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The impact of integration between lean accounting and just-in-time technique on cost reduction in modern sustainable manufacturing environment in Saudi companies

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ABSTRACT

This article examines the impact of integration between Lean Accounting (LA) tools and Just-in-Time (JIT) techniques on Cost Reduction (CR) in a modern sustainable manufacturing environment in Saudi companies, Ethical Standards (ESs) mediate these two variables. A quantitative methodology was used for realizing the study goals and answering study questions. The main tool used for producing the primary data was a fully structured questionnaire with closed-ended questions which was designed and distributed online through a chosen sample of 109 managers and accountants in Saudi industrialization companies. Descriptive and deductive statistics were adopted to deduce the findings. The gathered responses analyzed by SPSS and AMOS and the results pointed out that there is a direct and indirect impact of LA tools and JIT techniques on CR in Saudi industrial companies especially when using ESs. Moreover, these findings could provide decision- makers in Saudi manufacturing companies with the importance of adopting both methods in an integrated way to maximize the profits of these firms. The practical implications of this study are that the implementation of these methods has a positive impact on the promotion of sustainable manufacturing and consequently the achievement of distinct sustainable performance.

Contribution/Originality: The primary contribution of this study is guiding the interrelationships between LA tools and JIT techniques and their economic consequences. This guide will serve as a basis of knowledge for decision-makers in Saudi manufacturing companies as they enhance strategies for achieving sustainable manufacturing.

1. INTRODUCTION

New technological advancements and environmental alterations that have taken place in modern periods have affected the economic surroundings and remarkably influenced the accounting scope where an enormous expansion of industrial companies has arisen which guides to enlarge contesting and complicatedness of customers' matters (Alobaidy, 2019).

The main purpose of the economic firms is to maximize the shareholders' wealth and maximization of shareholders' wealth indicates increased profits in long run orientation. The only way to guarantee maximizing profits in the long run has been to implement CR methods. However, in recent years, traditional CR methods have been unable to realize the prospective outcomes (Emmanuel, James, & Offiong, 2018). There are several criticisms of the conventional management accounting system that restrain it from realizing its goals; some of those criticisms relate to the management accounting system and others related to the financial accounting system.

Therefore, these systems were not harmonized well with the requirements of the modern manufacturing environment (Ali, Khan, Shah, & Ahmad, 2021). These factors and others have led to the actuality that there is no existence for traditional companies due to relying heavily on technology orientation. So, many companies tend to integrate with others to block themselves from strong competition. This alteration of standpoint has determined the search for new alternative methods for manufacturing and managing that encounter the client's requirements and strengthen the competitive advantage of companies (Ofileanu & Topor, 2014).

New management philosophies appeared such as total quality management systems, Value Stream (VS) system, Lean Production (LP), Just-In-Time (JIT) technique, etc. due to manufacturing evolution. The appearance of these philosophies had a considerable influence on the structure of manufacturing costs such as increasing product quality, loweing defects and wastage, reducing manufacturing time, reducing inventory cost, etc. (Mohamed & Mwanyota, 2018).

The observed of the classical management accounting system which concentrates mightily on the human component, find it inappropriate for the quick growth in contemporary manufacturing systems which made it necessary for management accounting to go along with these advancements. As a result, some advancements manifested in costing systems such as activity-based costing systems, target costing systems, product life cycle systems, throughput accounting**,** Backflush Costing (BC) systems, Lean accounting (LA) tools, etc. (Almashkor, 2021)**.**

Numerous studies in the literature have investigated the impact of LA tools and JIT techniques on cost reduction individually (Almashkor, 2021; Muhammad & Isah, 2020; Sunday, 2022). However, there is no study that tested the influence of integration between LA tools and the JIT method on cost reduction. Therefore, this study addresses this gap. Accordingly, the aim of this study is to determine how the application of LA tools and the JIT method affects cost reduction and hence increasing profitability in Saudi companies. The structure of this paper includes an introduction, literature review, methodology, results, a conclusion, the study implication, and the last section on limitations and future directions of study.

2. LITERATURE REVIEW

Almashkor (2021) focused on the effect of integration between throughput accounting and LA tools on CR in Saudi industrial establishments. This study deduced that the two methods are interrelated in their efficiency to minimize manufacturing expenditures. Kadhim, Kadhim, and Azeez (2020) discussed the amalgamation of LA tools and activity-based budgeting for upgrading a company's performance. This study concludes that the conjunction between LA tools and activity-based budgeting leads to reliable financial and non-financial information. Al-Dulemi and Shehadeh (2018) investigated the function of LA tools in lowering manufacturing expenditures in Jordanian industrialization companies. The researchers induced that the implementation of LA tools participates in decreasing manufacturing expenditures.

Alobaidy (2019) examined the correlation between LA methods and a balanced scorecard to assess the fulfillment of some companies which showed that there is a fundamental relation between LA tools and a balanced scorecard perspective. Amusawi, Almagtome, and Shaker (2019) concentrated on the impact of LA tools on financial achievement. They noted that the application of the VS system encourages directors to differentiate between value-added and non-value-added activities, consequently removing the squandering and exploitation of the available resource more effectively. Muhammad and Isah (2020) condensed on the effect of LA tools on the financial activity of private companies. This study concludes that LA tools play an essential role in upgrading the financial performance of these institutions. Airout and Alhajahmad (2022) examined the impact of using LA tools on industrial companies and found that using LA tools has a considerable influence on developing the lean planning level in these companies.

Pawlik, Ijomah, Corney, and Powell (2022) investigated the application of lean tools in industrial remanufacturing processes. The outcomes of these investigations pointed out that there are specific lean tools that assist in managing the complexity of the manufacturing processes and then ameliorate the aggregate productivity. Marques, Carvalho, and Santos (2021) stated how a lean approach might not be used only to upgrade operational achievement but also for achieving sustainable performance. Bwaliez and Abushaikha (2019) investigated the integration of lean supplier relationship management (LSRM) and lean tools which showed that LSRM procedures are positively correlated with each other and they have a positive relationship with financial performance. Shakil and Parvez (2018) examined the implementation of lean manufacturing in a sewing line for improving performance effectiveness and found that batch size has a considerable influence on waiting time and transportation period.

According to Singh and Kumar (2021) and Bertagnolli, Herrmann, Rittmann, and Viere (2021) lean principles are all about reducing waste and maximizing value concerning time, cost, quality and function. Many studies (e.g., (Dave & Sohani, 2019; Okolocha & Anugwu, 2022; Prasad & Vasugi, 2023; Yang, Hong, & Modi, 2011)) defined the lean approach as a management philosophy used to improve the products' value by eliminating waste and promoting this value during the production process. Numerous studies (e.g., (Agyabeng-Mensah, Ahenkorah, Afum, & Owusu, 2020; Arafeh, 2015; Marques et al., 2021; Muhammad & Isah, 2020; Vinodh & Joy, 2012)) believed that the prime aim of the lean approach is to eliminate waste and reduce unnecessary costs associated with activities to provide positive returns to the manufacturing companies.

Therefore, LP is a tool that company exercised to remove non-value-added activities in their production process to reduce production costs (Alobaidy, 2019). According to Ofileanu and Topor (2014) the idea of LP is not unprecedented, being a conjunction of the techniques applied in the past and offered in an integrated way such as JIT production. Therefore, some researchers (e.g., (Belekoukias, Garza-Reyes, & Kumar, 2014; Ghaithan, Khan, Mohammed, & Hadidi, 2021; Wickramasinghe & Wickramasinghe, 2017)) are set some dimensions of LP: provider feedback, JIT, client partnership, pull approach, setup time lowering, complete preventative maintenance, statistical procedure control, and employee participation. Some studies (e.g., (Emmanuel et al., 2018; Romana & Gestoso, 2021)) believed that the efficient implementation of LP tools concentrates on cutting off non-value-added periods and waste costs to upgrade customer service and acquire higher satisfaction scales. Several researchers (e.g., (Emmanuel et al., 2018; Losonci & Demeter, 2013; Vanichchinchai, 2019)) argued that using the lean idea economically removes dissipation in the inventory management area. Nevertheless, the decrease in inventory volume passively affects the income result and drops out a deceptive effect. De Arbulo-López and Fortuny-Santos (2010) showed that operational privilege and waste removal should lead to an advancement in effectiveness, a CR, and ultimately growth in net profit.

However, this is not the case. Numerous companies find that their accounting techniques are inconsistent with their LP actions and ESs. Emmanuel et al. (2018) also argued that LP introduces methods that are not congruent with traditional costing systems, consequently necessitating the search for appropriate accounting techniques such as LA tools to fill this gap. Elsukova (2015) believed that the cost accounting system plays a substantial factor in upgrading the economic situation of companies by supplying advantageous facts for decision-making concerning cost control and product pricing. However, Muhammad and Isah (2020) argued that most conventional cost accounting systems do not align with the modern environment's information needs. Therefore, picking the appropriate cost accounting system has been considered a challenge in most companies because it influences financial performance. Amusawi et al. (2019) believed that newfangled cost management needs elaborate cost information on the particular element of the production system. Managers tend to use the LA tools to eliminate waste, reduce production costs and increase profits to deal with these challenges (Aziz, Awais, Rahat, Hasnain, & Shahzadi, 2017).

According to Ozdemir (2017) manufacturing companies now have more benefit from lean orientation for several reasons, such as CR, profit maximization, productivity improvement, elasticity improvement, etc.

Muhammad and Isah (2020) and Rossi et al. (2022) showed that the idea of LA tools should be understood as a set of tools that reduce elements that do not add value to a product to satisfy the customers' needs and create additional gains. Enoch (2013) defined LA as applying lean techniques to a firm's accounting control and measurement procedures to assist lean management in realizing lean philosophy. Alobaidy (2019) defined LA as a modernistic accounting method that reflects gaunt applications and gaunt thought by increasing work effectiveness and promoting decision-making by providing understandable and precise facts. According to Ofileanu and Topor (2014) LA refers to the management accounting tools and the financial accounting information being produced through specific rules that should be offered in accordance with legal requirements.

LA tools primary goals are completely compatible with companies' purposes in the modernistic surroundings with regard to CR, quality improvement, customer gratification, etc. (Alobaidy, 2019). Sunday (2022) considered that LA tools draw knowledge from such lean tools as continuous improvement, target costing, VS, JIT, and BC, as tools build up LA. Madanhire, Kagande, and Chidziva (2013) defined the JIT technique as a system for producing necessary units with required quality and necessary quantities at a specific time. The JIT technique is a different approach to inventory management compared to the economic order quantity model for inventory control in companies that maintain an ample amount of commodity inventory.

As LA tools, the JIT technique is a manufacturing philosophy that targets removing squandering that does not add value to the product (Benah & Li, 2020; Madanhire et al., 2013). However, Fonseca and Domingues (2018) argued that the JIT technique is not about eliminating inventories only but rationalizing them. So inventory grades must be optimal.

Milewski (2022) believed that there are benefits and costs related to preserving inventory when using the JIT technique. Therefore, this requires a balance between benefits and costs in implementing this system. Siddiqui (2022) and Shah and Ward (2007) showed that the JIT technique has manifested that it could save a lot of waste for the company which leads to more profits. The best method to get these benefits is to concentrate on what is needed and not waste time and money in inventory. Arai (2021) showed that companies implementing the JIT technique have adopted an accounting system called LA that addresses financial and non-financial measures. Therefore, according to Siddiqui (2022), JIT techniques are holistic approach that focuses on the performance of the company as a whole and its main objective is to remove the inventory at the minimum level.

According to some studies Kocamiş (2015), Bonaccorsi, Carmignani, and Zammori (2011) and Schoeman, Oberholster, and Somerset (2020), the VS system is a tool exercised by LA tools to ameliorate and improve the decision-making process to identify and eliminate unfruitful activities. Therefore, according to Maskell, Baggaley, and Grasso (2017) the VS system comes up with understandable and adequate facts for cost management in the company. The BC system is a costing system commonly used in the JIT technique. According to this system, companies primarily work backward, calculating products cost after they has been sold or shipped. Al-Dulemi and Shehadeh (2018) and Nunes et al. (2022) believed that the VS system and the BC system used the pull principle which is based on the customer's request for the product and then the company provides raw materials needed for production and hence no need for inventory retention. Therefore, the VS system and BC system are used as synonyms in LA tools and JIT techniques. The researcher believes that all the above previous studies agree that the use of LA tools and JIT techniques contributes significantly in reducing costs and hence improving financial performance. The difference between this study and previous studies is that this study examined the influence of a combination of LA tools and JIT methods on cost reduction in Saudi manufacturing companies especially when the managers of these companies take ES into account in the CR process.

3. METHODOLOGY

This study investigates the impact of integration between LA tools and JIT methods on CR in modernistic sustainable industrial environment in Saudi firms. This study used prime and secondary data based on quantitative

and empirical study layouts. We have collected secondary data from various sources such as journals, theses, scientific books, etc. to familiarize ourselves with issues connected to the LA tools and JIT techniques concept. The primary data were produced through a questionnaire. This questionnaire was circulated randomly for several managers and accountants in Kingdom of Saudi Arabia (KSA) manufacturing companies to assess the influence of integration between LA tools and the JIT method on CR. The study tool was prepared in five reply options of a Likert scale (i.e. strongly agree, agree, neutral, disagree and strongly disagree).

A quota sampling technique was adopted for this study. The questionnaire was designed based on previous literature which included two sections for a number of closed statements, directed at collecting data on the study variables: the first section related to demographic data (age, qualification, job title and experience). Table 1 shows the frequencies and percentages for the study sample. The second section involves four parts related to the study variables. The first part includes a set of seven items asking about the first independent variable JIT technique. The second part inquiries about the second independent variable LA tools which contains eight items. The third part is connected to the mediator variable ES which includes three items. Moreover, the last part was related to the dependent variable CR which contains four items. The description of variable items is shown in Table 1.

Competent experts have arbitrated the questionnaire and an experimental test of the questionnaire was achieved to afford high quality and verify the questionnaire's precision. The outcome of the precision test shows that the designed questionnaire is mightily dependable. This questionnaire was distributed online through a chosen sample of 109 directors and accountants in Saudi manufacturing companies. The selected criterion items were translated from English into Arabic to minimize translation mistakes and to appear to have veritable sense and local knowledge as most respondents have used Arabic to obtain dependable data.

The framework shown in Figure 1 was developed to assess the direct and indirect influence of integration between LA tools and the JIT method on CR in the recent sustainable industrial environment in Saudi companies following the discussions in the introduction and literature review. This assessment can be carried out by formulating the following four hypotheses:

H_1: There is a significant effect of using LA tools on CR. In this hypothesis we discuss the relations between LA tools and CR. We believe that LA tools have a direct effect on CR. This can be realized by concentrating on LA tools to reduce elements that do not add value to the product and thereby reducing production costs.

H_2: There is a significant effect of using JIT technique on CR.

We begin our hypothesis discussion by developing the relations between JIT technique and CR. We believe that the JIT technique contributes to remove squandering that is not adding value to the product by doing this, production costs have been minimized to as little as possible. Additionally, according to the JIT technique, there is no need for storage procedures that increase the production cost.

$H_{3.1}$: ESs mediates the effect of using LA tools on CR.

In this hypothesis, we believe that ESs play an essential role in applying LA as a vital tool in CR. Managers sometimes concentrate on CR unethically to gain self-interest.

$H_{3.2}$: ESs mediates the effect of using JIT on CR. In this hypothesis, we believe that ESs play an important role in applying JIT as a vital technique in CR because managers sometimes concentrate on CR by using unethical ways to obtain self-interest. In addition, we discuss to what extent there is integration between LA tools and the JIT technique reducing production costs.

The model used in this study contained three variables: the first variable relates to lean accounting tools, the second variable is relates to just-in-time technique and the third variable relates to cost reduction. The first and second variables were mediated by ethical standards. Therefore, the model tested the integration between first and second variables mediated by ethical standards and its impact on the third variable. This model makes this study differs from past studies with its diverse and integrated variables. Figure 1 shows the study model and its variables.

Table 1. Description of variables items.

Variables	Items	Description
JIT technique	Value-added activity (VAA)	This item refers to any activity that increases the product value. It directly contributes to meeting customer needs, and customers are willing to pay for it (Mohamed & Mwanyota, 2018).
	Setup time reduction (STR)	This element is a crucial point that determines the pliability of a manufacturing arrangement such that it can readily accommodate diversification in the resource and programs. Therefore, STR assesses how much setup period can be minimized before production (Ghaithan et al., 2021).
	Inventory level (IL)	Inventory costs money for storage and management, so inventory increases the financial risks. Only minimal or nil inventories should be maintained.
	Defect product (DP)	This item refers to a product that fails to meet the customer's needs. Therefore, it is necessary to design a product that contributes to realizing a competitive advantage for the company (Ghaithan et al., 2021).
	Supplier development (SD)	This item explores the continuous advancement of suppliers' achievement by measuring supplier competencies and addressing basic interests (Jajja, Kannan, Brah, & Hassan, 2017; Martínez-Jurado & Moyano-Fuentes, 2014; Sahoo, 2020).
	Resources utilization (RU)	This element refers to how much of the available resources are currently used by the company. Therefore, this helps the company to plan how to use its resources in a more effective way (Woehrle & Abou-Shady, 2010).
	Competitive advantage (CA)	This item refers to factor allowing a company to produce products better than its competitors. This factor allow the company to generate more sales than its market rivals (Muhammad & Isah, 2020).
Lean accounting	Value-added activity (VAA)	This item indicates to any activity that enhances the product value. Therefore, it directly contributes to realize customer needs (Mohamed & Mwanyota, 2018).
	Setup time (ST)	This element is important point that sets the flexibility of a manufacturing process such that it can readily accommodate diversification in the resources. Therefore, ST assess how much setup time can be minimized before manufacturing (Ghaithan et al., 2021).
	Inventory level (IL)	According to this variable, only minimal or nil inventories are needed.
	Defect product (DP)	This item refers to a product that fails to meet the customer's needs. It is necessary to design a product that contributes to realizing a competitive advantage for the company (Ghaithan et al., 2021).
	Resources utilization (RU)	This item refers to how much of the available resources are currently used by the company. This helps the company to plan how to use its resources in a more effective way (Woehrle & Abou-Shady, 2010).
	Competitive advantage (CA)	This item refers to a factor allowing a company to produce products better than its competitors. This factor allows the company to generate more sales than its market rivals (Muhammad & Isah, 2020).
	Continuous flow (CF)	CF evaluates if there is a gradual permanent flow on the manufacturing floor ensuring no big downtime (Ghaithan et al., 2021).
	Customer involvement (CI)	CI is a fundamental measurement that describes whether client needs have been met and their gratification has been realized.

Variables	Items	Description
		This measure inspects the narrow relation between the company and client (Sila & Ebrahimpour, 2005).
Cost reduction	Operating cost (OC)	This element relates to the operation cost of business (Marques et al., 2021).
	Design cost (DC)	This element relates to the cost of product development in an earlier stage.
	Inventory cost (IC)	This element relates to a cost of maintaining and managing inventory (Mohamed & Mwanyota, 2018).
	Defects cost (DC)	This item refers to a cost that fails to meet the customer's needs.
Ethical standards	Truthful information (TI)	Information is truthful if it reflects reality. Information may be disclosed in a way that is contrary to the actual position (Moyano-Fuentes & Sacristán-Díaz, 2012; So & Sun, 2010).
	Safe products (SP)	This item refers to a product that provides a lower risk taking into account the rational exercise of the product and the need for maintaining a high level of consumers' preservation (Ghaithan et al., 2021).
	Transparency (T)	This element refers to the basic principle that obliges companies to publish information of public concern and make it accessible (Shaqour, 2022).

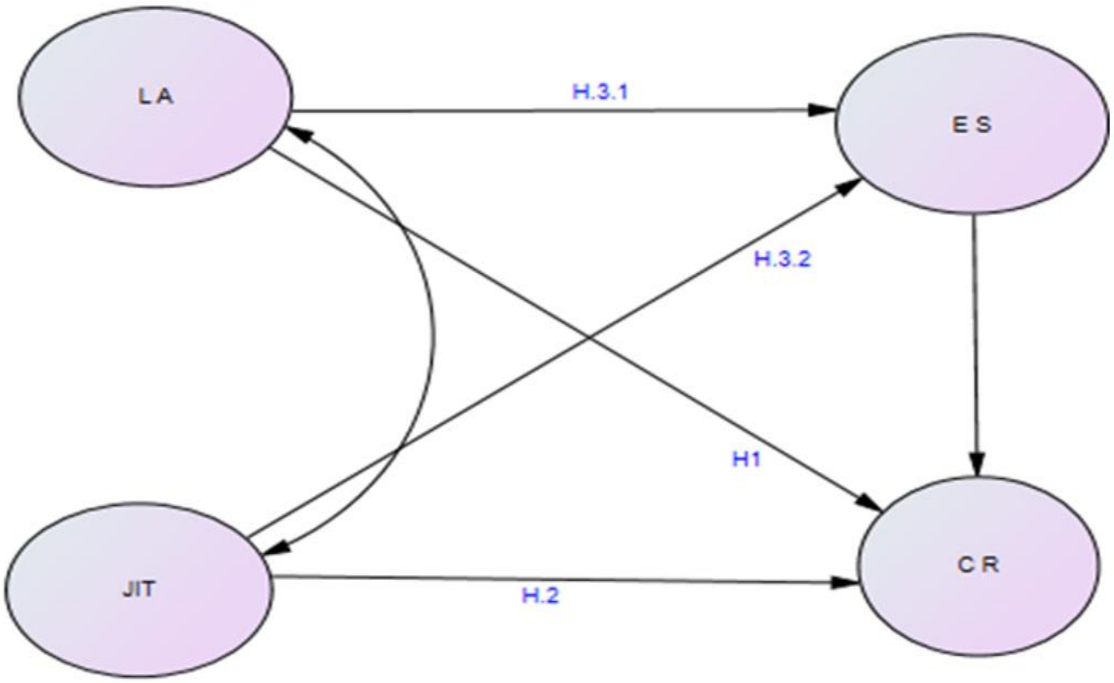

Figure 1. The study model with reference to study hypotheses and variables.

4. STUDY RESULTS

4.1. The Demographic Data

The demographic data of the study sample in Table 2 presents that the specimen comprises two types of workforce in Saudi industrial companies which are accountants by a percentage of 60.6% and managers (production manager, financial manager, industrial engineer) by ratio of 39.4% . This result indicates the majority of study participants are managers and accountants involved in the decision-making process. However, the most shared in this study was age section below 40 years old with a ratio of 76.1% followed by 22.9% of individuals from 40 to 55 years old, and lastly 0.9% of individuals aged is older than 55 years. This result indicates the majority of study participants are young people below 55 years old (99%). The majority of the study participants were well educated,

having a bachelor's degree (67%), a higher diploma with a ratio of 21.1%, a master's degree with a ratio of 7.3% and a Ph.D. with a ratio of 4.6% . In context of experience, the analysis shows that employees of 5 to 10 years of experience are highly score (47.7%) followed by employees with less than 5 years of experience (26.6%) followed by employees of 11 to 20 years of experience (18.3%) and lastly employees with more than 20 years' experience (7.3%). This result indicates the majority of study participants have more than five years' experience (73.3). In general, this result indicates that the study participants were highly qualified people who know the study field and this presents their capability to answer the study questions with high reliability.

Table 2. Demographic data.

Data	Statement	Frequency	Percent %
Age	Less than 25	19	7.4
	25 to 39	64	58.7
	40 to 55	25	22.9
	Over 55	1	0.9
	Total	109	100%
Qualification	Bachelor	73	67.0
	Higher diploma	23	21.1
	Master	8	7.3
	PhD	5	4.6
	Total	109	100%
Job title	Accountant	66	60.6
	Production manager	12	11.0
	Financial manager	14	12.8
	Industrial engineer	17	15.6
	Total	109	100%
Experience	Less than 5 years	29	26.6
	5 to 10	52	47.7
	11 to 20	20	18.3
	More than 20	8	7.3
	Total	109	100%

4.2. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA)

EFA identifies all variables and loads each variable with a set of questionnaire statements. The study concluded that the questionnaire form statements were loaded with underlying factors of over 70%. As shown in Table 3, the Kaiser-Meyer-Olkin (KMO) measured 0.813. This is an appropriate ratio because the KMO value is over 0.60, and the extracted value is higher than the value determined by Hair, Anderson, Tatham, and Black (1998). Thus, the sample is congruent with the study and the CFA was used to ascertain the plausibility of the factor frame generated by the EFA. After the statistical analysis results, it was confirmed that only 22 factors of the four study variables have been valid. According to study analysis, Eigenvalues for all four variables JIT, LA, ES, and CR are more than one (7.20, 6.46, 4.71, and 1.80, respectively). According to study analysis, variance explained for all four variables JIT, LA, ES and CR indicates good results (32.71, 29.35, 16.88, and 8.18, respectively) with a cumulative value of 87.11. This means that there is no dominant variable means and all reduction in costs related to these variables, the remaining value (12.89) for other variables as shown in Tables 4 and 5 in Figure 2.

Table 3. KMO and Bartlett's test.

Kaiser-Meyer-Olkin measure of sampling adequacy.	0.813	
Bartlett's test of sphericity	Approx. Chi-square	3970.614
	Df	253
	Sig.	0.000

Table 4. Factor analysis matrix.

Factor		Component			
	Code	1	2	3	4
Value-added activity (VAA)	JIT1	0.985			
Setup time reduction (STR)	JIT2	0.967			
Inventory level (IL)	JIT3	0.966			
Defect products (DP)	JIT4	0.964			
Supplier development (SD)	JIT5	0.933			
Resources utilization (RU)	JIT6	0.921			
Competitive advantage (CA)	JIT7	0.884			
Value-added activity (VAA)	LA4		0.923		
Setup time reduction (STR)	LA1		0.910		
Inventory level (IL)	LA3		0.892		
Defect products (DP)	LA2		0.891		
Resources utilization (RU)	LA5		0.879		
Competitive advantage (CA)	LA6		0.855		
Continuous flow (CF)	LA7		0.826		
Customer involvement (CI)	LA8		0.817		
Operating hours cost (OHC)	CR1			0.967	
Product design cost (DDC)	CR2			0.961	
Inventory cost (IC)	C63			0.935	
Defects cost (DC)	CR4			0.791	
Truthful information (TI)	ES2				0.906
Safety products (SP)	ES1				0.899
Transparency (T)	ES3				0.747

Table 5. Eigenvalues and variance explained.

Total variance explained									
	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
Components	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	7.196	32.708	32.708	7.196	32.708	32.708	6.414	29.157	29.157
2	6.457	29.349	62.057	6.457	29.349	62.057	6.408	29.128	58.285
3	3.713	16.876	78.933	3.713	16.876	78.933	3.645	16.566	74.851
4	1.799	8.177	87.110	1.799	8.177	87.110	2.697	12.259	87.110
5	0.665	3.025	90.135						
6	0.480	2.183	92.318						
7	0.356	1.618	93.936						
8	0.331	1.505	95.441						
9	0.171	0.777	96.219						
10	0.154	0.701	96.919						
11	0.143	0.649	97.568						
12	0.116	0.527	98.095						
13	0.089	0.407	98.501						
14	0.071	0.324	98.825						
15	0.067	0.305	99.130						
16	0.051	0.233	99.363						
17	0.048	0.216	99.579						
18	0.029	0.133	99.712						
19	0.024	0.110	99.822						
20	0.019	0.086	99.909						
21	0.013	0.060	99.969						
22	0.007	0.031	100.000						

Note: Extraction method: Principal component analysis.
Source: SPSS results

4.3. The Hypotheses Test

This study examined the direct and indirect, positive and negative influence of integration between LA tools and JIT methods on CR. Path analysis (PA) was used to test the hypotheses as one of the structural equation modeling methods (SEM) as shown in Figure 2 and Tables 5, 6 and 7 where it was found that by using AMOS software version 24 and SPSS software version 24. For data analysis, there is a statistical and positive effect for the LA tools on CR where the P-value reached 0.002 and this is less than 5% which confirms acceptance of *H_1: There is a significant effect of using LA tools on CR*. There is no statistical and negative effect for the JIT technique on CR where the P-value reached 0.494 and this was more than 5% which indicates the rejection of *H_2: There is a significant effect of using the JIT technique on CR*. There is indirect and positive effect for the LA on CR throw ESs where P-value reached 0.000 and this is less than 1% which confirms acceptance of *$H_{3.1}$: ESs mediate the effect of using LA tools on CR*. There is an indirect and positive effect for the JIT technique on CR throw ESs where the P-value reached 0.000 and this is less than 1% which confirms acceptance of *$H_{3.2}$: ESs mediates the effect of using JIT on CR*.

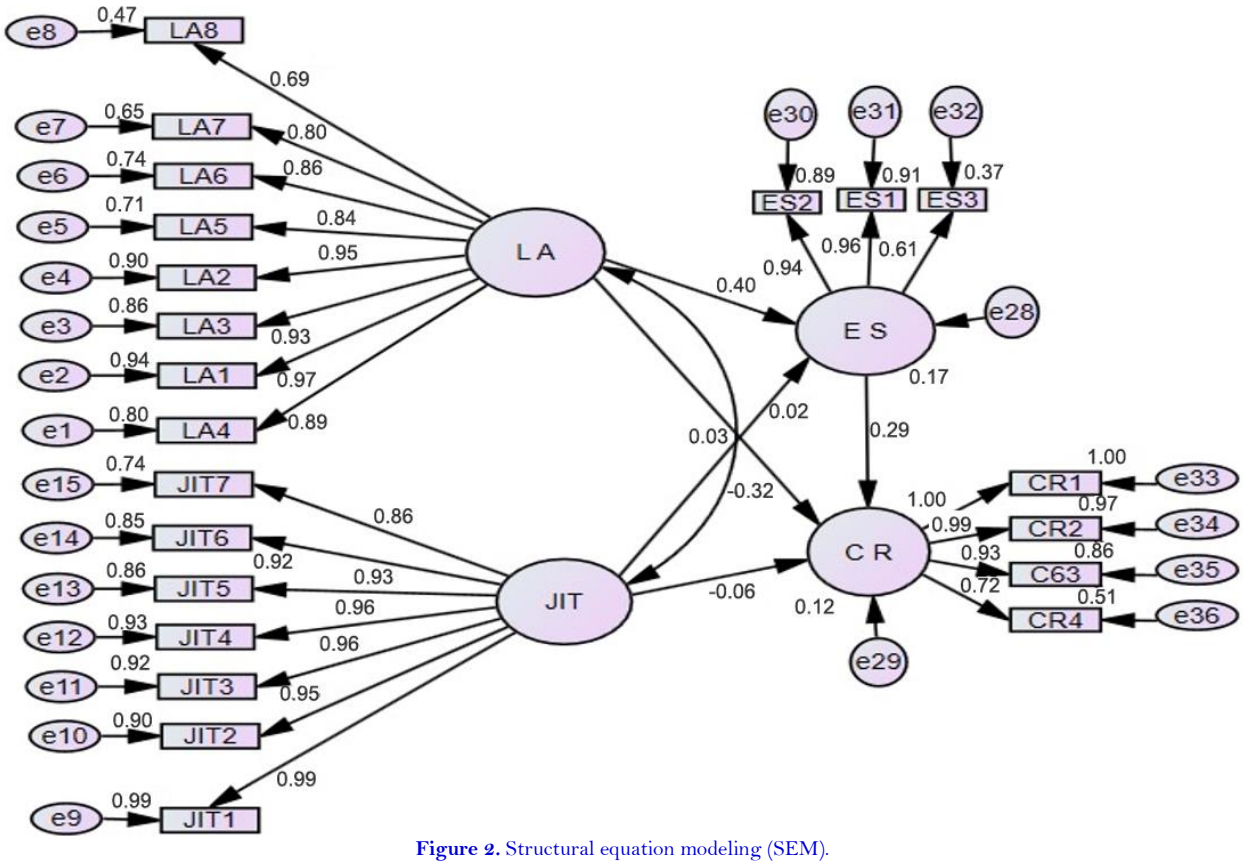

Figure 2. Structural equation modeling (SEM).

Table 6. Regression weights (Direct effects).

Variables	Estimate	S.E.	C.R.	P-value	Result
CR <--- LA	-0.304	0.098	-3.107	0.002**	Accept
CR <--- **JIT**	-0.058	0.085	-0.684	0.494	Reject

Note: **, p-value < 0.05. Significant at the 0.05 level.

Table 7. Regression weights (Indirect effects).

Hypothesis					P-value	Result
CR	<---	ES	<---	LA	***	Accept
CR	<---	ES	<---	JIT	***	Accept

Note: ***, p-value < 0.001. Significant at the 0.05 level.

5. CONCLUSION

The study's aim is to investigate the impact of integration between LA tools and JIT techniques on CR in a new industrial environment in Saudi companies. This study focused on testing the direct and indirect impact of LA tools and JIT techniques on CR and the integrated impact of LA tools and JIT techniques on CR in chosen companies. The findings of this study displayed that there is a direct effect of LA tools (0.3) on CR (H.1). This result is in line with previous studies that claimed the direct and positive impact of LA tools on CR and performance (Almashkor, 2021; Amusawi et al., 2019; Kadhim et al., 2020; Muhammad & Isah, 2020; Ofileanu & Topor, 2014). However, the findings of this study also showed that there is no direct effect of JIT technique (0.03) on CR (H.1) despite some previous studies showing the direct effect of JIT technique on CR (Arai, 2021; Siddiqui, 2022). The results of this study also showed that there is an indirect effect of LA tools (0.29) on CR when ESs was used (H.3.1). This study indicates an indirect effect of the JIT technique (0.29) on CR, when ESs was used (H.3.2). This means that ESs play a marvelous role for the application of LA tools and JIT techniques as significant factors in CR especially cost that is related to operating cost (0.967), design cost (0.961), inventory cost, (0.935) and defect cost (0.791). The reason for that is managers sometimes concentrate on CR by using unethical ways to obtain self-interest. Therefore, in these cases, the company needs to use some ESs when it applies LA tools and JIT techniques.

The two applications were agreed in some items with regard to integration between LA tools and the JIT technique on CR:

Value-Added Activity (VAA): The two applications concentrate on VAA to remove non-value added activities in the production process to reduce production costs, the factor analysis for the JIT technique and LA tools of this item was 0.985 and 0.923 respectively. Therefore, this result directly contributes to meeting customer needs, and customers are willing to pay for company products.

Setup Time (ST): Both applications try to reduce ST from purchasing raw materials to delivering production to the customer to reduce production costs, the factor analysis for JIT techniques and LA tools of this item was 0.967 and 0.910 respectively. Accordingly, this result directly contributes in reducing setup period that is needed before production and hence speeding up the process of delivering products to customers.

Inventory Level (IL): The two applications try to decrease IL and only a minimal or nil inventory should be maintained to reduce production costs, the factor analysis for JIT techniques and LA tools of this item was 0.966 and 0.892 respectively. Therefore, this result directly contributes in saving money for maintaining and managing inventor by doing this, the financial risks will be declined at a lower rate in the company.

Defect Products (DP): Cooperatively both applications try to reduce DP that occurs during production to meet the customer's needs and hence reduce production costs, the factor analysis for JIT techniques and LA tools of this item was 0.964 and 0.891 respectively. Accordingly, this result directly contributes in realizing a competitive advantage for the company by doing this, it will gain more customers.

Resources Utilization (RU): The two applications try to make optimal use of available resources by doing this, the company utilizes its resources in a more effective way and hence reducing costs. The factor analysis for JIT techniques and LA tools of this item was 0.921 and 0.879 respectively. Therefore, this result directly contributes to making optimal use of available resources, hence achieving high sustainable performance for the company.

Competitive Advantage (CA): Both applications try to increase the CA; the factor analysis for JIT technique and LA tools was 0.884 and 0.855 respectively. Therefore, this result helps companies acquire a competitive advantage that allows them to generate more sales than their market rivals and hence promotes their financial performance.

Additionally, when the managers of companies consider the ESs in the CR process, this cost reduction will be real and accurate especially standards that relate to truthful information (0.906), safe products (0.899), and transparency (0.747) as shown in Table 4.

According to this analysis, both applications play an important role in CR by eliminating waste and reducing unnecessary costs associated with activities such as removing non-value added activities, maintaining lower

inventory, producing non-defective products and realizing optimal use of available resources; therefore by doing so, the companies ensure sustainable manufacturing; this is one of the Sustainable Development Goals (SDGs). The outcomes of this study pointed out that the implementation of LA tools and the JIT method has a positive influence on the advancement of sustainable production and consequently the achievement of distinguished sustainable performance. This result is in line with previous studies that claimed the direct and positive impact of these applications on realizing sustainable performance (Chen, Lujan-Blanco, Fortuny-Santos, & Ruiz-de-Arbulo-López, 2020; Mao, Lu, & Shieh, 2023; Yin & Liu, 2023).

6. THE STUDY IMPLICATIONS

The results of this study have theoretical and practical contributions that could be of interest for decision - makers in Saudi manufacturing companies. The study findings provide guidance on the interrelationships between LA tools and JIT technique and their economic consequences. Moreover, the study findings will serve as a basis of knowledge for decision-makers in Saudi manufacturing companies as they enhance strategies to deal with lean manufacturing. The implementation of LA tools and JIT techniques has led to cost reductions and hence strengthened profitability indicators. Accordingly, the financial performance measures will be improved by cost reduction taken by managers of Saudi manufacturing companies. Additionally, the implementation of LA tools and JIT techniques contribute to make optimal use of available resources and hence achieving high sustainable performance. Furthermore, when Saudi industrial companies make safe products they will acquire a competitive advantage that allows them to generate more sales than their market rivals. Therefore, the findings of this study provide managers in Saudi manufacturing companies with the shrewdness into the momentousness of adopting both LA tools and JIT techniques in their firms in an integrated way to decrease cost and increase the gains of these companies. These factors led decision-makers in these companies to concentrate on factors that contribute to profit maximization especially factors related to LA tools and JIT techniques such as value-added activity (0.985 and 0.923), setup time reduction (0.967and 0.910), inventory level (0.966 and 0.892), defect products (0.964 and 0.891), resources utilization (0.921 and 0.879) and competitive advantage (0.884 and 0.855) as shown in Table 4.

7. LIMITATIONS AND FUTURE DIRECTIONS OF STUDY

Some limitations need to be considered in spite of the theoretical and practical contributions of this study. The first limitation of this study concerns the difficulty in generalizing study results. This study was applied only to manufacturing companies in Saudi Arabia. Therefore, it is difficult to generalize these results to industrial companies in other countries. The second limitation concerns the sample size of the study. This study was concentrated on a small number of managers and accountants in manufacturing companies in the Saudi Arabia. Another limitation of this study is that it did not include service establishments in Saudi Arabia environment. This study was concentrated on manufacturing companies but **service** facilities were ignored. Some presuppositions made in this study require extra future study, for example, the JIT technique is relatively new to the Saudi Arabian environment may be that the majority of Saudi manufacturing companies have not yet implemented both LA tools and JIT techniques. Therefore, the respondents' background on these applications is limited. Thus, the respondent's answer to this field might not be inaccurate. Therefore, we recommended examining the level of integration of both applications in Saudi Arabian industries especially with regard to other variables **and** contradictory variables found in this study that the effect of integration between LA tools and JIT techniques on CR. These variables lead to CR (12.89%) as shown in Table 5. Therefore, we recommended examining the level of integration of both researching the relationship between the VS system and BC system as a tool used in LA tools and JIT techniques.

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Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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