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Lean-Based Design and Analysis of a Continuous Improvement Engineering Approach for Jordanian Land Transport Industry

Mohammad D. AL-Tahat[1,2,*], Mohammed Juma Mohammed[1].

[1]*Industrial Engineering Department, School of Engineering, The university of Jordan, Amman 11942, Jordan*
[2]*Mechanical and Industrial Engineering Department, Faculty of Engineering, Liwa College, United Arab Emirates, Abu Dhabi.*
**Corresponding author: mohammad.altahat@lc.ac.ae, altahat@ju.edu.jo*

Abstracts: For an open, competitive, and lean economy, especially in industrialized development nations like Jordan, competitiveness, efficiency, and low global transportation costs are crucial. It is vital to address these concerns to sustain lean transportation services. This paper intends to present a lean-based analysis of a continuous improvement approach for Jordanian land transport industry, the aim behind that is to improve the overall effectiveness of the Jordanian land transportation sector. The research uses the Structural Equation Modelling (SEM) as a lean tool to fill the knowledge gap between theory and practice and to shed light on the continual improvements of Jordan's land transportation sector. Five of the largest land transportation companies have provided data, which has been gathered using primary and secondary data sources. Managers, drivers, and operations officers are polled using a 65-question Five-Point-Likert survey. The research looks at how the cost of transportation, customer satisfaction, safety, management emphasis, travel time, and driving abilities affect overall effectiveness. Operations, technical, and managerial efficiency are the metrics used to evaluate efficiency. Eight hypotheses between three efficiency measures and six independent variables are brought up. Correlations, tolerance tests, and Variance Inflation Factor (VIF) multicollinearity tests validate and confirm the findings. The research identifies significant barriers impeding the effectiveness of Jordan's land transportation industry and seeks to close the gap between theory and practice. Future research plans to investigate how other Jordanian service sectors measure their efficiency because the developed approach is useful and applicable.

Keywords: Efficiency Improvements, Land Transport Industry, Jordan, Lean Methodology, Continuous Improvement, Lean.

1. INTRODUCTION

The free economic opening to fiercely competitive markets is one of the effects of globalization, Industry 4.0, and the Internet of Things (IoT), continuous improvements methodologies, and lean management philosophy. Taiichi Ohno, a Toyota chief engineer (1912-1990) [1], developed some of the basic ideas and procedures that have come to be known as continuous improvement methodologies. Continuous improvement methodologies have a proven track record in diverse sectors, including manufacturing, healthcare, transportation industry and services [2,3]. The choice of methodology depends on the needs and goals of an organization. Key aspects of continuous improvement methodologies include Kaizen, Structural Equation Modelling (SEM), Total Quality Management (TQM), Agile Principles, Lean production, Lean Six Sigma, Furthermore, the PDCA (Plan-Do-Check-Act). Theory of Constraints (TOC) etc. This necessitates flexibility and a persistent focus on service efficiency and prices, including transportation services. Countries with transportation systems that are competitive and remain so will have more conventional systems. As a result, urgent concerns about global transportation costs, efficiency, and competitiveness are raised, particularly in industrialized development nations like Jordan. Jordan is a country in Western Asia formally known as the Hashemite Kingdom of Jordan. It is located in the Levant region, on the East Bank of the Jordan River, at the intersection of Asia, Africa, and Europe [4]. Jordan plays a vital role in the transportation sector due to its geographical position between the company clean area on the one hand and Gulf centuries, Syria, Iraq, and other Asian countries on the other hand; the government of Jordan, represented by the Ministry of transport, can enforce several rules and project to develop and optimize most of the factors influencing the sector [5, 6]. The transportation ministry was established in 1971; it is responsible for policymaking, monitoring, coordinating, and supporting all transportation sectors and developing plans and studies to help boost these vital

sectors [7]. A new law was passed in 2003, granting the Ministry of Transportation the responsibility of overseeing, assisting, and controlling with legal personality Land Transport Regulatory Commission (LTRC). According to the LTRC annual reports, 336 businesses were registered between 2003 and 2018; these businesses specialize in the movement of goods both domestically and internationally, and they fall into nine categories: container transport, general cargo transport, heavy-duty transport refrigerator, cattle transport, plant oil transport, crude oil transport, and ready concrete transport [8].

The transportation avenue provides tertiary services and thus plays a major part in the Jordanian economy [9]. More specifically, in promoting economic activity across sectors and regions, transport plays a vital role [10,11]. Due to the economic improvement of the world as well as rapid capital flow and knowledge flow, modern methods of logistic management in the field of transportation have been put into operation [12]. It has thus become financially inefficient to own one's fleet of automobiles [13, 14]. Consequently, in the transportation sector, the question of inefficiency must be discussed. Greater coordination across the transportation supply chain would be required to maintain transport efficiency in a trading climate defined by low inventory and quick reaction [15, 16]. However, this partnership needed to be improved by a lack of reliable data on transport efficiency levels across the chain, among other things [17, 18].

Industrial practitioners and researchers have developed different continuous improvements methodologies and lean methods for monitoring and assessing the output performance of systems in terms of efficiency [19, 20]. Organizations did incorporate some mechanisms to establish primary performance measures regardless of their operating sector. They continually evaluate their efficiency to enhance it and reduce the gaps by taking corrective actions [21]. Practical efficiency evaluation shall be based on precise, measurable, reliable, and comprehensive measurements [22]. After careful consideration, five performance indicators have been created, representing the significant interest in loading vehicles and fuel economy. Their choice was to strike a compromise between the government's objective to increase knowledge of the factors that influence energy usage in the freight transport industry and the desire of businesses to achieve greater operational efficiency and service quality initiatives. Vehicle loading is first based on the average height of the pallets, the number of pallets, and the payload weight. Historically, load factors have only been determined for weight in official government freight surveys. (2) Empty running: The vehicle's total distance traveled while in good condition. This prevents the collection of a backhaul load by excluding the return movement of empty handling equipment. As a loaded trip type, these motions are logged individually. (3) The amount of fuel used (4) Utilization of vehicle time. And (5) Deviations from the schedule and delays.

1.1 Research Objective

This research aims to investigate how operational, technical, and managerial transport aspects affect the leanness of land transport in the Jordanian industry. As a lean tool for continual improvement, a Structural Equation Modelling (SEM) as is developed, a three main constructs of overall service performance (operational efficiency (OE), technical efficiency (TE), and managerial efficiency (ME) will be the focus of the SEM model, which will combine questionnaires and structured interviewing techniques to collect data. The research will specifically look at the impact of transportation cost (C), customer satisfaction (CS), adhered safety (S), management focus (MF), transportation time (T), and drivers' skills (DS) on the effectiveness of land transport. The research uses structural equation modelling as a lean tool to fill the knowledge gap between theory and practice and to shed light on the continual improvements of Jordan's land transportation sector.

1.2 Research Question

The finding of this research is expected to answer the following questions.

(1) How do these variables impact the leanness in term of overall efficiency of the land transport sector in Jordan?

(2) How do this lean approach impacts the improvements of operations efficiency (OE), technical efficiency (TE), and managerial efficiency (ME)?

2. MODELLING AND HYPOTHESES OF EFFICIENCY MEASUREMENT

Companies have practiced efficient management to ensure proper operation [23]. Efficiency tracking is a helpful way to help envision and track progress toward a specific target [24]. It also explains the state of organizational behaviors and how they are linked. The efficiency metrics must streamline the flow of content, information, and cash, simplify decision-making operations, and remove steps that do not add value. According to Parmenter [23], the benefits of efficiency measurement in organizations are supporting progress, ensuring fulfillment of customer's needs, the company can better understand its procedures, helping to recognize which problem or bottleneck needs to be solved, improved, or changed and where that will happen, guarantees that decisions are based on evidence, not speculation or supposition, and ensure that targeted progress is occurring. That enables organizations to understand consumers, the organization's processes challenges, and the big picture of the organization's performance measurement system in practice [24].

The organization may use various efficiency metrics for various purposes, including quality, cost, finances, flexibility, delivery, employee satisfaction, safety, learning, and development. These metrics can be found in the literature and are used by numerous organizations for assessing and controlling efficiency [23:25]. This research uses transportation cost, customer satisfaction, adhered safety, management focus, transportation time, and the degree of drivers' skills as metrics for the efficiency evaluation of land transport in Jordan. These metrics are [24, 26] reliable, obvious and quick to conclude, able to process and collate the data, capable of articulating new emerging patterns, representative, resilient, capable in the face of shifts inside and outside the company, capable of updating data rapidly and comfortably [27]. These metrics are considered independent modeling variables. The overall efficiency and its three efficiency measures are considered dependent variables.

A questionnaire draft was developed, and it was pilot tested and reviewed by managers of several firms, and literature, then from a sample of convenience that represents some Jordanian companies, the data was collected. The questionnaire is designed based on a five-point Likert scale at (1) ‘‘Poor”, (2) “Fair”, (3) “Good”, (4) ‘‘Very good”, and (5) ‘‘Excellent”. Responses were collected. The theoretical model in Figure 1 shows the causal relationships between the different model components; accordingly, a list of hypotheses is proposed, as shown in Table 1.

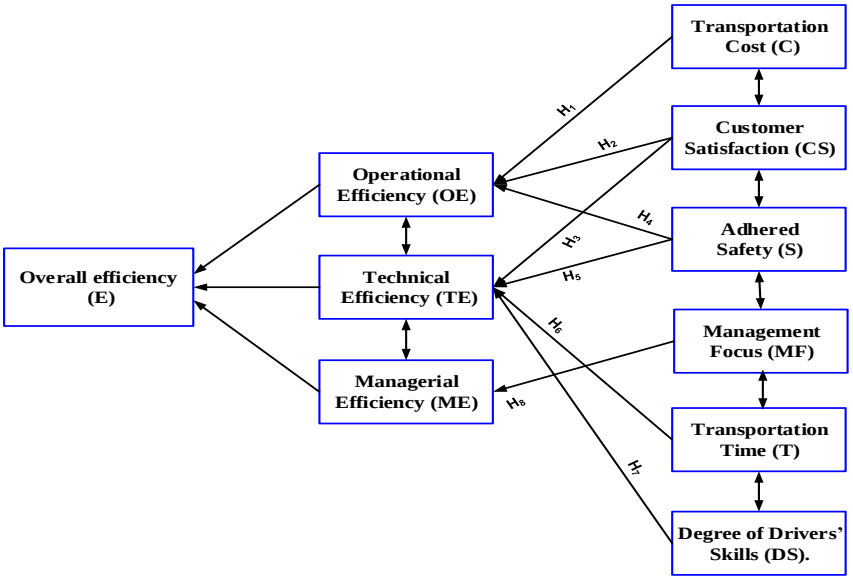

Figure 1. Hypothesized causal relationships.

Table 1. The proposed hypotheses.

Hypothesis	Implication
H1	Transportation cost has a positive effect on operational efficiency
H2	Customer satisfaction has a positive effect on operational efficiency
H3	Customer Satisfaction has a positive effect on technical efficiency
H4	Adhered safety has a positive effect on Operational efficiency
H5	Adhered safety has a positive effect on technical efficiency
H6	Transportation time has a positive effect on technical efficiency
H7	The degree of driver's skills has a positive effect on technical efficiency.
H8	Management focus has a positive effect on managerial efficiency

3. METHODOLOGY

3.1. Population of the Research

The population of the research includes (1) road transport of goods, specialized road transport companies according to the mode of transportation presented in Table 2, and (2) Passenger transport, different means of transport, and their numbers used to transport passengers are presented in Table 3. This research will focus on the biggest five land transportation companies according to the number of trucks. The letters A, B, C, D, and E will be used to express these five companies, Table 4 and Table 5 show the most important data related to these companies. At least three managers (from any level), five drivers, and five operations officers are surveyed from each company, accordingly, feedback from 142 respondents out of 150 surveyed bodies.

3.2. Data Sources

The research collected data from the surveyed respondents using a well-structured questionnaire. The collected data was then analyzed with the statistical package for social sciences (SPSS) and Minitab according to the hypothetical efficiency evaluation model proposed in Figure 1. The weight capacity and utilization, the distance traveled, the fleet used, and its utilization are evaluated. A panel of judges conducted the validity testing; they provided guidance in the choice of the data collecting technique, assessed the questionnaire's structure and design, and afterward verified the findings.

Table 2. Number of specialized road transport companies according to the mode of transportation.

Mode of transportation	Number of companies
Containers	125
General Merchandise	126
Cars	10
Weights and coolant	19
Livestock, Vegetable oils and sheep	7
Crude oil and its derivatives	57
Ready-made concrete	6
Total	350

Table 3. Different means of transport and their numbers used to transport passengers.

The statement	Number
A public service within the jurisdiction of the Transport Authority	1013.0
General average within the jurisdiction of the Transport Authority	3521.0
A public bus within the authority's jurisdiction	734.0
Tourist rental cars	11267.0
Number of tourist rental car offices	234.0
Number of vehicles registered as private	12742.0
Number of privately registered medium buses	11798.0
Number of privately registered buses	944.0
Number of vehicles registered as tourist transport	802.0
Number of medium buses registered as tourist transport	287.0
Number of buses registered as tourist transport	529.0
Yellow taxi cars	5382.0
Number of taxi offices	143.0
Airport taxis	228.0
Crossing taxi cars	30.0
Luxury cars, taxis (limousines)	526.0
Number of luxury car taxi offices	23.0
Hotel taxi office cars	130.0
Number of hotel taxi offices	14.0
Number of taxis for people with special needs (yellow taxi)	30.0
International transport fleet	236.0
Number of international carriers	35.0
Fleet rental companies	976.0
Number of medium buses registered as rental	575.0
Number of buses registered as rental	399.0
Number of leasing companies	21.0
Foreign travel cars	1072.0
The number of smart application companies	7.0
Fleet of smart applications	12695.0
Number of school transport companies	13.0
School transportation fleet	126.0
Number of buses for people with special needs	24.0
Updated public bus numbers	24.0
Number of public buses that have been updated (cumulative for all years)	3535.0
Fleet number, buses, passenger cars, small rides, and taxi.	37184.0
Degree of satisfaction with public transportation services	0.7
Number of buses per 1000 person	0.7
Capital expenditures during 2020 (JOD)	7,729,198.0
Average operating life of a public transport fleet (years)	10.6

3.3. Evaluating Independent Variables

The work uses 41 variables for evaluating the six independent variables; for each variable, several attributes were to be examined. The SPSS program manipulated the obtained data depending on the statistics, see the data sample in Table 6. The score evaluation of each attribute depends on its statistical mean of it; if the mean is between (1.00 – 2.99), the attribute is weak; if the mean is between (3.00 – 3.89), the attribute is average; and if the mean between (3.90 – 5.00) the attribute is strong.

3.4. Overall Efficiency

This research aims to obtain the effects of transportation cost, customer satisfaction, adhered safety, management focus, transportation time, and the degree of drivers' skills on the overall efficiency of the Jordanian land transport industry. Literature [28, 29] showed different indicators for measuring overall business efficiency. Overall efficiency is evaluated in terms of three indicator measures: operations efficiency, technical efficiency, and managerial efficiency. Similarly, the score evaluation of each efficiency indicator depends on its statistical mean of it; if the mean is within the interval [1.00 – 3.0[the indicator is weak; if the mean is within the interval [3.00 – 3.9[the indicator is average. Otherwise, the indicator is strong. The statistics for the overall efficiency of dependent variables are presented in Table 7.

Table 4. Operational information related to the biggest five land transportation companies A, B, C, D, and E.

Company	Average Number of monthly trips	Utilization			Average Vehicles		Weight (tons)	
		Load	Travelled distance	Fleet	Total	Active	Total loaded	Available
A	11500	0.97	0.51	0.85	78	63	62000	64000
B	1660	0.98	0.50	0.50	137	108	102000	104000
C	1060	0.92	0.66	0.88	100	89	44000	47000
D	760	0.99	0.57	0.58	180	160	47000	48000
E	1500	0.99	0.54	0.66	105	70	81000	82000

Table 5. Containers and general cargo categories related to the biggest five land transportation companies.

Company	Number of employees	Number of drivers	Fleet size	Number of managers & Supervisors	Founding year
A	334	70	285	20	2006
B	230	100	136	20	1984
C	192	125	100	25	1999
D	200	181	181	20	2006
E	130	97	107	33	1992

Table 6. Resulting Statistics for the attributes of independent variables, (data sample).

Attribute	Code	N	Mean	σ	Skewness	Kurtosis	Evaluation
1	C1	142	3.517	1.226	-0.324	-0.800	Average
2	C2	142	4.258	0.924	-1.250	1.211	Strong
3	C3	142	3.349	1.149	-0.308	-0.502	Average
4	C4	142	4.191	0.952	-1.284	1.609	Strong
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
38	DS6	142	3.191	1.322	0.062	-1.312	Average
39	DS7	142	2.989	1.301	-0.105	-1.153	Weak
40	DS8	142	3.955	1.097	-1.020	0.529	Strong
41	DS9	142	3.360	1.141	-0.232	-0.559	Average
	Valid N	140					

Table 7. Statistics for the overall efficiency: Dependent variable.

No	Efficiency indicator	N	Mean	Std. Deviation	Variance	Kurtosis	Evaluation
1	OE	142	3.315	1.24	1.5	-1.04	average
2	TE	142	3.06	1.20	1.45	-1.08	average
3	ME	142	3.496	1.389	1.365	-.963	average
	Valid N (list-wise)	142					

4. LEAN-BASED ANALYSIS OF THE PROPOSED DESIGN

The attribute-variable to variable-score correlations is examined to determine if an attribute accurately represents the related variable as intended. Calculating the arithmetic average of the scores of the qualities that make up the variable yields its score. Varimax rotation was used to clarify and confirm the link between the components (attributes and variables). As a result, statistics of the underlying connection structure are displayed in Table 8; removing the middle ground in the varimax rotation simplifies the loading of attributes. Only factor loadings of 0.5 or higher and 0.35 or lower on the remaining factors are considered. Four significant variables with eigenvalues larger than one that explained 77.100% of the variation were found using the varimax analysis. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy was used to validate the percentage of variation for the variables that underlying causes might have caused. This number of KMO suggests a suitable Interco connection with Bartlett's Test of Sphericity, which is also determined to be significant (Chi-square = 3872.700, $p < 0.001$). The KMO measure of sample adequacy is 0.779. These variables are customer satisfaction (CS) (6 attributes), transportation time (8 attributes), adhered safety (S) (6 attributes), management focus (MF) (7 attributes), and Transportation Time (T) (4 attributes), the analysis indicates satisfactory results, Thus, therefore the model with the four variables is adequate to represent the data. The rate of change in the relationships between two variables and noise control in relations can be measured by eigenvalues; if one eigenvalue is zero and the other is negative, the relationship is stable. On the other hand, if (at least) one of the eigenvalues is positive, the relationship is unstable. In Table 9, the eigenvalue of 1.511 clarifies 49.012% of the variance. The KMO of 0.681 indicates sufficient Interco relations, while Bartlett's test of Sphericity is significant (Chi-square = 202.8, p =0.000).

Table 8. SPSS results for factor analysis and scale reliabilities of E elements (Independent variables) (N =142).

Attribute No	Variable	Average Factor Loading	Reliability	Statistical measures	
10 - 15	Customer Satisfaction (CS)	0.736	75.80%	Chi-Square	3872.7
16 - 21	Adhered to Safety (S)	0.778	75.30%	Eigenvalues	14.1
22 - 28	Management Focus (MF)	0.741	77.90%	Variance Explained	0.771
29 - 32	Transportation Time (T)	0.756	72.75%	KMO	0.779

Table 9. SPSS Results for factor analysis and scale reliabilities of performance measures (Dependent variables).

Efficiency Indicator	Factor Loading	Reliability		
OE	0.876	79%	Eigenvalues	1.511
TE	0.703		Percentage of Variance Explained	49.012%
ME	0.801		KMO Measure	0.681
			Chi-Square	202.8

4.1. Multicollinearity analysis

Multicollinearity measures a regression model's intercorrelations among two or more independent variables. High correlations create redundant information and skew the results in a regression model. Perfect multicollinearity means that the regression model exhibits a deterministic linear relationship, whereas no multicollinearity (the absence of perfect multicollinearity) means an exact (non-stochastic) linear relation among the predictors. A correlation matrix can investigate only simple correlations between two decision variables. Thus, multicollinearity

investigates multiple correlations among more than three variables. Multicollinearity can be measured either by the 'Tolerance' method or by the 'Variance Inflation Factor' (VIF); see equation (1) and equation (2).

Tolerance = 1 – (Coefficient)2 (1)

VIF = 1/Tolerance (2)

A low tolerance value indicates a high level of multicollinearity, and a significant VIF value indicates a high level. While Hair et al. [30] reported that "10" was the greatest level of VIF, Ringle et al. [31] reported that "5" was the maximum level of VIF [31], as shown in Table 10 the VIF value for developed model is 3.87, the results confirmed that multicollinearity among the variables is not a problem.

Multiple linear regression analysis was used to test the proposed model hypotheses. Independent variables were regressed on overall efficiency. As seen in Table 10, the results of regression analysis revealed that all predictor variables were significant, and hence the regression model of estimating the overall efficiency (E) can be described as in equation (3)

E = 0.401-0.1C+0.139S+0.062DS+0.43MF-0.14T+0.01CS+e (3)

Management focus (MF) was the strongest predictor (βMF = 0.430, P < 0.001), followed by transportation time (T) (βT = 0.140, P < 0.001), adhered safety (S) (βS= 0.139, P <0.001), then transportation cost (C), degree of drivers' skills (DS), and customer satisfaction (CS) with (βC= 0.100, βDS= 0.062, βCS= 0.010 respectively, P <0.001). Although the regression coefficients (βC, βDS, βCS) are somewhat low, there was a positive relationship between their corresponding predictors and the overall efficiency's predicted value.

4.2. Hypotheses Testing Results

Similarly, regression coefficients between different model components are shown in Figure 2; the results of the relationship supported most of the hypotheses proposed previously in Table 1. Hypothesis H1, H2, and H3 stated that (transportation cost and customer satisfaction have a moderately positive effect on efficiency); all these hypotheses were strongly confirmed by the data (p <0.01). The survey data strongly confirms the hypothesis H4, H5, H6, H7, and H8 (p < 0.01). Results also reveal that the transportation cost and time are inversely proportional to the overall efficiency. Model validation has been carried out by a board of adjudicators who are recommended in the choice of data collection method, assessed the questionnaire shape and layout, suggested a nonprobability suitability sample of size, and accordingly Verification the obtained results.

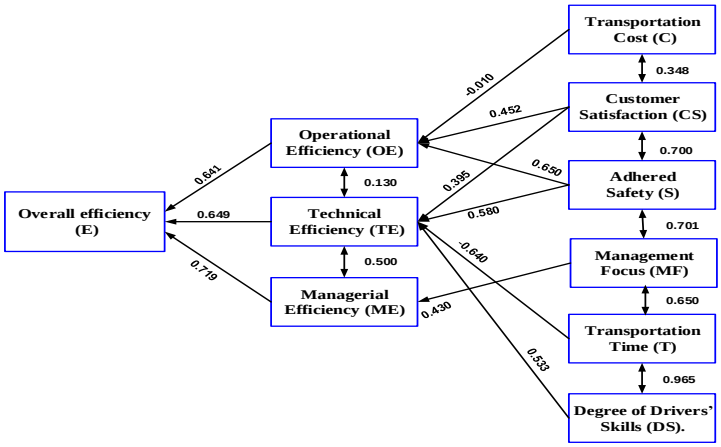

Figure 2. Hypothesized causal relationships.

Table 10. SPSS Results for factor analysis and scale reliabilities of performance measures (Dependent variables).

Predictor variables	Standard Error	Regression Coefficients		t	Sig.	95% Confidence Interval		Multicollinearity	
		Unstand. β	Stand. β			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	0.622	0.401		0.641	0.524	-0.840	1.640		
(C)	0.174	- 0.100	0.059	0.638	0.525	-0.240	0.460	0.69	1.45
(S)	0.148	0.139	0.146	0.973	0.333	-0.150	0.440	0.26	3.87
(DS).	0.165	0.062	0.047	0.366	0.715	-0.270	0.390	0.35	2.83
(MF)	0.128	0.430	0.428	3.32	0.001	0.170	0.680	0.35	2.83
(T)	0.166	- 0.140	0.111	0.840	0.403	-0.190	0.470	0.34	2.96
(CS)	0.125	0.010	0.012	0.100	0.921	-0.240	0.270	0.44	2.28

CONCLUSIONS

The main concept of interest here is to implement the philosophy of continuous improvements and lean management in Jordanian industrial firms. It was determined that the efficiency improving methodology used in this research is practicable. The Jordanian land transportation sector may utilize it at various phases for ongoing development. Companies in the Jordanian land transport sector is starting to understand that increasing productivity is the best path to long-term success. Implementing an enhancing policy to increase efficiency has proven challenging for many businesses. The most prevalent elements impacting effective efficiency improvement for land transportation businesses have been covered in this essay. Results have demonstrated that the link between the variables considered, and the overall effectiveness of land transportation businesses is complicated. Land transport firms must be aware that these predictors, which are crucial to total efficiency, might fluctuate over time, vary depending on the efficiency dimension, and vary for each organization. The developed model has led to a variety of results, some of which are:

1. Adhered to safety, degree of drivers' skills, and management focus, customer satisfaction positively affects the overall efficiency of land transport companies.

2. Transportation cost, and transportation time, customer satisfaction harms the overall efficiency of land transport companies.

3. There is a strong relation between regression predictors, especially between transportation time and the degree of drivers' skills.

4. There is a strong relationship between technical efficiency and managerial efficiency.

This research will theoretically contribute to understanding the actual and effective implementation of the KPIs adopted inside the most prominent shipping companies in practically solving the performance issues in Jordan as it is imperative to recognize how well a certain company is, by comparing it with similar ones. The existence of containers with a fixed capacity causes the exploitation of the capacity of transporting loads as shown in Company C and thus an increase in the cost of delivery on the shipping company, and accordingly, it is recommended to have transport containers with variable vehicle sizes to serve the requirements of different loads. It is also recommended that all companies formulate routing systems to maximize distance utilization and reduce unproductive distance, and this can be done by including more duties during the return trip.

The current research examines the efficiency of five major land transportation companies in Jordan, but caution is needed in generalizing findings to the entire land transportation sector. Relying on three indicators to measure efficiency may overlook crucial information about the transportation's overall effectiveness. Future research should scrutinize influential factors, assess their criticality, and explore connections with efficiency improvements, incorporating principles of lean management and emphasizing the importance of continuous improvement. To

enhance representativeness, a broader sample size of companies from diverse sizes and regions in Jordan is recommended. Additionally, incorporating indicators like financial success and environmental impact will contribute to a more comprehensive land transportation assessment.

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