

# Causal Analysis of ISO/TS16949 Efforts in Automotive Industry

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**Abstract.** The principal aim of this study is to determine the impact of ISO/TS16949 efforts on total quality management (TQM) and the ISO/TS16949 efforts relationship in Malaysian automotive industry. A survey method was employed to collect data using English version for Malaysian respondents. Exploratory factor analysis and reliability analysis empirically verified and validated the underlying items of TQM, ISO/TS16949 and organizational performance. Structural equation modeling was employed to test the proposed model. Data analysis revealed that TQM implementations have a strong and positive impact on organizational performance through direct relationship as well as through a mediating role of ISO/TS16949 efforts. From the research findings, it is viable to recommend that ISO/TS16949 should be incorporated with philosophy and methods of TQM to achieve better performance. This study proved to be valuable to academic researchers as well as automotive practitioners. It systematically analyzes the mediating effect of ISO/TS16949 efforts on TQM and organizational performance relationship.

**Keywords** – ISO/TS16949 efforts, Automotive Industry, Mediator, Organizational performance, Structural equation modeling and Total quality management.

## 1. Introduction

The implementation of quality management system has not occurred in the same pace in different regions of the world [1]. While early implementation started in Japan, it later shifted to the US, then Europe, and later to the developing countries. To compete in the global market, these countries, especially the late bloomers, need to implement quality management practices, tools, and techniques within all sectors of their industries [2]. Despite the huge number of publications and research on quality management, little empirical work has been carried out in developing countries, particularly in the ASEAN region [3,4]. Thus, this research contributes to the understanding of the differences that could exist in this part of the world with regard to quality management implementation.

Majority of existing research focuses on TQM implementation and performance relationships [5,6], whereas the role of ISO/TS16949 efforts on TQM and performance relations in the context of automotive industry is largely neglected. The practice of TQM also affects from the



national level to the international level [6], which helps organizations to compete internationally and gain a competitive edge in the global market [7].

ISO/TS16949:2002 is an ISO technical specification that represents a comprehensive quality management system for the global automotive industry to achieve world class levels of product quality, productivity, competitiveness and continual improvements. It was clear from its inception that ISO/TS16949:2002 was different than its predecessor, QS 9000, for many reasons.

Previous studies have also failed to consider the significant potential of mediating variables such as ISO/TS16949 certification in automotive industry. Positive relationship (in the sense of certification leads to better performance) between TQM and organizational performance is often taken for granted even though this relationship has not been proven. Furthermore, critics who opined that ISO certification provide only “hollow achievement” [7] is gaining mileage. Whether ISO/TS16949 certification produces the expected benefits or it is just a hollow achievement, empirical evidence has yet to be found. At the very least it is important to assess the performance of organizations with ISO/TS16949 certification if indeed better than those of without certification.

The purpose of this paper is to propose a structural model that relates TQM ISO/TS16949 and organizational performance. It is an attempt to contribute to the extant literature by incorporating TQM practices and ISO/TS16949 efforts on organizational performance relationship within the context of an emerging automotive industry. By using structural equation modeling, the study analyzes both direct and indirect effects of each construct on organizational performance.

## 2. Methods

Mail survey was conducted to collect data in this study because of its relative simplicity in collecting large quantitative data. The survey kit consisted of a large (9” x 12”) mailing envelope which include the survey instrument and cover letter stapled together, as well as a post-paid self-addressed envelope. The survey kit was mailed in various batches to the target respondents.

Second mail to non-responding respondents was done one month after the initial mails. To minimize costs, survey kits with reminder were sent to every alternate non-responding target on the mailing list. Post-paid post cards were sent to the remaining non-responding respondents as reminders requesting the recipient to complete and return the questionnaire. In the case where the original survey was lost and the recipients were willing to complete the survey, new survey kits were sent.

Even after the follow up mails were done, the response rate was still around 10% especially in Thailand. To increase the response rate telephone calls and follow-up fax transmission were made to persuade them to fill up the questionnaires. In Malaysia, the questionnaire was distributed to a total of 650 companies and 161 completed forms were received giving a response rate of 25%.

### 2.1. Treatment for missing data

Since the structural equation modeling (SEM) software was used to analyze part of the data, missing data became an issue. SEM requires that “complete data are required for the probability density and adjustment must be made to data sets that are incomplete” [8]. Missing data can exist in two forms, either due to omission during data entry process or accidental lack of response by the respondent. Different procedures were used to adjust to the missing data under each situation. The first procedure was to eliminate input errors on the part of the data entry by re-examining the original questionnaire and the data entry error. There were five cases in Malaysia dataset of this type.

The second procedure addressed the issue no response by respondents. In this study, if less than 5% of the data is missing, the missing data were filled in with the mean value [9], otherwise, the data were dropped from the study. For Malaysian respondents, there were 10 cases the missing data filled in with the mean value and four cases were dropped from the dataset. Validity and reliability Exploratory factor analysis (EFA) with varimax rotation was performed on the TQM constructs, organizational performance (OP) measures and ISO/TS16949 efforts. At a minimum, a 0.4 loading of each item on its respective factor were considered adequate for that factor and a minimum of 0.5 loading for items that cross-load on multiple factors were considered adequate [10]. The EFA of 53

items of TQM constructs yielded eight factors explaining 57.92% of the total variance. The result indicated that eight TQM constructs have been identified with 40 items as compared to the original questionnaire which had 53 items. Subsequently, the EFA of 14 items of organizational performance were loaded on two factors explaining 51.70% of the total variance. No items were recommended to be omitted. Finally, the EFA of 34 items of ISO/TS16949 were loaded on four factors explaining 61.58% of the total variance. No items were recommended to be omitted from the original questionnaire.

The Cronbach's  $\alpha$  measure of reliability for TQM constructs and organizational performance was between 0.851 and 0.730. According to Aamadi [11], the generally accepted minimum value of  $\alpha$  is 0.70, however, Nunnally [12] allowed a slightly lower minimum limit, such as 0.6 for exploratory work involving the use of newly developed scales. Since the Cronbach's  $\alpha$  value for each factors was above 0.70, all factors were accepted as being reliable for the research. Table 2 shows the results of EFA and reliability analysis.

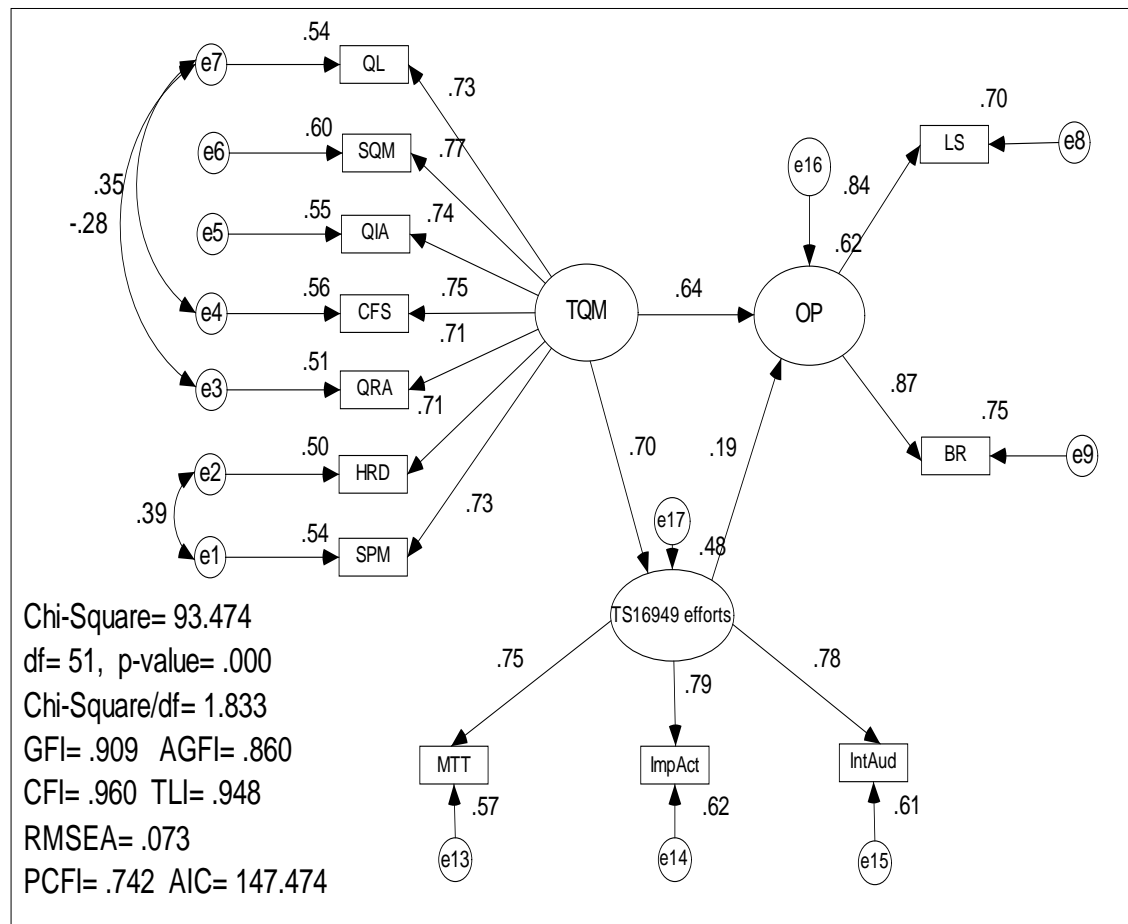
**Table 2.** EFA and reliability analysis of the TQM, OP and ISO/TS16949

Factors	Number of items	First Eigen-value	Percentage of variance explained	Cronbach $\alpha$
<i>TQM</i>		21.03	57.92	
QL	7			0.851
CFS	5			0.795
QIA	4			0.802
HRD	4			0.824
SPM	5			0.799
SQM	5			0.836
QR	5			0.746
QA	5			0.730
<i>OP</i>		6.09	51.70	
LS	6			0.816
BR	8			0.842
<i>ISO/TS</i>		15.54	61.58	
CP	3			0.769
MTT	19			0.946
ImpAct	8			0.912
IntAud	4			0.858

### 3. Results and Discussion

#### 3.1 Mediating effect of ISO/TS16949 efforts in Malaysia

Figure 1 shows both inner and outer regression weights for the structural relationships between TQM, ISO/TS16949 efforts and organizational performance, based on structural equation modeling for Malaysia automotive industry ( $n = 157$ ).



**Figure 1.** Inner and outer regression weights for the structural relationship between TQM and OP with a mediation of ISO/TS16949 efforts for Malaysia automotive industry

The goodness-of-fit indices for the structural model ( $\chi^2/df = 1.833$ , GFI = 0.909, AGFI = 0.860, CFI = 0.960, TLI = 948, and RMSEA = 0.073) were well within the generally accepted limits, indicating a good fit to the data. The results showed that, the standardized regression weight for *H1a* was found to be 0.644 and significant ( $p < 0.001$ ). This result provided support for the *H1a* which states that TQM implementation has a direct and strong impact on organizational performance of Malaysian automotive industry.

The standardized regression weight for the hypothesized relationship between TQM implementation and ISO/TS16949 was found to be positive (0.696) and significant ( $p < 0.001$ ), confirming *H2a* that TQM had a strong positive direct impact on the level of ISO/TS16949 efforts.

The standardized regression weight for the direct relationship between ISO/TS16949 efforts and OP was found to be positive (0.190) and insignificant with p-value of 0.085 which was more than 0.05. The result did not provide support hypothesis *H3a* that ISO/TS16949 efforts have a direct and strong impact on organizational performance.

Organizational performance is also indirectly affected by TQM through ISO/TS16949 efforts. In order to test whether ISO/TS16949 efforts are an important mediator of TQM with organizational performance (OP) relationship the rule of thumb was followed Hair [13], namely (i)  $IE < 0.085 \Rightarrow$  Non mediator, (ii)  $IE > 0.085$  and  $IE \approx DE \Rightarrow$  Partial Mediator (TQM  $\rightarrow$  OP relationship,  $p < 0.05$ ) and (iii)  $IE > 0.085$  and  $IE \gg DE \Rightarrow$  Total Mediator (TQM  $\rightarrow$  OP relationship,  $p > 0.05$ ).

Table 3 shows the standard Indirect Effect (IE) of TQM to OP is 0.132 which was more than 0.085. Thus, ISO/TS16949 efforts mediate the relationship between TQM and organizational performance (OP). Since, the p-value for Direct Effect (DE) between TQM to OP was less than 0.05, the ISO/TS16949 efforts were considered as partial mediator. In conclusion, this finding provides support to *H4a* hypothesis: the impact of TQM implementation on organizational performance increases with a mediating role of ISO/TS16949 efforts in Malaysian automotive industry.

**Table 3.** Direct (DE) and Indirect Effects (IE) analysis for Malaysia automotive industry

	Std. Total Effect			Std. Direct Effect			Std. Indirect Effect		
	TQM	TS16949	OP	TQM	TS16949	OP	TQM	TS16949	OP
TS16949	0.692	0.000	0.000	0.692	0.000	0.000	0.000	0.000	0.000
OP	0.777	0.190	0.000	0.646	0.190	0.000	0.132	0.000	0.000

Note: Std. Total Effect = Std. Direct Effect (DE) + Std. Indirect Effect (IE)

The discussion thus far revealed that the structural models were valid for Malaysia. Table 4 shows that relationship between TQM and organizational performance for Malaysia automotive industries were found to be positive and significant, confirming that TQM implementation had a strong positive direct impact on the organizational performance. The direct effect relationship between TQM implementation and organizational performance found in this study corroborates the findings of some previous studies including Ahire and Golhar [14], [5] and [15]. Table 4 also presents the relationship between TQM implementation and ISO/TS16949 efforts. The findings indicate that TQM implementation had a positive and strong direct impact on ISO/TS16949 efforts.

**Table 4.** Inner regression weights between latent variables in the structural model for Malaysian automotive industries

Country	Hypothesis	Structural relationships	Standardized regression weight
Malaysia	<i>H1a</i>	TQM – OP	0.644*
	<i>H2a</i>	TQM – ISO/TS16949	0.696*
	<i>H3a</i>	ISO/TS16949 – OP	0.190
	<i>H4a</i>	TQM – OP (indirect relationship)	0.132*

Note: \*p < 0.001

#### 4. Conclusion

This study has provided an empirical justification for a research model that identifies the relationship among TQM implementation, ISO/TS16949 certification and organizational performance. Many studies have been performed to identify enabling factors for successful implementation TQM. However, very limited previous studies had investigated the relationships between TQM practices and organizational performance, especially amongst ASEAN countries. Data for the study were collected from a sample of 161 Malaysian automotive industries. Based on the exploratory factor analysis and reliability analysis, all factors were accepted as being valid and reliable for the research. The results of this study showed that ISO/TS16949 efforts partially mediate the relationship between TQM implementation and organizational performance in Malaysian automotive industry.

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