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Structural Equation Modeling of Relationships Among Lean Operational, Financial Performance, and Customer Satisfaction

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Abstract

Objectives: The challenges of implementing a lean business system can be solved by Structural Equation Modeling. In this research, the link between lean operational, financial performance, and customer satisfaction has been investigated in the Akaki Basic Metal Industry in Ethiopia. **Methods:** A lean operational performance that met the needs of the industry was identified by conducting a structural survey questionnaire to collect feedback data from experts. The model was developed including 28 variables from the experts in the industry. The collected responses were tested for reliability and validity using Cronbach's alpha, composite reliability, convergent, and discriminant validity. **Findings:** From the use of Analysis of Moments and Structures (AMOS-SEM), the results confirmed that C.R. > 1.96, $p < 0.001$, and $p < 0.05$ on quality and delivery. This shows a significant positive direct effect on customer satisfaction by 25.8% on quality, 24.9% on delivery, and 10.3% on cost. **Novelty:** Even though LM has become a fundamental aspect of industrial manufacturing processes, lack of understanding (knowledge) and practicing how to implement the positive impact on lean operational, financial performance, and customer satisfaction are still not sufficiently exploited particularly in developing countries. This research adds values to the practical use of the concept by examining the relationship among lean operational, financial performance, and customer satisfaction within basic metal manufacturing industry in Ethiopia. In addition to this, the findings have demonstrated improved organizational performance through structural equation modeling. It also helps leaders to focus more on training employees on quality issues and developing an awareness of quality achievement as a core value in the industry.

Keywords: Confirmatory factor analysis; Exploratory factor analysis; Lean operational performance; Structural equation modeling; Customer satisfaction

1 Introduction

Currently, with the globalized world and highly competitive markets, companies face a multitude of complex factors affecting their activities [1]. To operate under such conditions, they have to be continuously creative, innovative, and efficient [2]. Global events and unexpected crises worldwide urge companies to analyze their processes and operations and look for ways to improve their efficiency and effectiveness. The Lean philosophy, which has evolved from the Toyota production system (TPS), is one of the wide-ranging ways to promote efficiency while emphasizing a high level of awareness about the customer [3]. It provides a suitable framework to address the high degree of complexity in the company environment while focusing on customer value. Through the systematic interaction of principles and methods, the Lean concept aims to increase the economic efficiency of production by consistently and thoroughly eliminating different types of wastes [1].

For several decades, researchers and practitioners all over the world have been investigating the Lean operational performance concept. The research works and examples of good practice worldwide show, that Lean is not limited to a specific type or size of business. It is acceptable for various business types, sizes, and industries that strive to improve their operations, increase competitive advantage, and enhance profits [4]. Manufacturing industries in Ethiopia are typically basic metal industries, which play a crucial role in job creation, gross domestic product (GDP) contribution, and driving innovation. Ethiopia's metal industries have low export performance of 8% and a GDP contribution of 0.40%. Despite this, the industry´s contributions to GDP such as productivity, financial performance, and global competitiveness caused cost-related issues to corporate sustainability were low and inexperience. Ethiopia's steel and iron sectors were also in their infancy with a low market share of GDP contributions. This is because most local industries have low technological capabilities, inadequate resource utilization, limited, ineffective continuous improvement programs, product quality and related issues [5].

However, the extent of Lean operational measure practice in Ethiopia has yet to be examined. Despite using technology, there is still lack of knowledge on the use of Lean Manufacturing (LM) which has encouraged the initiation of this research. From a long-term global viewpoint, a successful strategy is the best and the way to increase LM. Many of the previous studies discussed that lean operational performance indicators apply to all types of businesses. However, there is lack of understanding the connection among lean operational performance indicators such as quality, cost, delivery, productivity, flexibility, financial, and customer satisfaction among experts in the industry. Therefore, further study is needed to answer how the industry analyzes lean operational performance measures (quality, cost delivery, productivity, flexibility, financial and customer satisfaction), as well as to find the reason why the industry failed to implement these factors. To address these questions, the case study method was selected in this study.

Based on the findings of the previous studies, this study constructed a research model that developed seven lean operational performances including 28 measurable variables such as quality, delivery, cost, productivity, flexibility, financial, and customer satisfaction concerns. Therefore, the proposed research model was empirically investigated, and the structural equation modeling relationship among lean operational, financial performance, and customer satisfaction was analyzed. The physical observations indicated that proper identification of the main lean operational performance is essential to increase the chance of success in LM adoption for the Akaki Basic Metal Industry (ABMI). However, this research was not previously studied in the ABMI and was distinctive.

The main research problem addressed in this study is to determine the extent to which the implementation of lean operational performance indicators, particularly in the areas of quality, productivity, cost, delivery, flexibility, and financial and customer satisfaction impacts the organizational performance of the manufacturing industry. Therefore, this research aims to bridge the gap in the literature by providing a quantitative analysis of the structural equation modeling relationship among lean operational, financial performance, and customer satisfaction. Finally, it is important to monitor and evaluate the results of the lean operational performance regularly such as cost, delivery, flexibility, finances, productivity, quality, and customer satisfaction. By examining these factors, this study aims to ensure that the organization is achieving its goals and objectives in the specific context of the manufacturing sector in Ethiopia's basic metal industry.

Considering the above-mentioned research objectives, this work will be a new contribution for the industry to enhance its productivity, profitability, and growth. Furthermore, the findings from this study will contribute to the existing knowledge and understanding of this relationship and provide valuable insights for practitioners to prioritize predominant lean operational performance measures. Moreover, management and policymakers can work on a suitable improvement strategy to move forward and become more sustainable in organizational performance.

1.1 Theoretical Research Model

1.1.1 Lean operational performance

Lean operational performance is an approach to streamlining productivity processes by eliminating waste. It is a concept that focuses on continual development to foster an organizational culture of excellence. By implementing this, companies can reduce costs, enhance productivity, and improve consumer satisfaction by accepting lean principles reported in [6]. Lean implementation provided several benefits, including the reduction of various types of resources, reduced delivery time, increased productivity, reduced cost, improved quality, faster problem-solving and decision-making processes, and higher levels of customer satisfaction.

The LM concept is recognized by many as an organizational philosophy that attempts to methodically reduce waste and create value for customers. It develops as a method for improving quality, meeting customer expectations, reducing waste in all forms, increasing employee satisfaction, and shortening delivery times [7]. Many research studies have been conducted to study the aspects that contribute to the effective application of LM methods in enterprises from various global contexts. The current study aims to comprehensively explain the link between the seven components. Three questions are essential for this research:

1. What are the key lean operational performance indicators?
2. Do lean operational performance indicators have any links to industry customer satisfaction?
3. Do these lean operational performance metrics have any effect on financial performance?

To get insight into these questions and achieve the study objectives, a structural equation model approach was employed to analyze the relationships among lean operational, financial performance, and customer satisfaction. This approach offers direction to practice the organization's lean operational performance and its advantage. Finally, relevant improvement suggestions were proposed and can be used as a reference by related industry, senior management, as well as other relevant departments and employees.

The following are the key perspectives or dimensions of overall lean operational performance that are found in the literature.

Cost: Lean operational performance is linked to cost reduction due to the elimination of unnecessary expenses and optimization of processes. By implementing lean principles such as continuous improvement, waste reduction, and value stream mapping, the industry can simplify its operations, reduce lead times, improve quality, and ultimately reduce costs [8]. The industry can ensure that they can make the most use of resources and attain the best results possible. Cost reduction is an essential aspect of any successful business, as it helps to increase profits and improve competitiveness.

Quality: implementation of quality in industries through tools such as regular audits, statistical process control, and continuous training which minimizes defects suggested [9]. Total Productive Maintenance (TPM), and Kaizen are technologies used to improve the industry's quality, productivity, and profitability. Organizations can achieve sustainable growth through productivity improvement techniques while maintaining high-quality standards and meeting customer needs by taking a proactive approach to these initiatives as reported in [9].

Flexibility: Long-term success requires adaptable procedures and systems that can respond to changing market conditions for client expectations. This involves the capacity to change plans and modify operations quickly in response to new opportunities or difficulties. Organizations can remain active and responsive by adopting flexibility which ensures the changing demands of customers [10].

1.1.2 Customer Satisfaction

Implementation of customer feedback mechanisms is a crucial aspect of ensuring customer satisfaction. The industry can enhance products and services to better satisfy the demands of its customers by actively asking for and responding to customer feedback [7] [10]. Collecting and analyzing customer input to find areas for development as well as creating a culture of customer service excellence throughout the company are important areas. Hence, lean operational performance improvement in industries is critical that build strong relationships and increase loyalty to achieve long-term success in any industry [10].

1.1.3 Financial Performance Impact

Financial performance impact on lean operational performance in the manufacturing industry has a great role in improving operational efficiency through the application of lean principles. Therefore, lean operational performance can lead to better financial performance in manufacturing, such as increased profitability, reduced costs, and improved customer satisfaction [10]. However, there is growing recognition that financial performance can also have a major impact on overall operational performance. In this context, it is important to understand the connection between lean operational and financial performance in manufacturing and how companies can optimize both to achieve sustainable growth and profitability. Financial performance can also be impacted by operational inefficiencies, such as waste, defects, and delays [11].

Based on the conducted review of the literature, the practice of lean operational performance concept is a gap in the ABMI industry in Ethiopia. In addition to this, there is no guidance for employees regarding lean operational performance measures to evaluate organizational performance in a holistic approach such as cost, quality, delivery, productivity, flexibility, financial performance, and customer satisfaction. Therefore, this research work is aimed to address the problem by modeling structural equation analysis.

1.2 Research Model and Hypotheses

Based on the conducted survey in the research model developed as shown in Figure 1, it has been observed that cost (C), quality (Q), delivery (D), flexibility (F), productivity (P), financial performance impact (FPI), and customer satisfaction impact (CSI) were investigated. This conceptual model used empirical data and the constructs were assessed with Covariance Structural Equation Modeling (CB-SEM) and confirmed with Analysis of Moments and Structures Structural Equation Modeling (AMOS-SEM) graphics using SPSS Version 23. The following hypotheses were proposed:

- Hypothesis 1. Cost is positively related to customer satisfaction.
- Hypothesis 2. Quality is positively related to customer satisfaction.
- Hypothesis 3. Delivery is positively related to customer satisfaction.
- Hypothesis 4. Productivity is positively related to financial performance.
- Hypothesis 5. Flexibility is related to financial performance.
- Hypothesis 6. Customer satisfaction is related to financial performance.

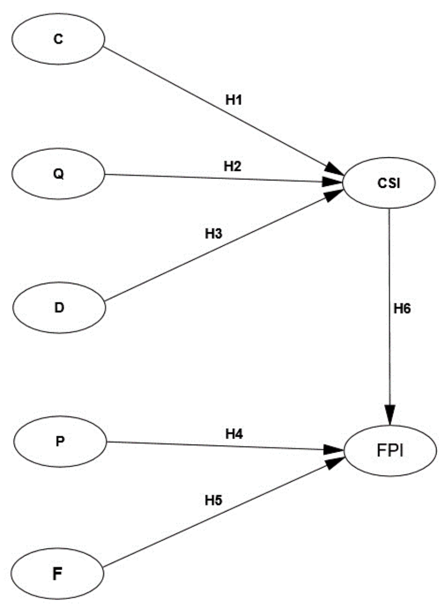

Fig 1. Hypothesis and research model

2 Methodology

The lean operational, financial performance, and customer satisfaction are used to improve the organizational performance of ABMI. The survey design was used for this study as a methodology and a data-gathering tool to generate and validate the data as described.

2.1 Sample and Data Collection

The data for this study was obtained from the Akaki Basic Metal Industry (ABMI) in Ethiopia collected from 20/10/22 to 15/8/2023. The survey was designed for Structural Equation Modeling of Relationships among Lean Operational, Financial Performance, and Customer Satisfaction. The questionnaires were distributed to the participants and field visits, and interviews were conducted physically for the survey. To enhance the reliability of the survey, the questionnaires were primarily completed by the engineers, technical experts, production heads, and quality department managers. These individuals have the most critical information on knowledge management, quality, productivity, customer satisfaction, and production processes in the industry.

2.2 Variables and Measures

In this study, which was employed a 5-point Likert scale to quantify the research variables, a methodological choice to capture the degree of respondents' attitudes or emotional responses towards specific issues. The measurement system where a score of 1 signifies "strongly disagree", while a score of 5 represents "strongly agree". This scaling approach effectively transforms attitudinal concepts into quantifiable metrics. These tangible numerical values then enable sophisticated analyses through methods such as the AMOS SEM method. This ensures a robust and interpretable dataset that lends to comprehensive analysis, thereby adding empirical rigor to the study.

2.3 Instrument Design

The study was designed to identify the constructs at the initial instrument design phase of the investigation. As a result, a literature review was conducted utilizing the databases Elsevier, Emerald, IEEE, Springer, Wiley, and Google Scholar. A pilot test was carried out to get feedback on the questionnaire from industry experts and academicians to confirm the questionnaire's reliability and construct validity.

2.4 Variable operationalization

The seven lean operational performance measures represent the latent variables studied through the survey. To achieve this, it was necessary to work from the conceptual definitions and list of indicators for each construct as shown in Appendix A. An item that permitted the indicator to be measured had to be given. This was the first process of operationalization of the latent variable. Following that, a list of indicators for each construct was provided, along with an item that allowed the indicator to be assessed.

Cost (C) is the first parameter for operationalizing the latent variable. It was defined by indicators, where each indicator is labeled as C1operating at low unit product high per unit cost producing a single unit of particles. It is also the amount of money spent by the company during a period for producing a single unit of the particular product by item C2, operating at low unit costs associated with operating cost by item C3, and reducing inventories (improved demand for casting) by item C4.

Quality (Q) is the second parameter for operationalizing the latent variable. It is defined by five indicators. Each indicator is labeled as meeting customer specification which is measured through item Q1 and confirms design specification by item Q2. In addition, this contributes to good product service design and performance by item Q3 and improved lifecycle of product. Customer specification is also when a product is introduced to the consumer market until it declines or is no longer being sold by item Q4.

Delivery (D) is the third process for operationalizing the latent variable. It was defined by four indicators. Each indicator is labeled as meeting delivery promises which is measured through item D1. In the same way, offering a short delivery lead time by item D2 where the supervisor's effectiveness in solving problems to meet supplier delivery schedule by items D3 and D4 indicates reduced work in process.

The fourth process of operationalization of the latent variable is Flexibility (F). It is defined by four indicators. Each indicator is labeled as suppliers and employee flexibility in responding to volume changes which is measured by item F1. A high response to new product service changeovers was created by item F2. While offering a wide range of product services by items F3 and F4 that measure a high response to change market needs.

Productivity (P) is the fifth procedure for operationalizing the latent variable. It is defined by four indicators such as a percentage change in output when decreased indicates a through item P1. When a percentage change in labor productivity decreased created by item P2, the percentage in material productivity also decreased by items P3 and P4 causing a percentage change in rejection to be decreased.

The sixth process of operationalization of the latent variable is financial performance impact (FPI) which is defined by four indicators. Each indicator is labeled as a capital investment; the company is quite effective in measuring item FPI1. Over the last three years the company has experienced customer growth by item FPI2, the sales volume of our product offers has increased by item FPI3 and FPI4 which means the company had remarkable customer growth.

The seventh procedure of operationalization of the latent variable is Customer satisfaction impact (CSI) which is defined by four indicators. Each indicator was labeled as increased customer satisfaction as measured by item CSI1. When customer satisfaction was reduced as complaints item CSI2, the number of repeat customers increased by item CSI3 and CSI4 measured the consistent and short delivery lead time.

2.5 Content validation

The instrument was developed based on a literature survey and validated before its final administration. It is crucial to refine the measures before doing confirmatory tests. Even if statistical construct validity and reliability were sufficient, the study's results were flawed if the content of a construct or questionnaire was incorrect and improper. The instrument was pre-tested and reviewed by industry experts, related academics, and lean manufacturing consultants to ensure the content's validity, readability, and brevity.

The study examined the aspects of measurement scales, such as whether any questions should be included or excluded. When the instrument's content was sufficient; the appropriate questions were posed, and the questions were clear to comprehend. Participants' feedback was used to improve the instrument's clarity and language, and some measuring items were added, removed, or adjusted, and the pre-test revised instrument was used to examine the relationship between each variable. Model fitness also refers to the model's ability to replicate the current linkage with other data that was examined under similar conditions. A well-fitted model maintains consistency and eliminates the need for rework. This confirmed that the critical model fitness was achieved after proving reliability and validity before examining the link between variables as reported in [12].

2.6 Statistical analysis for instrumental validation

Two tests were used to validate the questionnaire's reliability and validity of indirectly observable variables to assess the factor analysis. The data surveys were entered into the software to verify which outliers and assumptions of univariate with multivariate normality were checked. In addition to this missing data, multicollinearity, and observations with distinctive features were investigated based on the reports of researchers [13]

2.7 Data analysis

Exploratory Factor Analysis (EFA) was described as the arrangement of an overview to interrelate the measurement which is typically used to study the possible underlying factor structure of a survey a collection of observable variables with an inflexible structure on the outcome. However, EFA was depicted as a tool for dealing with large sample sizes that offer information about which aspects of the measured variable were the best to be used for this case. This was a crucial phase of exploratory factor analysis that involved verifying the loading factors. Rotation of the principal component analysis (PCA) was performed using the extraction method. EFA was performed to ensure that the value of factor loading was valid and reliable for further observation.

The questionnaire data were tested using SPSS version 23 software, KMO, and Bartlett's sphericity tests were used to judge whether the questionnaire and scale were suitable for factor analysis. The KMO value was 0.835, which was significantly higher than the standard value of 0.70. This elevated KMO value confirms that the sample was sufficient for ensuing factor analysis, strengthening the structural validity of the model. These results are in line with the previous work conducted by [14]. To further support this point, Bartlett's sphericity test yielded significant results of $p < 0.0001$, indicating that the sample was suitable for factor analysis. Subsequently, the confirmatory factor analysis of AMOS was used to develop the primary model to validate the absolute and incremental parsimonious model fit indices. The measurement model was initially validated to confirm the scale's validity and reliability. In the next step, structural links were applied to the test.

3 Results and Discussion

3.1 Exploratory Factor Analysis

The component was extracted using the estimation of maximum likelihood and varimax rotation method in exploratory factor analysis [13]. Table 1 shows that a total of 28 variables were initially selected before rotation for measuring the seven lean operational performances. Varimax rotation is the most important technique in EFA interpretation which is used in this investigation aside from distributional assumptions, less likely to give incorrect solutions or factors that were not associated as Table 2 shows the results of the factor matrices before the rotation. The structural validity of the measurement model was confirmed through exploratory factor analysis results, including rotating summing of squared loadings and the resulting factorial loading for the complete sample of 28 variables. These findings are in line with the previous work[13].

3.1.1 Analysis of factor extraction and rotation

Table 1 gives the examined and calculated total variance and number of significant components, which was crucial to understand, and only extracted and rotated values were readable. The components were ranked in order of highest explained variance. The first component has a value of 7.89 > 1, the second component has a value of 4.297 > 1, the third component has a value of 3.806 > 1, the fourth component has a value of 3.493 > 1, the fifth component has a value of 3.062 > 1, the sixth component has a value of 2.618 > 1, and the seventh component has a value of 2.253 > 1.

Table 1. Total variance data

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of variance	Cumulative %
1	7.890	28.178	28.178	7.890	28.178	28.178	3.977	14.205	14.205
2	4.297	15.347	43.524	4.297	15.347	43.524	3.959	14.141	28.346
3	3.806	13.594	57.118	3.806	13.594	57.118	3.954	14.122	42.469
4	3.493	12.476	69.594	3.493	12.476	69.594	3.946	14.095	56.563
5	3.062	10.935	80.529	3.062	10.935	80.529	3.900	13.928	70.491
6	2.618	9.348	89.877	2.618	9.348	89.877	3.894	13.906	84.397
7	2.253	8.047	97.924	2.253	8.047	97.924	3.787	13.527	97.924
8	0.121	0.431	98.355						
9	0.073	0.262	98.617						
10	0.060	0.214	98.831						
11	0.050	0.179	99.010						
12	0.048	0.171	99.180						
13	.035	0.126	99.306						
14	0.031	0.110	99.416						
15	0.025	0.090	99.506						
16	0.022	0.080	99.586						
17	0.019	0.067	99.653						
18	0.017	0.062	99.715						
19	0.014	0.052	99.767						
20	0.014	0.048	99.815						
21	0.012	0.041	99.856						
22	0.010	0.036	99.892						
23	0.009	0.032	99.924						
24	0.007	0.024	99.949						
25	0.005	0.016	99.965						
26	0.004	0.014	99.980						
27	0.003	0.011	99.991						
28	0.002	0.009	100.000						

3.1.2 Analysis of total variance

The eigenvalue represents the total number of retrieved components which should equal the total number of items processed for factor analysis. The item that follows presents all of the recovered analysis factors, as well as their eigenvalues. The sums of the

Initial Eigenvalues and the Extracted squared loadings were used for evaluation and interpretation. The Load Extraction Sums Squared were equal to the Initial Eigenvalues except for factors with eigenvalues less than one. The extracted sum of square loading percent of the variance of the first factor shows (Table 1) that an account's value of 28.178%, the second value of 15.347 %, the third value of 13.594 %, the fourth value of 12.476 %, the fifth 10.935, the sixth for 9.348%, and the seventh for 8.047%. The interpretation rates of individual factors were all below 40%, thus meeting a minimum variance of 75% is deemed acceptable. The cumulative explained variance was 97.9%, indicating that all variables had high loadings with eigenvalues greater than one. These results demonstrated the analyzed items were significant which is in line with the previous research work conducted [(15)].

3.1.3 Pattern matrix with component loadings after rotation

The goal of rotating the variable was to decrease the number of components with high loadings in the variables. Since the rotation does not affect the analysis, it makes it easier to grasp which is good for confirmatory factor analysis. The rotating component matrix was analyzed for component identification. The factor loadings of the 28 variables were significant, hence no items were eliminated as indicated in Table 2. A factor loading is a relationship that exists between each variable. The interpretation of each factor loading was defined in terms of its relevance. The variable would therefore be more suggestive of the factor if it had a higher factor loading. The quantity of factor loading should be properly taken into account in this study. Factor loading greater than 0.50 was practically significant as mentioned in [(16)]. Confirmatory factor analysis revealed that all variables having factor loadings > 0.5 were acceptable as shown in Table 3. The factor loading was utilized with all items and factors because they were realistically meaningful.

Table 2. Pattern matrix with component loadings after rotation

Variables	Principal components						
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
C1					0.979		
C2					0.986		
C3					0.965		
C4					0.969		
Q1			0.962				
Q2			0.971				
Q3			0.969				
Q4			0.968				
D1				0.969			
D2				0.972			
D3				0.976			
D4				0.963			
F1							0.923
F2							0.943
F3							0.957
F4							0.950
P1		0.986					
P2		0.992					
P3		0.994					
P4		0.989					
FPI1	0.990						
FPI2	0.990						
FPI3	0.993						
FPI4	0.983						
CSI1						0.947	
CSI2						0.942	
CSI3						0.947	
CSI4						0.946	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

3.1.4 Validity of the construct

EFA was implemented to assess the validity of all variables using principal components analysis (PCA) with varimax rotation to measure the factor analysis of all structures. Table 3 reveals that the variable factor loadings were greater than 0.70 indicating a significant level as described [16].

Table 3. Construct reliability and validity

Main constructs	Variables	Factor loadings	Cronbach's Alpha	CR	Average
Cost	C-1	0.979	0.989	0.989	0.959
	C-2	0.986			
	C-3	0.965			
	C-4	0.969			
Quality	Q-1	0.962	0.995	0.995	0.981
	Q-2	0.971			
	Q-3	0.969			
	Q-4	0.968			
Delivery	D-1	0.969	0.994	0.994	0.976
	D-2	0.972			
	D-3	0.976			
	D-4	0.963			
Flexibility	F-1	0.923	0.98	0.98	0.926
	F-2	0.943			
	F-3	0.957			
	F-4	0.95			
Productivity	P-1	0.986	0.996	0.996	0.984
	P-2	0.992			
	P-3	0.994			
	P-4	0.989			
Financial performance impact	FPI-1	0.99	0.996	0.996	0.986
	FPI-2	0.99			
	FPI-3	0.993			
	FPI-4	0.983			
Customer satisfaction	CSI-1	0.947	0.995	0.995	0.982
	CSI-2	0.942			
	CSI-3	0.947			
	CSI-4	0.946			

The finding indicated C (4-item) factor loadings that were greater than the standard values (0.979, 0.986, 0.965, and 0.969), while Q (4 items) factor loading was greater than the intended values (0.962, 0.971, 0.969 and 0.968). The result also revealed that the D factor loadings were greater than the standard values (0.969, 0.972, 0.976, and 0.963), while P factor loading was 0.986, 0.992, 0.994, and 0.989, where these four items are greater than the standard values, respectively. F factor loadings were 0.923, 0.943, 0.957, and 0.950 greater than the standard value; FPI factor loadings ranged from 0.990, 0.990, 0.993, and 0.983 which all were higher than the standard values. Finally, the CSI factor loadings were higher than the recommended standard values of 0.947, 0.942, and 0.947 and 0.946, these results consistent with the previous work conducted [16]

3.2 Confirmatory factor analysis

Confirmatory Factor Analysis (CFA) was carried out using SPSS AMOS version 23. Outliers and data multicollinearity were considered any difficulty with the first two assumptions was eliminated and the sample size of 220 surveys was retained for the subsequent tests. The model augmentation was active for enhancement at the proposed levels. It excluded some items and numerous trials were performed to get the specified scale levels. The reliability value and the factor loadings of all the items were greater than 0.7 which is significant as shown in Table 3, which was reported by [16].

3.2.1 Construct reliability

The Cronbach's alpha test of the variables that describe the latent constructs to be tested was referred to as construct reliability. Since all results were higher than the threshold of 0.7 for each construct ranging from 0.98 to 0.996, the questionnaire and its components can be considered reliable as shown in Table 3, which was supported by[16]. This indicated that the constructs of the internal consistency were high, and the data were used for further analysis.

3.2.2 Composite reliability

The combination of the latent constructs of reliability that underlie a scale is known as composite reliability (CR). A composite reliability range of 0.98 to 0.996 was greater than the threshold value of 0.70, indicating that the scale was reliable as indicated in Table 3 which was supported by[16].

3.2.3 Convergent validity

The Average variance extracted (AVE) was used to assess convergent validity, for the seven constructs were 0.986, 0.959, 0.981, 0.976, 0.926, 0.984 and 0.982, these indicated that all values were greater than 0.5 confirming a good convergent validity as shown in Table 3 which demonstrated[16].

3.2.4 Discriminant validity

Discriminant validity determines how distinct one construct is from the others. The diagonal square root of AVE for each construct was greater than the variance shared between the construct and other constructs in the model as indicated in Table 4. The results satisfied the discriminant validity in line with the previous studies[16]. All diagonal values in this study exceeded all the diagonal confirming the good discriminant validity of each construct.

Table 4. R esults of discriminant validity

Items	CR	AVE	MSV	ASV	Financial Performance	Cost	Quality	Delivery	Flexibility	Productivity	Customer_ Satisfaction impact
Financial_ performance	0.996	0.986	0.017	0.009	0.993						
Cost	0.989	0.959	0.055	0.017	0.023	0.979					
Quality	0.995	0.981	0.113	0.043	0.075	0.086	0.991				
Delivery	0.994	0.976	0.106	0.036	0.111	0.056	0.260	0.988			
Flexibility	0.980	0.926	0.128	0.046	0.099	0.235	0.258	0.129	0.962		
Productivity	0.996	0.984	0.015	0.006	-0.098	0.009	-0.026	-0.089	-0.014	0.992	
Customer_ Satisfaction impact	0.995	0.982	0.128	0.069	0.132	0.194	0.336	0.325	0.358	-0.123	0.991

Note: CR is the critical ratio; AVE is the average variance extracted; ASV is the average shared variance; MSV is the maximum shared variance.

Measurement model

3.3.1 Absolute fit measure

AMOS produces highly complex outputs, either graphically or numerically that fulfill all the criteria of the measurement model as shown in Figure 2. Table 5 shows measurement model fitness summaries indicating that the chi-squared/degree of freedom (CMIN/DF) value was 2.242 which lies between the 2-5 ranges which indicates the model was an acceptable fit. The RMSEA value was 0.075 which lies between $0.05 < 0.075 \leq 0.1$ indicating an acceptable fit. The AMOS computed value of the Standardized Root Mean Squared Residual (SRMR) was 0.0222, which is also between $0 \leq 0.0222 \leq 0.05$ indicating the model was a perfect fit, these findings are in line with the previous studies conducted by[12].

3.3.2 Incremental fit index (IFI)

In this research finding, Normal Fit Index (NFI) value was 0.956 which lies between $0.95 \leq 0.956 \leq 1.00$ which indicates a perfect fit. The Comparative Fit Index (CFI) value was 0.975 and lies between $0.95 \leq 0.975 \leq 1.00$ indicating a perfect fit. In addition, the Tucker-Lewis index (TLI) was checked and the path coefficient in the context of AMOS was evaluated. The TLI value of 0.971 lies between $0.95 \leq 0.971 \leq 1.00$ this confirmed a perfect fit of the finding. The value of IFI was 0.975 which indicates a perfect fit since it lies between $0.95 \leq 0.975 \leq 1.00$. Relative Fit Index (RFI) is truncated in AMOS graphics value of 0.950 which indicates an acceptable fit lies between $0.90 \leq 0.950 < 0.95$, these results are in line with the previous work conducted by [17].

3.3.3 Parsimonious Fit Index (PFI)

Table 5 shows the result of the Measurement Model fitness summary and Measurement model estimation using CB-CFA shown in Figure 2. The Parsimonious Comparative Fit Index (PCFI) and Parsimonious Normal Fit Index (PNFI) generated through AMOS graphics software were 0.849 and 0.832 > 0.50, respectively, indicating that the model was an acceptable fit, these results were in line with the previous work [12], [17].

Table 5. Measurement model fitness summary

Fit Index	Perfect Fit	Acceptable Fit	Result	Model fit verification
Absolute fit measure		$p < 0.001$	0.000	Significant
CMIN/Df		<5	2.242	Acceptable Fit
RMSEA	$0 \leq RMSEA \leq 0.05$	$0.05 < RMSEA \leq 0.10$	0.075	Acceptable Fit
SRMR	$0 \leq SRMR \leq 0.05$	$0.05 < SRMR \leq 0.10$	0.0222	Perfect fit
Incremental fit measure				
NFI	$0.95 \leq NFI \leq 1.00$	$0.90 \leq NFI < 0.95$	0.956	Perfect fit
CFI	$0.97 \leq CFI \leq 1.00$	$0.95 \leq CFI < 0.97$	0.975	Perfect fit
TLI	$0.95 \leq TLI \leq 1.00$	$0.90 \leq TLI < 0.95$	0.971	Perfect fit
IFI	$0.95 \leq IFI \leq 1.00$	$0.90 \leq IFI < 0.95$	0.975	Perfect fit
RFI	$0.95 \leq RFI \leq 1.00$	$0.90 \leq RFI < 0.95$	0.950	Acceptable Fit
Parsimonious fit measure				
PCFI		>0.50	0.849	Acceptable Fit
PNFI		>0.50	0.832	Acceptable Fit

3.4 Structural Equation Model

The SEM was used for data analysis to evaluate causal links between constructs and handle complex models using robust statistical approaches. This permits researchers to examine the interactions between some dependent and independent factors simultaneously. The CB-SEM model was examined by AMOS version 23 in utilizing maximum likelihood (ML) estimation approaches as shown in Figure 3.

As shown in Table 6 the structural model fit summary indicated the value of CMIN/Df as 2.234 < 5, RMSEA value of 0.075 < 0.10, and SRMR value of 0.027 < 0.05. This indicated that the values confirmed the absolute fitness. Incremental fitness measurement results of NFI, CFI, TLI, IFI, and RFI were 0.943, 0.967, 0.957, 0.967, and 0.925 > 0.9, respectively. This confirmed that the model was an acceptable fit. PCFI and PNFI values for parsimonious fitness were 0.760 and 0.722 > 0.50, respectively, indicating an acceptable fit. The model with an absolute, incremental, and parsimonious fit was used for hypotheses testing because it meets the criteria for a good fit, these results were in line with the previous work conducted by [17].

The AMOS-SEM model depicted the link between variables and the evaluation of model fitness, reliability, and validity were performed after verification. As shown in Table 7, the structural equation modeling analysis provides strong evidence that the H1, H2, and H3 hypotheses were positive and direct effects on customer satisfaction were supported. At 20%, the customer satisfaction impact change describes the variation in cost, quality, and delivery. According to the path correlation result presented in Table 7, discovered that cost, quality, and delivery had a substantial direct effect on customer satisfaction with standardized regression coefficients of 0.158, 0.258, and 0.249 and C.R.> 1.96 and p-value < 0.001 respectively.

This was feasible to conclude that SEM relationships in cost, quality, and delivery had a direct impact on customer satisfaction and an indirect effect on financial performance. Table 7 shows that quality was at a confidence level of 99% and

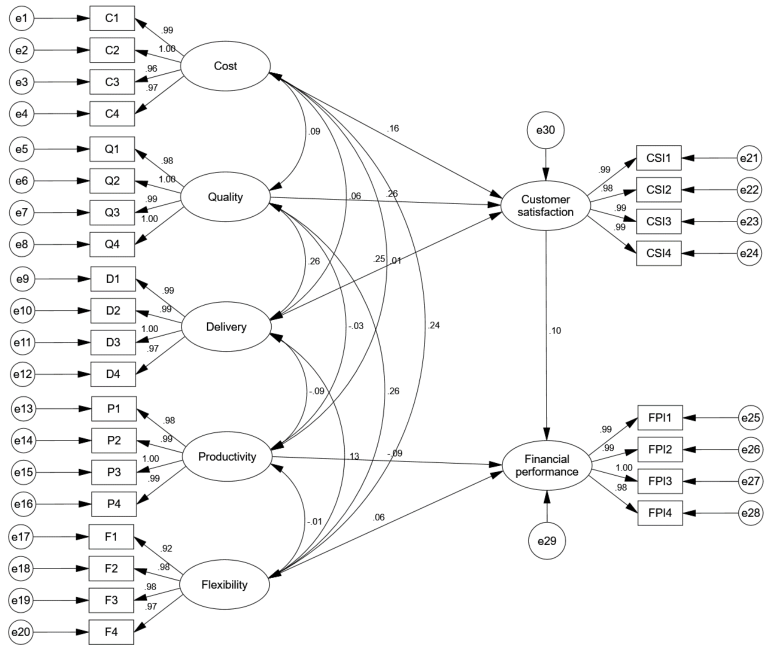

Fig 2. Measurement model estimation using CB-CFA

Table 6. Structural model fit summary

Fit index	Perfect fit	Acceptable fit	Result	Model fit verification
Absolute fit measure		$p < 0.001$	0.000	Significant
CMIN/Df		<5	2.266	Acceptable fit
RMSEA	$0 \leq RMSEA \leq 0.05$	$0.05 < RMSEA \leq 0.10$	0.076	Acceptable fit
SRMR	$0 \leq SRMR \leq 0.05$	$0.05 < SRMR \leq 0.10$	0.05	Perfect fit
Incremental fit measure				
NFI	$0.95 \leq NFI \leq 1.00$	$0.90 \leq NFI < 0.95$	0.955	Perfect fit
CFI	$0.97 \leq CFI \leq 1.00$	$0.95 \leq CFI < 0.97$	0.974	Perfect fit
TLI	$0.95 \leq TLI \leq 1.00$	$0.90 \leq TLI < 0.95$	0.971	Perfect fit
IFI	$0.95 \leq IFI \leq 1.00$	$0.90 \leq IFI < 0.95$	0.974	Perfect fit
RFI	$0.95 \leq RFI \leq 1.00$	$0.90 \leq RFI < 0.95$	0.949	Acceptable fit
Parsimonious fit measure				
PRATIO		>0.50	0.766	Acceptable fit
PCFI		>0.50	0.861	Acceptable fit
PNFI		>0.50	0.844	Acceptable fit

has a strong positive and direct influence of 25% on customer satisfaction. Furthermore, the findings of the SEM analysis revealed that quality, cost, and delivery had an indirect effect on financial performance. The finding confirmed that customer satisfaction was influenced by quality[18], [19]. This suggested that the evidence at hand supports the finding that quality and consumer satisfaction were positively correlated, which was drawn from earlier research that showed an improvement in quality perception[19].

As these findings show, to build customer trust and achieve financial success, prioritizing quality and customer satisfaction is recommended. Organizations may acquire a competitive advantage by satisfying customer needs, boosting productivity, and maintaining a high and constant level of quality. The study's findings suggested that superior quality stands out from the competition as a result of positive customer experiences, which is also supported in the previous work conducted by[20].

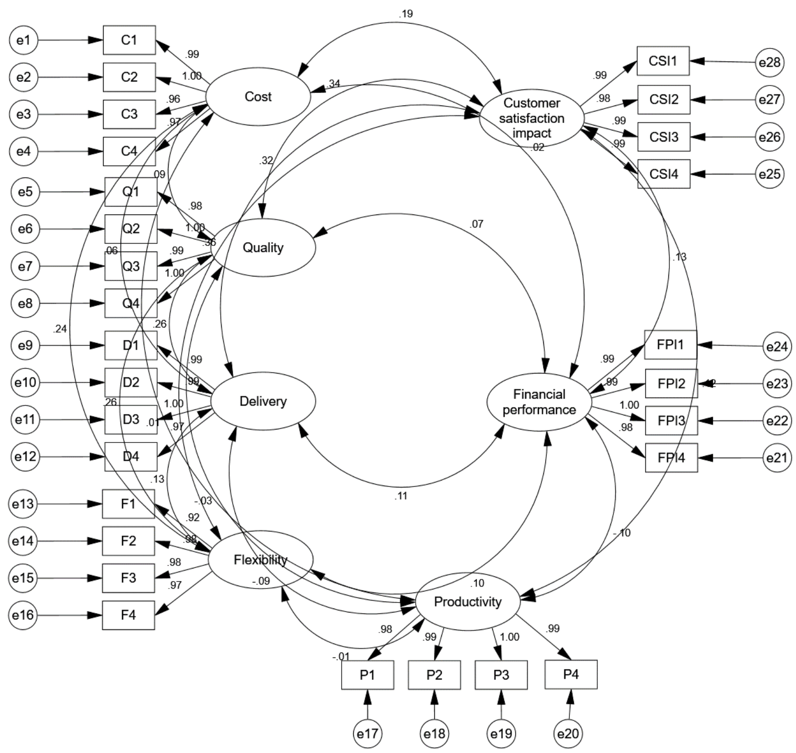

Fig 3. Structural equation modeling estimation CB-SEM

Furthermore, these results were in line with the previous works conducted by[21], the constant for quality improvement is an important strategy to increase customer satisfaction and improve the confidence of the market. In general, a company should make every effort to the quality of the product to satisfy customer requirements to gain a competitive edge in the market[22].

Table 7. Structural model values for hypothesis testing

Hypothesis	Relationship			Estimate coef.	Standardized Regression Coef.	S.E.	C.R.	P	Decision
H1	CSI	<—	C	0.103	0.158	0.040	2.567	0.010	Supported
H2	CSI	<—	Q	0.198	0.258	0.048	4.090	***	Supported
H3	CSI	<—	D	0.273	0.249	0.069	3.948	***	Supported
H4	FPI	<—	P	-0.052	-0.086	0.040	-1.281	0.200	NS
H5	FPI	<—	F	0.065	0.063	0.071	.924	0.355	NS
H6	FPI	<—	CSI	0.096	0.100	0.065	1.475	0.140	NS
R^2 FPI = 0.024; R^2 CSI = 0.20									

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. C = Cost, Q = Quality, D = Delivery, P = Productivity, F = Flexibility, FPI = Financial Performance Impact, CSI = Customer Satisfaction Impact. R^2 = Square Multiple Correlations.

4 Conclusion

This study explored the role of LM as a fundamental aspect of industrial manufacturing processes; but little is known about its impact on lean operational performance. This study adds value to the literature by examining the key lean operational performance (quality, productivity, cost, flexibility, delivery, financial, and customer satisfaction relationships) within the manufacturing industry. To our knowledge, this work can have significant implications for improving manufacturing organizations. According to the hypothesis test result, it can be concluded that assessing lean operational performance regarding quality, delivery, and cost indicators has a positive and significant impact on total customer satisfaction, whereas quality has a strong and significant impact on customer satisfaction, while flexibility, productivity, and financial performance indicators have quite little impact. Many experts and practitioners regard quality as one of the most effective strategic tools for increasing productivity and boosting consumer satisfaction and reliability in firms. To that end, these findings present empirical evidence in line with the previous work conducted by Kafuku[(21)], that the constant for quality improvement is an important strategy to increase customer satisfaction and reliability in firms. The novelty of this research work is that it provides a new perspective on applying the structural equation modeling of relationships among lean operational, financial performance and customer satisfaction have important implications for the improvement of the organizational performance. To conclude, the finding of this study can increase competitiveness of a firm that may enable the industry to implement a higher level of customer satisfaction due to the need to outperform its quality constantly and keep its competitive position. They recommend to satisfy the desires of customer satisfaction; staff should be trained in the quality program and have an established understanding of quality attainment as a common aim because it provides a firm with enhanced capital. Therefore, these findings have important implications for decision-makers to improve organizational performance.

Implications

This study provides information to researchers and practitioners about a statistical methodology (AMOS-SEM) that is currently being used to analyze the structural equation modeling of relationships among lean operational, financial performance, and customer satisfaction indicators. Furthermore, the study identifies the selection of appropriate variables, validated by AMOS-SEM, to construct new prediction models. Industries' continuous improvement teams can use this type of research to determine the most common lean operational performance that is applied to improve organizational performance. Therefore, the findings allow industries to make decisions based on the information revealed that it contributes to the governments, policymakers, organizations, and stakeholders, a thoughtful knowledge of the lean operational, financial performance, and customer satisfaction impact in continuous improvement of the organizations.

Limitations and Directions for Future Research

The limitation of this study is that the research covers a survey of Ethiopia's basic metal manufacturing industry carried out using the AMOS-SEM methodology to analyze the relationships among lean operational, financial performance, and customer satisfaction. On the other hand, limitations provide opportunities for future research, which may include specific analyses in other regions or countries, according to companies' size, types of companies, and organizational culture. Finally, practitioners and researchers can broaden this study using other methodologies, such as LSS, PLS, ISM, and MLR, and establish the results obtained with those methodologies differ from those indicated in the present study.

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