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RESEARCH ARTICLE

Critical Success factor of Malcolm Baldrige National Quality Award (MBNQA), Lean Practice with Thai Automotive Industry

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ABSTRACT

This study aims to identify and evaluate the critical success factors (CSFs) affecting the implementation of the Malcolm Baldrige National Quality Award (MBNQA) and Lean Practices (LP) in the Thai automotive industry. A comprehensive literature review was conducted to identify potential CSFs for MBNQA and LP implementation. Data were collected through a survey questionnaire administered to 453 Thai automotive suppliers. Exploratory factor analysis (EFA) and Confirmatory Factor Analysis (CFA) were employed to validate the measurement model. The results reveal four CSFs for MBNQA implementation: leadership, strategy planning, customer focus, and workforce focus. Additionally, three CSFs were identified for LP implementation: continuous flow, 5S, and Total Preventive Maintenance (TPM). All factors were found to be valid and reliable based on the EFA, CFA, and reliability analyses. The findings suggest that automotive companies in Thailand should prioritize the development of strong leadership, strategic planning, customer-centricity, and workforce engagement to effectively implement the MBNQA framework. Simultaneously, they should focus on continuous flow, 5S, and TPM to successfully adopt lean practices. Managers can use these insights to allocate resources and develop targeted strategies to enhance their organization's quality management and operational performance.

INTRODUCTION

Critical Success Factors (CSFs) are essential tools for achieving successful quality management, organizational targets and goals, and business performance (Kulenović et al.,2021). The Malcolm Baldrige National Quality Award (MBNQA) and Lean practices (LP) have been important in encouraging operational excellence in Thailand's automotive industry. The MBNQA, a comprehensive framework for achieving high performance, encompasses key criteria such as leadership, strategic planning, and customer focus (NIST, 2015). It has played a crucial role in supporting Thai automotive companies in aligning their strategic goals with quality standards that foster long-term success (Alqershi et al., 2022). These criteria drive firms to improve their performance by prioritizing the delivery of excellent goods and services that satisfy customer requirements and expectations.

MBNQA is one of the most popular awards for business excellence aimed at acknowledging and rewarding business excellence in all sectors in many countries. It was introduced in 1987 to enhance the quality of American products in an ever-expanding global market. Originally, the award included manufacturing, service and small businesses, and also education and health organizations since 1998.

Since 2006, it is also available for participation by non-profit organizations (Alanazi, 2020). This has resulted in more than 2 million award versions from companies in 100 countries. The MBNQA model offers a framework in which to analyze the relation between organizational activities and results (NIST, 2021). Furthermore, there is a criterion for results reflecting customer satisfaction, financial outcomes, products, markets, etc. The seven critical aspects of organizational management and performance are those criteria.

In addition, As the main principle between lean practices and MBNQA is continuous improvement strongly recommend (Mohammad & Oduoza,2020; Tashtoush et al., 2023b).it takes on a major role in the model. This approach is a significant one. It therefore needs to be considered a systematic driver for all other organizational activities. On the other hand, lean practices, which originated from the Toyota Production System, emphasize waste reduction, continuous improvement, and value maximization. In Thailand's automotive sector, these practices have been adopted to increase efficiency and flexibility in manufacturing processes, thus enabling companies to respond more rapidly to market changes and consumer demands (Womack & Jones, 2003; Jam et al., 2014). The integration of lean tools and techniques such as Just-In-Time (JIT), Kaizen, and 5S has not only improved operational efficiency but also led to significant cost reductions and quality improvements.

Together, the MBNQA framework and lean practices form a comprehensive approach to organizational excellence in the Thai automotive industry. By combining the broad, strategic quality focus of the MBNQA with the specific, tactical efficiency of lean methodologies, companies are able to achieve superior performance outcomes. This dual approach ensures that organizations do not just focus on immediate efficiency gains but also on long-term strategic success, making them more competitive both domestically and internationally (Dahlgaard-Park,2011; Tashtoush et al., 2023b). In Thailand's automotive industry, the implementation of the Malcolm Baldrige National Quality Award criteria and lean practices has not been fully optimized due to several gaps. Cultural differences hinder the full adaptation of these frameworks, leading to resistance and superficial implementation. There is also a lack of integration between the strategic, broad scope of MBNQA and the specific, operational focus of lean, which prevents companies from realizing potential synergies. Moreover, sustainability issues arise from a decline in commitment after initial implementation phases, often exacerbated by changes in leadership. Additionally, there has been a lack of extensive research on the essential components of MBNQA and lean techniques. Aquilani et al. (2017) found that MBNQA has been used in several industries, ranging from manufacturing to services. Furthermore, Anvari & Moghimi (2012) determined that there is a lack of clarity regarding the challenges and commonalities between MBNQA and LP. Some individuals contended that the MBNQA is regarded as instruments and methodologies of lean. Both are encompassed inside distinct classifications.

Therefore, the aim of this research is to develop a model that demonstrates the connections between MBNQA and LP, and to undertake an empirical inquiry through a preliminary study in industries in Thailand.

Objectives

The objectives of the study were:

- To investigate and determine the elements that contribute to the success of Malcolm Baldrige National Quality Award (MBNQA) in automotive industry.
- To investigate and determine the elements that contribute to the success of both Lean Practices (LP) in automotive industry.
- To recognize these practices as they are portrayed in automotive industrial sectors. In addition, this work aims to utilize contemporary statistical approaches, specifically principal component analysis, for the purpose of data reduction.

LITERATURE REVIEW

Malcolm Baldrige National Quality Award (MBNQA)

The Malcolm Baldrige National Quality Award (MBNQA) is a prestigious award that recognizes U.S. organizations for their outstanding performance excellence. In academic research, the MBNQA has been studied extensively as a framework for quality management and organizational excellence. Previos research have investigated the impact of the Baldrige criteria on organizational performance, the relationship between the criteria and other quality management frameworks, and the implementation of the criteria in various sectors, including healthcare, education, and business. Organizations that have adopted the Baldrige criteria have shown improved performance in areas such as customer satisfaction, financial results, and employee engagement (Evans & Jack, 2003; Jacob, Madu, & Tang, 2004; Jam et al., 2018). Several studies have found that organizations adopting the Baldrige criteria have shown improved performance in areas such as customer satisfaction, financial results, and employee engagement (Evans & Jack, 2003; Widjajanto & Rimawan, 2021; Jarrah et al., 2022b). For instance, Evans and Jack (2003) validated the key linkages in the Baldrige Performance Excellence Model, demonstrating its effectiveness in driving organizational success. Similarly, Wan & Purba (2021) provided empirical evidence of the positive impact of MBNQA implementation on the financial performance of award-winning companies.

Furthermore, researchers have explored the compatibility of the Baldrige criteria with other quality management frameworks, such as ISO 9000 and Six Sigma (Peng et al., 2020 ; Wilson & Campbell, 2020; Tashtoush et al., 2023b). Anvari & Moghimi 2012 investigated the integration of quality management systems and found that the MBNQA criteria can be effectively combined with other frameworks to enhance organizational performance. Peng et al. 2020 examined the evolving theory of quality management and highlighted the role of the Baldrige criteria in promoting a holistic approach to quality improvement.

The integration of MBNQA and LP has been a topic of interest for researchers and practitioners in the automotive industry. While the MBNQA provides a comprehensive framework for quality management and organizational excellence, Lean Practices focus on the continuous improvement of processes by eliminating waste and maximizing value creation (Pakdil & Leonard, 2014; Tashtoush et al., 2023a). The combination of these two approaches has the potential to drive significant improvements in quality, efficiency, and overall performance in the automotive sector. The successful integration of MBNQA and lean Practices in the automotive industry requires a holistic approach that considers both strategic and operational aspects. Sunder (2016) proposed a framework for integrating Lean and Six Sigma with the Baldrige criteria in the automotive sector, emphasizing the need for leadership commitment, customer focus, and continuous improvement. Gijo & Antony 2019 also explored the integration of Lean Six Sigma and the Baldrige criteria in the Indian automotive industry, providing a roadmap for implementation and identifying critical success factors. In summary, the Malcolm Baldrige National Quality Award has been a significant subject of academic research, providing insights into the effectiveness of quality management practices and the factors that contribute to organizational excellence**.**

However, the well-established benefits of MBNQA and LP in the manufacturing industry, there are still significant research gaps and challenges associated with their implementation. One of the primary research gaps is the lack of empirical studies investigating the synergistic effects of combining LP and MBNQA practices (Soliman, 2020; Zakariya et al., 2023).

Lean Practices

Lean practices are widely used in the manufacturing industry (Womack & Jones, 1994) that use “pulled” from upstream to downstream as they need with necessary items, at the necessary time, in the necessary quantities (Sugimori et al. 1977). Toyota who is the big carmaker in Japan, which has

succeeded in using this system. The aims of lean practices to integrate all the activities that impacted to goods and service and delivered to customers with zero waste while minimizing the cost and maximum efficiency (Moyano & Sacristán ; 2012). Lean practices have come to be critical perspectives of effective supply chain management in terms of cost saving and responding to customers' needs. The previous study strongly suggests the relationship with lean on organization performance such as on-time delivery, building a good relationship with a customer, increase productivity and increase flexibility.

In the automotive industry, the basis for the continuous improvements was lean practices, with more worker involvement, through teamwork and problem solving, reduced inventory through proper inventory management procedures ; use of pull systems and kanban ; and production of customer-based products and the disposition of over production (Shah & Ward, 2007).The traditional elements of lean practices are those components originally invented into the Toyota Production System by Taiichi Ohno (1912-1990). Traditionally, lean production (Toyota Production System) is a feasible technique of creating goods by removing waste leading to cost decrease, high performance and enhanced efficiency, as it is an efficient tool to achieve the ultimate objective-profit (Shakoor et al.,2017; Thunyachairat et al.,2023).

Numerous authors have undertaken the task of defining lean, depicting it as a set of techniques for waste reduction, a management philosophy, or a socio-technical system aimed at delivering value to customers (Shah & Ward, 2007; Soliman et al.,2018). This lack of consensus in defining lean reflects its widespread adoption over time and its configurational nature (Tiamaz & Souissi, 2019). Although numerous studies have been conducted to identify key lean practices, scholars often disagree on the significance of each practice (Bartezzaghi and Turco, 1989; Bhamu & Singh, 2014; Pakdil & Leonard, 2014; Alneyadi et al., 2023b). These discrepancies result in practitioners and researchers offering varying sets of practices to encompass the concept of lean manufacturing, influenced by their backgrounds and the features they prioritize (Tiamaz & Souissi, 2019; Tortorella et al.,2021; Wardat et al., 2024). Figure 1. presents the nineteen most commonly cited lean practices in the literature, organized by citation frequency. Both lean bundles and individual practices were included so as to determine whether it was more common to use individual practices or bundles of practices to study the effect of lean on business performance. As previously mentioned, several authors examined groups of lean tools rather than individual lean practices in their studies.

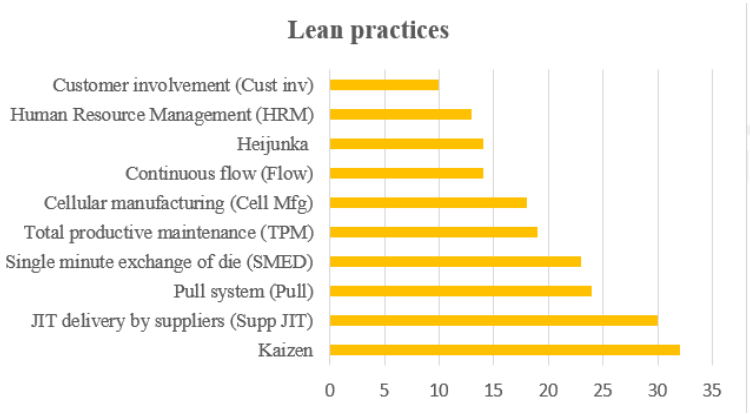

Figure 1: Most frequency of lean practices

Source: Compiled by Author

On the other hand, many manufacturing companies still struggle to transform themselves into lean organisations (Jadhav et al.,2015). This failure is attributed to an inappropriate implementation

environment, a lack of lean tools and techniques meeting the operational requirements, and the inability of the firms to sustain the initial momentum provided by the success of lean implementation (Netland 2016).

Conceptual Framework

A conceptual model has been developed to comprehend the links among the practices. The present research focuses around the suggested model, which consists of two multidimensional latent constructs. Figure 2 displays a path diagram that visually represents the cause-effect interactions inside the research model. The causal structure of this study is derived from a comprehensive evaluation of the existing literature. This study examines the influence of various elements on Malcolm Baldrige National Quality Award (MBNQA) in relation to Lean Practices (LP) dimensions, as suggested by the literature review. An integrated MBNQA with LP is a system that combines the principles of both TQM and LM. Figure 2 depicts the schematic representation of the suggested model. Structural equation modeling approaches are required to comprehend the connection between MBNQA and LP tools and methodologies, which is a topic of interest in this article.

As stated by Mohammad & Oduoza, 2020, the deployment of MBNQA is a necessary first step prior to implementing Lean Practices (LP). Anvari & Moghimi, 2012 contended that in order for organizations to establish a high-quality management system, it is imperative to incorporate MBNQA with other analogous principles like Lean Practices (LP).

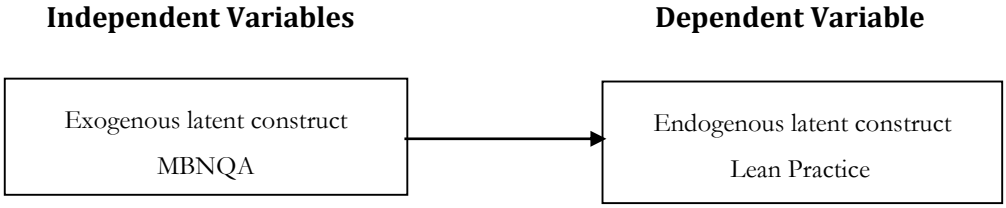

Figure 2 Conceptual framework

RESEARCH METHODOLOGY

Population

The population in this study is supplier Tier 1,2,3 in automotive industry. The unit of analysis of this study is at firm level. The target respondents were manager or middle manager who can evaluate MBNQA dimensions, Lean Practices. These key informants should be in charge of such functions as production, manufacturing, supply chain management, materail planning and logistics. The sources of company databases derived from the Thai Auto-Parts Manufacturers Association and The Thai Automotive Industry Association. The population from this source is approximately 1,800 firms.

Sample

Since this study employed the structural equation model to test the conceptual model, Bagozzi and Yi (2012) recommended that the sample size should be above 100, preferably 200. This aligns with Kline (2011), who suggested that sample size of 200 or greater is needed for a complicated model path. Moreover, Yuan et al (2010) indicated that the appropriate number of sample sizes of SEM is between 300 to 400. Therefore, the sample size of 400 in this study can achieve the respected to recommend sample sizes of structural equation model testing. Finally, 453 firms were chosen as the sample of this study.

Research Instrument

The survey instrument for this study used the five-point Likert scale representing a range of perception from very low to very high. The questionnaire was sent and reviewed by three experts from both academic and automotive industry to check for the content validity. The questionnaire was modified based on comments from these three experts. A pilot study was conducted to determine the clarity relevancy of the questions, clear meaning and jargons normally used in the industry, time taken to complete the whole questionnaire, and to test the internal reliability of the measures.

Table 1: Components of questionnaire

Construct	Original operational definition	Source
Leadership	1. The organization achieves high quality performance that applied through all facets of the organization. 2. The organization maintains effective communication channels to deliver the values and expectations of senior leaders to employees. 3.Management in the organization sets strategy, goals, and objectives 4. Management in the organization establishes and reinforces an environment that fosters empowerment and innovation. 5. Management encourages and supports organizational and employee learning 6. The organization regularly evaluates all functions' performance and capabilities. 7. The organization utilizes performance reviews to identify opportunities for improvement and innovation. 8. Management in the organization cares about the impacts of its products, services, and operations on society. 9. The organization actively supports and strengthens the relationships with key communities, such as religious and educational organizations and professional associations.	Wilson and Collier (2000) Aquilaniet al., (2017) and Alanazi, (2020
Construct	Original operational definition	Source
Strategic Planning	1. The organization establishes a short-term (1–2 years) plan to help achieve goals and objectives. 2. The organization establishes a long-term (2–5 years) plan to help achieve goals and objectives. 3. The organization establishes a strategy/plan to improve customer satisfaction. 4. The organization establishes human resource requirements and plans considering employees' capabilities and needs. 5. The organization establishes a strategy/plan to strengthen supplier–partner relationships. 6. The organization establishes a strategy/plan to address key goals and objectives. 7. The organization uses performance measures to track the progress of action plans. 8. The organization allocates resources to achieve overall action plans	Wilson and Collier (2000) Aquilaniet al., (2017) and Alanazi, (2020
Customer Focus	1. The organization measures and analyses customer satisfaction and dissatisfaction.	Wilson and Collier (2000)

	2. The organization compares its customer satisfaction results with its competitors or other benchmarks. 3. The organization has an official method to determine current product/service requirements and customer expectations. 4. The organization has an official method to determine future product/service requirements and customer expectations. 5. The organization has an official method to identify customer groups and market segments. 6. The organization implements effective customer relationship management practices to ensure customers seek assistance. 7. The organization continuously improves its customer relationship management practices. 8. The organization determines key customer requirements and delivers them to all employees in the response chain. 9. The organization resolves customer complaints promptly and effectively. 10. The organization officially examines customer complaints to improve its processes.	Aquilaniet al., (2017) and Alanazi, (2020
Information & Analysis	1. The organization regularly compares its performance with its competitors or other benchmarks to support its performance, evaluation, and improvement. 2. The organization systematically analyses performance data and information collected internally to support its overall quality goals. 3. The organization systematically analyses performance data and information collected externally to support its overall quality goals. 4. The organization monitors the processes producing products/services to identify necessary actions to make corrections.	Wilson and Collier (2000) Aquilaniet al., (2017) and Alanazi, (2020
Construct	Original operational definition	Source
Workforce Focus	1. The organization establishes human resource plans derived from its strategic plans to achieve the full potential of its workforce. 2. The organization supports a work environment that is beneficial to the well-being and growth of all employees. 3. The organization promotes cooperation, individual initiatives, innovation, and flexibility. 4.The organization regularly examines employee satisfaction and utilizes the results to support quality and innovation. 5. The organization's compensation, recognition, and related reward practices encourage high performance. 6. The organization establishes formal education and training programs to meet business and individual needs. 7. All employees in the organization receive the necessary training for accomplishing their job responsibilities.	Wilson and Collier (2000) Aquilaniet al., (2017) and Alanazi, (2020
Process Management	1. We have standardized operational processes which are clear and well understood by employees and customers	Wilson and Collier (2000)

	2. Most of the processes in our organization are automated, fool-proof, and minimizes human error chances. 3. We have the latest technology and equipment to serve our customers more effectively and efficiently 4. Our system allows us to inspect and track key processes that are critical to the organization 5. We regularly evaluate and improve our business processes to ensure quality	Aquilaniet al., (2017) and Alanazi, (2020
Pull Systems	1. Production at each station is pulled by demand from the next station. 2. Production is "pulled" by the shipment of finished goods. 3. Products are not produced unless orders for them are received from customers	Shah & Ward, (2007) Negrão et al., (2017) and Kamble et al., (2020)
Continuous flow	1. Our machines are grouped according to the product family to which they are dedicated. 2. The layout of our shop floor facilitates low inventories and fast throughput. 3. We have organized our plant floor into manufacturing cells. 4. We have located our machines to support JIT production flow.	Shah & Ward, (2007) Negrão et al., (2017) and Kamble et al., (2020)
Single minute exchange of die (SMED)	1. Our employees' practices are set up to reduce the time required. 2. Low supply lead times allow for quick responses to customer requests 3. We have low setup times of equipment in our plant. 4. We have converted most of our setup time to external time while the machine is running.	Shah & Ward, (2007) Negrão et al., (2017) and Kamble et al., (2020)
Heijunka (Level production)	1. Make to order by customer need. 2. Uses the Kanban system to control the production line. 3. We make every model of product every day to anticipate customer demand variability.	Shah & Ward, (2007) Kamble et al., (2020)
Construct	Original operational definition	Source
5S	1. Equipment is labeled to ensure it is in the correct place in the workplace. 2. Every workstation had its owner to ensure the workplace is clean and have been returned. 3. Unnecessary tools, machines were removed. 4. All tools were color coded and had a specific location. 5. The workstations were cleaned.	Shah & Ward, (2007) Negrão et al., (2017) and Kamble et al., (2020)
JIDOKA	1. Mistake or error proofing (Poke Yoke) available for each station 2.Autonomation Implementation available for each station 3. We make every model of product every day to anticipate customer demand variability.	Negrão et al., (2017) and Kamble et al., (2020)
Total Productive Maintenance (TPM)	1. A significant portion of our time is committed for planned equipment maintenance related activities every day. 2. Our firm carries regular maintenance of all equipment. 3. Our firm maintains complete and updated maintenance records for all the equipment. 4. The equipment maintenance records are shared with all the shop floor employees for active participation.	Shah & Ward, (2007) Negrão et al., (2017) and Kamble et al., (2020)

Data Collection

After the pretest study, minor adjustments were made to the questionnaire. The unit of analysis in this study was limited to firm level. The survey was restricted to the automotive industry in Thailand because the automotive sector has been leader in implement lean practices in the Thai industry. We began by sending a letter describing the purpose of research to the human resource department, asking for permission and participation in this research. . Then, we want to all research sites and explained to the manager, conditions for distributing questionnaires. For instance, the participants had to have knowledge of LP and MBNQA. Incentives were provided to respondents of both versions of the questionnaire. The incentive used for respondents of the paper-and-pencil questionnaire was stationary gift around THB 10 Thai baht for each completed questionnaire. Respondents who wanted to be included in the draw were asked to leave their email addresses at the end of the survey.

Data Analysis

The data obtained from the questionaire were analyze with statistical package and Analysis of Moment Structures (AMOS). Descriptive statistics like frequencies and percentages were likely employed to summarize the respones in the data. Two constructs were subjected to purification using exploratory and confirmatory factor analysis (CFA) using AMOS to assess how well the measured variables indicate each construct (Hair, 2010). The following tests assessed validity. Fornell and Larker (1981) suggested that this test assesses whether the variables (leadership, strategic planning, customer focus, Information & analysis, workforce focus, pull systems, continuous flow, single minute exchange of die, level production, 5S, jidoka, total productive maintenance) are conceptually distinct from each other. The average variance extraction (AVE) and discriminant validity are estimated.

Analysis software

The data gathered through survey questionnaires underwent analysis utilizing the Software Package for Social Sciences (SPSS) and Analysis of Moment Structures (AMOS).

Scale Evaluations

Exploratory Factor Analysis (EFA)

Exploratory factor analysis (EFA) allows the researcher to explore the nature and number of underlying factors (dimensions) in a battery of items (questions) (Henson and Roberts, 2006). Hair et., (2010) suggested that for testing EFA, the sample size should be more than 100. The KMO index ranges from 0 to 1, with 0.50 considered suitable for factor analysis (Hair et., 2010). .The Bartlett's Test of Sphericity should be significant ($p < .05$) for factor analysis to be suitable (Hair et al., 2010). Hence, before the extraction of the factor, the KMO and Bartless's test was estimated in this study.

Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis (CFA) and structural- equation modelling (SEM) were used to assess the scale. For a thorough assessment of the scales, the CFA was conducted to test the measurement model which involved examining the relationship between latent and manifest variables. SEM was employed for the structural model which comprised of LP, MBNQA. CFA tests proposed model and have assumption and expectations based on priori theory regarding the number of factors (Brown & Moore, 2012; Alneyadi et al., 2023a).

RESULTS

Figure 2 and 3 shows the result of descriptive statistics participants and the CSFs of LP and MBNQA in Thailand automotive industry. The various means for the perception of importance were analyzed. The overall mean for each factor was obtained to investigate the level of LP and MBNQA perceived by

respondents. These mean values range from 3.59 to 4.10 which is at good at LP level. The highest CSFs of MBNQA are customer focus (4.10) and process management (4.10). The next CSFs of LP were pull (4.23) and 5S (4.14), are the two highest both practice CSFs perceived by respondent.

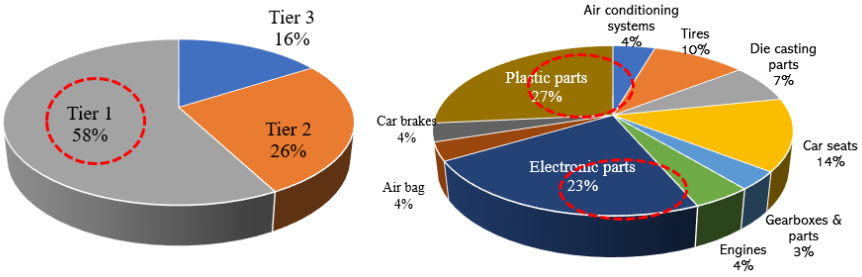

Figure 2: Type of Tier and Key of Business

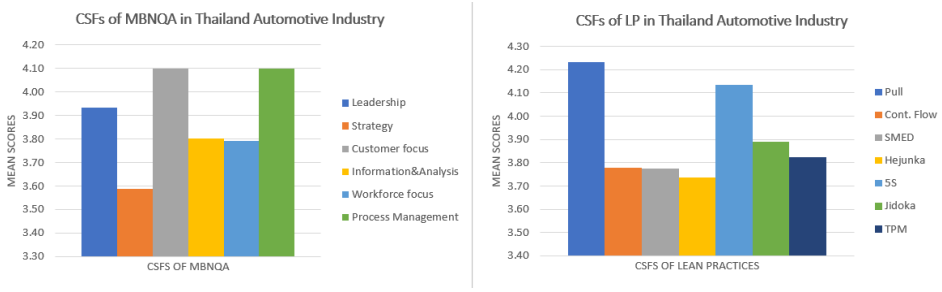

Figure 3: CSFs of LP and MBNQA in Thailand

The Exploratory factor analysis (EFA) with varimax rotation was performed on the MBNQA and LP constructs. The Kaiser-Meyer-Olkin (KMO) measures that sampling adequacy is 0.835 in MBNQA and 0.777 in LP which are more than 0.7, indicating that the present data is suitable for principal component analysis. Similarly, Bartlett's test of sphericity is significant (p , 0.001), indicating sufficient correlation between the items to proceed with the analysis. At a minimum, 0.7 loading of each item on its respective factor are considered adequate for that factor (Hatcher, 1994). The EFA of 69 items of MBNQA and LP construct have yielded in 34 factors explaining 83.981 percent of the total variance. The result indicates that MBNQA and LP have identified 35 items as compared to original questionnaire which are 69 items.

The Cronbach's a measure of reliability of MBNQA and LP construct is between 0.710 and 0.962. Nunnally (1978) allowed a slightly lower minimum limit such as 0.6 for exploratory work involving the use of newly developed scales. Since, Cronbach's a value for each factor above 0.70, all factor are accepted as being reliable for the research. Table II and Table III shows the result of EFA and reliability analysis.

Table II: EFA and reliability analysis of the MBNQA Constucts

Factors	Number of items	First eigen value	% of variance explained	Cronbach's Alpha
MBNQA		36.288	83.981	
Leadership	9			0.858
Strategy planning	8			0.959
Customer Focus	10			0.962
Information & Analysis	4			0.710
Workforce focus	7			0.802
Process Management	5			0.899

Table III: EFA and reliability analysis of the LP Constucts

Factors	Number of items	First eigen value	% of variance explained	Cronbach's Alpha
Lean Practices		24.763	77.536	
Pull Systems	3			0.786
Cont. Flow	4			0.887
SMED	4			0.706
Heijunka	3			0.910
5S	5			0.891
Jidoka	3			0.924
TPM	4			0.930

Extracted Success Factors

Factor extraction was conducted through Principal Component's Analysis (PCA) with varimax rotaton. PCA is a data reduction technique where the diagonal values of the correlation matrix. Applying PCA through SPSS for 43 items for MBNQA indicated that four factors have eigen values greater than 1 can be extracted. The final rotated component matrix resulted in 21 items, and the remaining items were discarded from further analysis as these have low communalities, cross loading issues, and low factor loading. This is presented in Table IV.

Table IV: Rotated component matrix for MBNQA

Item No.	Component 1	Component 2	Component 3	Component 4
LE1	0.751			
LE3	0.852			
LE5	0.876			
LE6	0.811			
STA1		0.790		
STA2		0.937		
STA3		0.830		
STA6		0.830		
STA7		0.904		
STA8		0.801		
CF1			0.920	
CF2			0.919	
CF3			0.912	
CF4			0.894	
CF5			0.845	
CF9			0.912	
CF10			0.839	
WF2				0.888
WF3				0.901
WF5				0.909
WF7				0.754
Alpha	0.878	0.841	0.853	0.853

Note: Leadership (LE), Stratagy planing (STA), Customer focus (CF), Workforce focus (WF)

Base on Table IV, the factor loading for all items are within limit 0.754-0.937, which is considered among the acceptable range. The first factor comprize four items (LE1, LE3, LE5, LE6) while the second factor comprises six items (STA1, STA2, STA3, STA6, STA7, STA8). The third factor comprises seven items (CF1, CF2, CF3, CF4, CF5, CF9, CF10) and the fouth factor comprises four items (WF2, WF3, WF5, WF7).

In addition, applying PCA through SPSS for LP indicated that three factors have eigen values greater than 1 can be extracted. The final rotated component matrix resulted in 14 items, and the remaining items were discarded from further analysis as these have lowcommunalities, cross loading issues, and low factor loading. This is presented in Table VI.

Table VI: Rotated component matrix for LP

Item No.	Component 1	Component 2	Component 3
CO1	0.836		
CO2	0.864		
CO3	0.880		
CO4	0.731		
SS1		0.802	
SS2		0.743	
SS3		0.727	
SS4		0.838	
SS5		0.898	
TP1			0.896
TP2			0.915
TP3			0.837
TP4			0.896
Alpha	0.887	0.891	0.930

Note: Continuous flow (CF), 5S (SS), Total Preventive Maintenance (TP)

Table VI shows that factor loadings for all extracted factors range between 0.727-0. 896 which considered an acceptable loading considering that the threshold is 0.55 (Hair et al.,2010). Based on rotated component matrix, the first factor continuous flow which is comprises four items, the second factor which is 5S has five items. Factor three, namely total preventive maintenance, comprises four items. In addition, the Cronbach alpha calculated for the extracted factors still acceptable

The next analysis involves testing the measurement model for CSFs of MBNQA and LP on multiple factor. Refer Table VII. The results of confirmatory factor analysis (CFA) indicating an excellent fit, with $\chi 2/df$ with a value less than 5.0 indicating a acceptable fit (Loo & Thorpe,2000). The GFI, AGFI, CFI and TLI are more than 0.9 indicate marginal fit and the RMSEA value of less than 0.08 showing good fit. The two constucts are graphically shown in Figure 5. The results suggest that four construct can be used to measure the MBNQA and three construct can be used to measure the LP implementation.

Table VII. The measurement model indices.

Model	$\chi 2/df$	GFI	CFI	NFI	RMSEA
MBNQA	4.90	0.90	0.94	0.91	0.07
Lean Practices	4.70	0.91	0.93	0.92	0.07

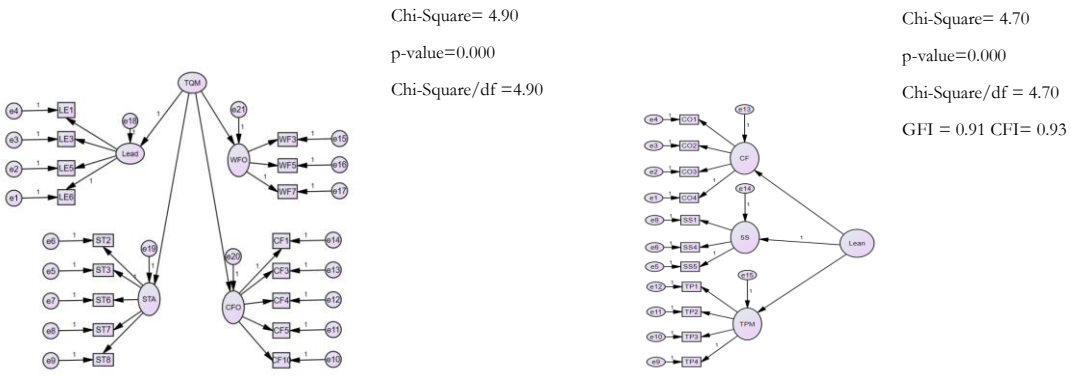

Figure 4: The output path diagram for MBNQA and LP

CONCLUSION

This study aimed to identify and evaluate the critical success factors (CSFs) affecting the implementation of the Malcolm Baldrige National Quality Award (MBNQA) and Lean Practices (LP) in the Thai automotive industry. The research employed exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and structural equation modeling (SEM) to analyze data collected from a sample of 453 Thai automotive suppliers.

The key findings of the study revealed four CSFs for MBNQA implementation: leadership, strategy planning, customer focus, and workforce focus. Additionally, three CSFs were identified for LP implementation: continuous flow, 5S, and total preventive maintenance (TPM). The EFA, CFA, and reliability analyses found all factors to be valid and reliable.The results of this study contribute to the existing academic literature by providing empirical evidence of the critical factors that influence the successful implementation of MBNQA and LP in the automotive industry. The identification of these CSFs can help organizations prioritize their efforts and resources to achieve better quality management and operational excellence. From a practical perspective, the findings suggest that automotive companies in Thailand should focus on developing strong leadership, strategic planning, customer-centricity, and workforce engagement to effectively implement the MBNQA framework. To successfully adopt lean practices, they should prioritize continuous flow, 5S, and TPM at the same time. By addressing these critical areas, organizations can improve their overall performance and competitiveness in the market. In conclusion, this study provides valuable insights into the critical success factors for implementing MBNQA and LP in the Thai automotive industry. By understanding and focusing on these factors, organizations can enhance their quality management practices, improve operational efficiency, and ultimately achieve sustainable business success.

Limitations and Future Research

The generalizability of the results beyond the Thai automotive context may be limited. Future research should consider testing the model in different manufacturing industries and geographical contexts. Additionally, empirical studies could include moderator variables, such as national culture, supply chain integration, and supplier relationship management, to examine their impact on MBNQA and LP adoption and business performance. The authors are also interested in studying the structural relationship between MBNQA and LP practices and firm performance in the Thai automotive industry.

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