises that expanding the standpoint of PI; manufacturing companies will be able to find the best ways to improve their FP. In other words, the respondent mangers are not aware of the benefits of adopting PI, which lead to a successes and enhance FP. Beyhan Yasar, Sezen [29] investigated the relationships between innovation, continuous improvement, and financial performance. Most importantly, they searched for the existence of a mediating effect of continuous improvement on relationship between innovation and financial performance. Accordingly, the author proposes that:

H2 Process Improvement (PI) has significant impact on financial Performance (FP)

LM was recognized as a powerful strategy for FP improvement [30]. According to [31] there are relationships between LM and environmental performance and FP mediated by environmental management practices.

Process Improvement (PI) is a fundamental concept in organizational management aimed at enhancing efficiency, reducing waste, and optimizing various aspects of operations. Its impact on Financial Performance (FP) can be crucial for achieving sustainable growth and competitiveness. Various studies have explored the connection between PI and FP, shedding light on their interdependence.

Kumar, Kumar [32] emphasized the significance of Lean Manufacturing (LM) in driving improvements in Financial Performance. They highlighted how the implementation of Lean principles, such as waste reduction and continuous improvement, can lead to cost savings and increased profitability. This aligns with the notion that a streamlined and efficient production process directly contributes to better financial outcomes.

Moreover, [31] extended the understanding of the relationship between LM, Environmental Performance, and FP by introducing the mediating role of environmental management practices. They demonstrated that the adoption of Lean practices not only affects operational and environmental aspects but also indirectly influences Financial Performance through effective environmental management. This highlights the multifaceted nature of LM's impact

on organizational outcomes, including financial aspects. Accordingly, the author proposes that:

H3 Lean Manufacturing (LM) has a significant influence on financial Performance (FP)

As mentioned above, there are numerous studies that examined process improvement and relationships between lean dimensions separately. This study takes a unique approach by collectively analyzing the concepts of Problem-solving, Go and See (Genchi Genbutsu), and Challenge under the umbrella term of "process improvement.". Specifically, our research seeks to uncover whether process improvement acts as a mediating factor in the connection between different lean dimensions (including just-in-time, built-in quality, production leveling plan, standardized work, and visual management) and a company's financial performance.

H4 Process Improvement mediate the effect of lean manufacturing on financial performance

3. Methodology

In order to gather data, an empirical survey was conducted in Libya, and a questionnaire was developed using insights from relevant studies. The primary sources of the scales used in the questionnaire can be found in Table 1.

Table 1. Research model items references.

Variable name	References
Just in Time	[33] [34] [14]
Built in Quality(Jidoka)	[33, 35]
Production Levelling Plan (Heijunka)	[33, 35]
Standardized Work	[33, 35]
Visual Management	[33, 36] [37]
Challenge	[12]
Go and See (Genchi Genbutsu	[34]
Problem Solving	[34] [35]

3.1 Model validation and analysis

This study employed SPSS Version 20 for descriptive analysis, including the examination of respondents' background information and descriptive statistics of latent constructs. Additionally, a two-stage multivariate data analysis was conducted to explore relationships between variables. Smart PLS 3 was utilized for both the measurement model and structural

model estimation. Following a two-stage process [38], the study assessed the outer model (measurement model) in the initial stage to evaluate construct validity and reliability. Subsequently, the inner model (structural model) was examined to discern interactions between exogenous and endogenous latent variables.

3.2 Response Rate

In the stage of data collection, 322 questionnaires were got returned from 500 questionnaires yielding 64.4 percent response rate within one and half month to three months' time period. Data were allocated among the respondents based on drop off/pick up method (DOPU). After one week one month and half of dropping off, the respondents were softly reminded to fill in the questionnaire. In this situation, 322 questionnaires were returned to the period of one and half three months. Among these 500 questionnaires, 308 were found suitable and rest 14 questionnaires were found unusable.

3.3 Descriptive Statistics

The study collected data from a sample of 308 respondents representing various departments in the manufacturing companies, including production, quality assurance, operations management, control management, and maintenance. The respondents' titles ranged from general managers to department managers and quality engineers.

Table 2 provides the profile of the respondents. The analysis of the demographic profile designates the majority of the respondents were quality manager, 26.3 % (81) as compared to general manager 4.9 % (15) the lowest number of respondents. Furthermore, in terms of the experience the majority was found having 6 to 10 years of experiences 40.6 % (125) whereas, only 11.7 % respondents were found having less than 5 years of experience. Again for the types of the organization, the highest number of respondents came from the cement and building material organization 38.6 % (119). Last, more than one-third of the respondent's organizations had employee's ranging from 1001 to 3000. Only 10.4 % (32) respondents have found worked in that organization where the numbers of employees are more than 3000.

Table 2 Background Information of the Respondents

Demographic Profile	Number of Respondents (N= 308)	Valid Percentage (%)
Current position of the Respondents		
General Manager	15	4.9
Control Manager	61	19.8
Quality manager	81	26.3
Operational manager	58	18.8
Production manager	59	19.2
Maintenance Manager	34	11.0
Experience of the Respondents		
Less than 5 year	36	11.7
From 6 to 10 years	125	40.6

From 11 to 20 years	108	35.1
More than 20 years	39	12.7
Types of Organization		
steel and Iron	42	13.6
automobile	25	8.1
Cement & Building Materials	56	18.2
Metal Parts	38	12.3
Plastic Parts	43	14.0
Chemical	35	11.4
Food and drink	33	10.7
Electrical and electronic devices	36	11.7
Number of Employees		
Less than 500	34	11.0
From 501 to 1000	123	39.9
from 1001 to 3000	119	38.6
More than 3000	32	10.4

3.4 Descriptive statistics of the Latent Constructs

The mean and standard deviation of the study variables are shown in Table 3. In the present study, a 7-point Likert scale was used to indicate the level of responses of all dimensions. In this study, mean value of all the variables was found to be higher than the midpoint 3.50. In this study, financial performance was found to have the highest scored with a mean value of 4.446. Further, the dispersion value testified through standard deviation specifies that the dispersion values were lower than 2 among all the dimensions of the current study. In this study, Standardize Work had a lower standard deviation with the value of 1.069. As showed in the next table.

Table 3 Descriptive statistics of the Latent Constructs

Dimensions	**N**	**Mean**	**Std. Deviation**
Just in Time	308.	4.090	1.427
Built in Quality	308.	3.610	1.303
Production Leveling	308.	4.014	1.235
Standardize Work	308.	3.903	1.069
Visual Management	308.	3.889	1.170
Challenge	308.	3.951	1.283
Go and See	308.	4.020	1.292
Problem Solving	308.	4.696	1.634
Financial Performance	308.	4.446	1.793
Valid N (listwise)	308		

3.5 Measurement Model Assessment

The measurement model assessment focused on evaluating the reliability and validity of the constructs. Reliability was assessed using Cronbach's alpha, composite reliability (CR), and factor loadings. All constructs exhibited acceptable levels of internal consistency, with Cronbach's alpha values above the recommended threshold of 0.70 and CR values exceeding 0.80 [39]. Furthermore, all factor loadings were significant and above the threshold of 0.50, indicating satisfactory convergent validity.

Table 4 composite reliability (C.R) Average Variance Extracted (AVE) and Cronbach's Alpha

The component	Cronbach's Alpha	composite reliability	Average Variance Extracted
Lean manufacturing	0.961	0.965	0.563
Process improvement	0.958	0.962	0.572
Financial performance	0.987	0.989	0.949

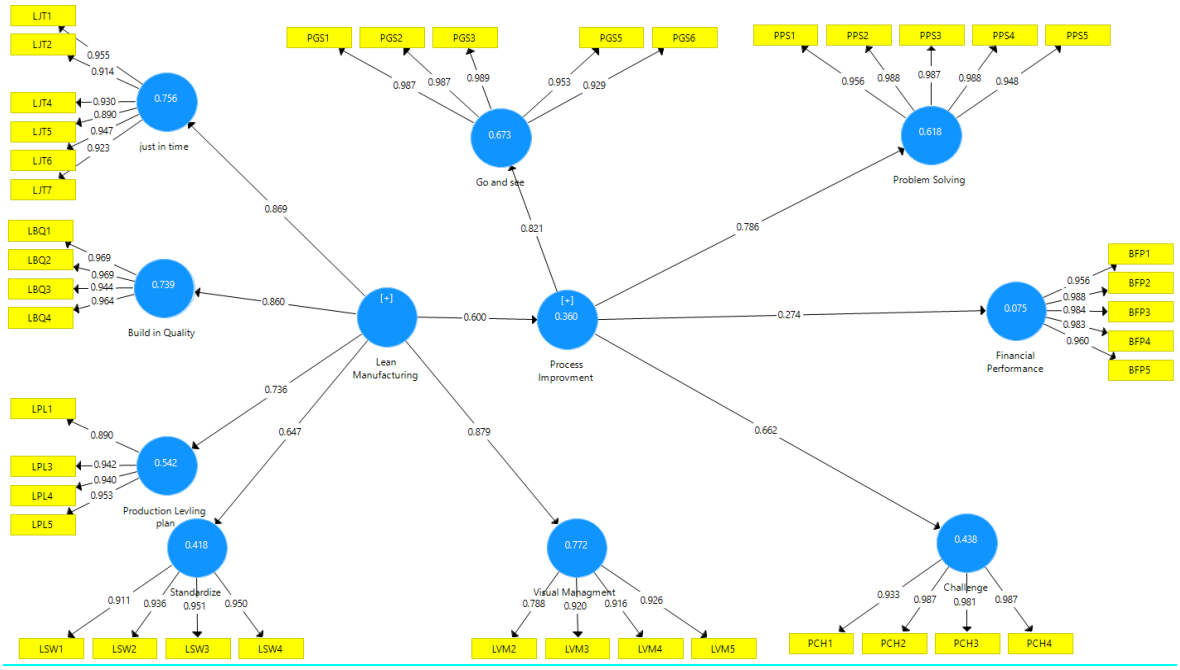

Figure 2: measurement model

3.6 Discriminant validity

Discriminant validity was assessed by examining the square root of the Average Variance Extracted (AVE) and comparing it with the correlation values between constructs. The results showed that the AVE values for each construct were higher than the squared correlations with other constructs, indicating adequate discriminant validity.

Table 5 Fornell-Larcker criterion analysis to check discriminant validity

	Financial Performance	Lean Manufacturing	Process Improvement
Financial Performance	0.974		
Lean Manufacturing	0.366	0.750	
Process Improvement	0.274	0.600	0.757

3.7 Structural Model Assessment

The structural model assessment aimed to examine the relationships between the constructs and test the proposed hypotheses. The results of the PLS-SEM analysis are presented in Figure 3, and table 6, which illustrates the path coefficients and their significance.

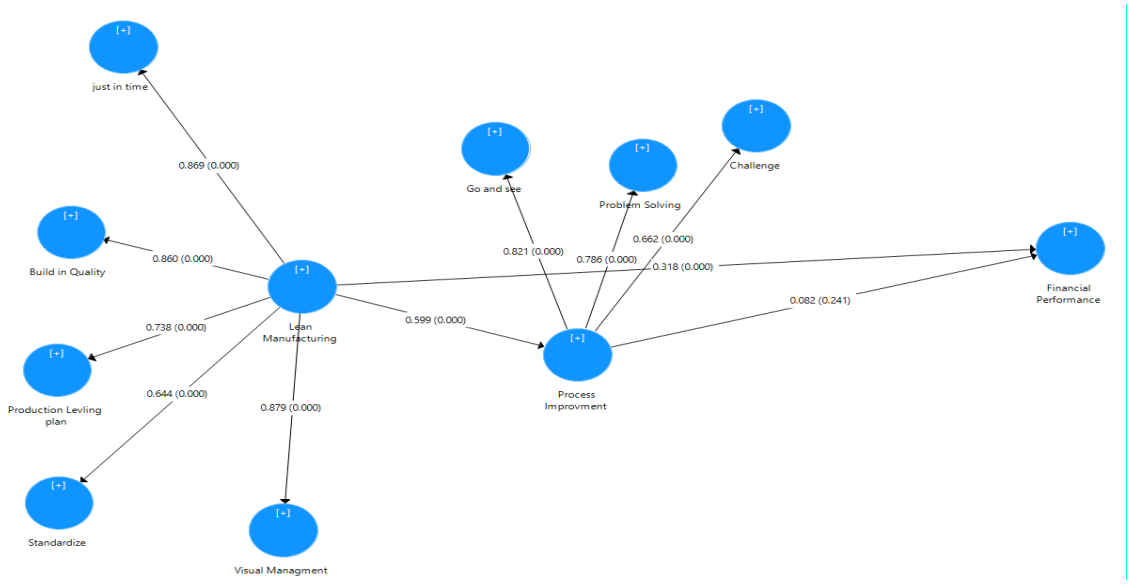

Figure 3: Structure model

Table 6: Summary of Path Coefficients

Hypotheses	Relationship	Std. beta	Std. error	t-value	P-value	Decision
H1	LM > FP	0.318	0.058	5.485	0.000	Supported
H2	LM > PI	0.599	0.038	15.765	0.000	Supported
H3	PI > FP	0.082	0.070	1.175	0.241	Not supported
H4	LM > PI > FP	0.049	0.042	1.161	0.246	Not supported

**Significant at p<0.01, *Significant at p<0.05, Bootstrapping (n = 500)

Hypothesis 1 proposed a significant influence of Lean Manufacturing (LM) on financial Performance (FP). The analysis demonstrated significant relationship between LM and FP, supporting Hypothesis 1 ($\beta = 0.318$, $p < 0.000$).

Hypothesis 2 proposed a significant impact of Lean Manufacturing (LM) on Process Improvement (PI). The analysis confirmed a positive and significant relationship between LM and PI, supporting Hypothesis 2 ($\beta = 0.599$, $p < 0.000$).

Hypothesis 3 suggested an insignificant impact of Process Improvement (PI) on financial Performance (FP). The results revealed that there is insignificant relationship between PI and FP, providing rejection for Hypothesis 3 ($\beta = 0.82$, $p > 0.0.05$).

Hypothesis 4 stated that Process Improvement mediates the effect of Lean Manufacturing on financial Performance. The results revealed that the indirect effect of LM on FP through PI was insignificant, providing the mediating role of PI in the relationship between LM and FP not supported.

3.8 Analysis of Predictive Relevance (Q^2)

To estimate the magnitude of the R^2 values as a standard of predictive accuracy, the Stone-Geisser's Q^2 value [40, 41] is assessed. In examining the predictive relevance, blindfolding measures were carried out employing omission distance as mentioned by Chin (1998b), who recommends that, the omission distance value between 5 and 10 are considerable. In this study, the omission distance G=7 is deliberated. Q^2 value is greater than zero specifies that the dependent variable have predictive relevance for the independent variable [42]. Based on the analysis presented in Table 7, the model is considered to have predictive relevance and consider acceptable.

Table 7: Result of Predictive Relevance (Q^2) and R-squared (R^2)

Predictor	Endogenous	Beta	Q^2 (CV Red)	R^2	Level
LM	Process Improvement	0.599	0.203	0.360	High
LM	Business Performance	0.318	0.127	0.075	Moderate
PI		**0.082**			

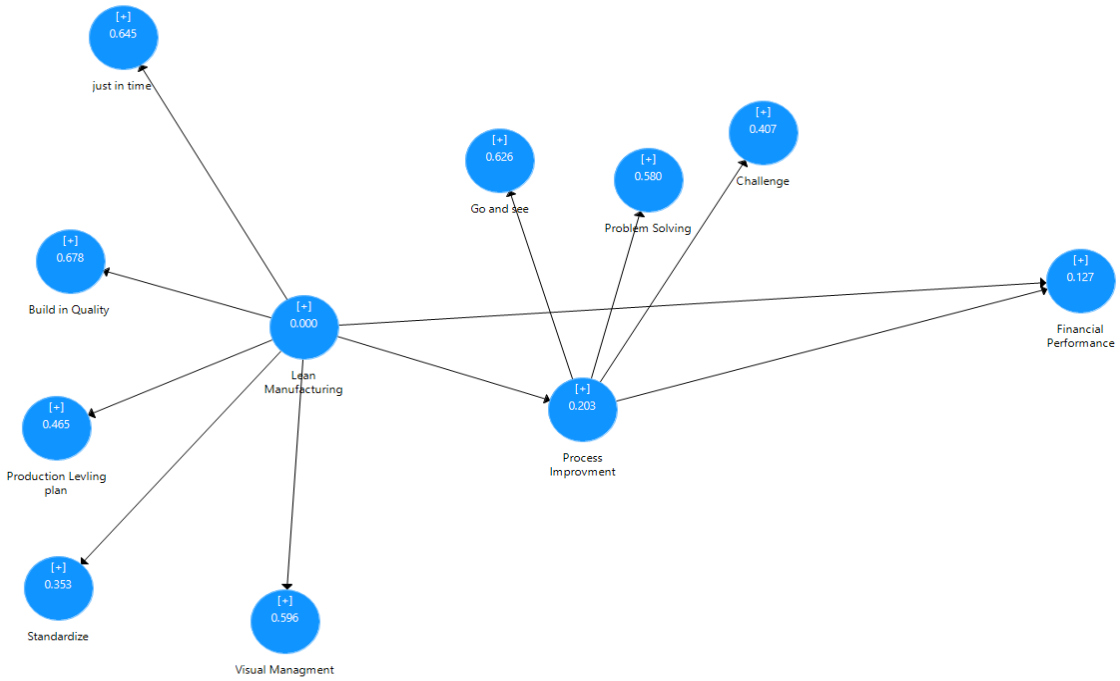

Figure 5: Predictive Relevance (Q2)

4. Discussion and conclusion

The findings of this study shed light on the intricate interplay between Lean Manufacturing (LM), Process Improvement (PI), and Financial Performance (FP) within the context of Libyan manufacturing companies. The empirical evidence presented herein substantiates the hypothesized relationships and contributes significantly to the existing body of knowledge concerning LM's impact on FP. The positive and substantial correlation between LM and PI underscores the potency of incorporating lean practices, such as just-in-time, built-in quality, production leveling plan, standardized work, and visual management, in fostering tangible process enhancements within manufacturing entities [43-45] .

However, the investigation reveals an intriguing outcome: a lack of significant influence of PI on FP. Contrary to certain antecedent studies [46-48], our findings challenge the notion that an emphasis on process improvement initiatives inherently translates to superior financial performance. While the hypothesis aligns with some previous research, such as that of [49] it contradicts others that advocate the positive correlation between lean principles implementation and sustainable enhancements in FP.

Furthermore, the study does not corroborate the hypothesized mediating role of PI in the connection between LM and FP. This implies that process improvement may not serve as an intermediary conduit through which the benefits of lean practices are transferred to improved financial outcomes. These findings deviate from certain studies that posit that effective incorporation of lean principles, coupled with process refinement efforts, results in heightened FP [50].

In summation, this study provides a nuanced understanding of the intricate relationships encompassing LM, PI, and FP. It underscores the pivotal significance of embracing lean principles and practices within manufacturing enterprises to catalyze process amelioration, which subsequently contributes to amplified financial performance. The results underscore the symbiotic nature of LM and PI in fostering enduring and comprehensive operational enhancements.

Nevertheless, the study is not devoid of limitations. The findings are contingent on data sourced exclusively from Libyan manufacturing companies, thus potentially confining their generalizability to broader industry contexts. Future research endeavors could extend the purview to diverse organizational settings, industry sectors, or geographical locations to corroborate, enrich, and broaden the applicability of the findings.

In summation, the empirical insights garnered from this study hold invaluable implications for manufacturing entities aspiring to augment their operational performance. By unravelling the intricate dynamics between LM, PI, and FP, organizations can make informed strategic decisions that drive sustainable and competitive advantages in the ever-evolving business landscape.

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