

Influence of Engineering Education and Integrated Quality & Environmental Management on Quality, Firm and Environmental Performance

Chayanan Kerdpitak¹, Kittisak Jermsittiparsert^{2,3*}

¹ Graduate School, Suan Sunandha Rajabhat University, Bangkok, Thailand
E-mail: chayanan.ke@ssru.ac.th

² Department for Management of Science and Technology Development, Ton Duc Thang University, Ho Chi Minh City, Vietnam

³ Faculty of Social Sciences and Humanities, Ton Duc Thang University, Ho Chi Minh City, Vietnam
Corresponding author: E-mail: kittisak.jermsittiparsert@tdtu.edu.vn

Article Info

Volume 82

Page Number: 3452 - 3463

Publication Issue:

January-February 2020

Abstract:

The current paper aimed to assess the role of engineering education (EE) on firm performance (FP), quality performance (QP) and environmental performance (EP). Furthermore, it has investigated the mediating role of integrated quality and environmental management practices (IQEMP) between EE and QP, EE and FP, and EE and EP. To analyze these relationships, the data was collected from construction sector of Malaysia where the employees and managers of construction companies were selected as sample of the study. 400 structured questionnaires were distributed among selected managers and employees out of which 311 valid responses were considered for analysis. Findings of the study suggested that EE significantly positively influences the QP, FP and EE. Furthermore, IQEMP also significantly mediated the relationship between EE and FP, between EE and QP, and between EE and EP because the EE significantly enhances the IQEMP which ultimately enhances the FP, QP, and EP. These findings and suggestions of this study will contribute to the literature and practice because they set guidelines regarding the role of EE and IQEMP in nourishing the QP, FP, and EP.

Keywords: Engineering education, integrated quality and environmental management, quality performance, firm performance, environmental performance.

Article History

Article Received: 18 May 2019

Revised: 14 July 2019

Accepted: 22 December 2019

Publication: 20 January 2020

I. INTRODUCTION

Quality performance of an organization refers to the quality of the products or services provided by an organization as well as the process or procedure to produce these products and provide the services. In order to improve quality performance, it is very important to sequence the processes in right way, avoid errors and wastage and increase the overall quality of service being delivered (Barrick, Thurgood, Smith, & Courtright, 2015). As a result of this, the organization with better quality performance will retain most of its customers and there is clear possibility of increase in their number in near future. Performance quality can be divided into two categories i.e. internal quality performance and external quality performance. Internal quality performance refers to the product quality and product design while external quality performance refers to the customer satisfaction with the

product. The design of the product is the most important indicator of quality performance because studies have shown that almost 85% costs of the product are committed by the time the design of the product has been prepared (Bennett, Bettis, Gopalan, & Milbourn, 2017). In addition design adds to the quality of the product and also enables the firm to speed up the production. The performance of a firm does not depend only on the efficiency but also on the type of market where the firm is operating. In financial context, we can call firm performance as financial health of the firm. This can be measured by various factors such as revenues, profits, sales etc. Different ratios can also be used to assess the firm performance of an organization. Different ratios are useful to measure firm performance in different sectors of industries (Bernard, Moxnes, & Saito, 2019; Blakely & Leigh, 2017). The ratios that may be useful for a manufacturing sector include return on assets ratio, inventory turnover ratio.

Similarly, in financial institutions, important and useful ratios may include cash flow ratio, stock price ratio etc. Another important aspect in the measurement of firm performance is the comparison of performance of different industries of same sector so that the result of the comparison can give a clear idea of comparative performance of a firm (Braam, de Weerd, Hauck, & Huijbregts, 2016). In another context, we can say that firm performance is the degree to which a firm can operate certain activities in a better way as compared to its competitors.



Figure 1. Quality and Environmental Performance (Source: loadhog.com)

Figure 1 shows different components regarding quality and environmental management policies. Environmental performance of an organization or company refers to the use of processes and procedures in the production of various products so that the environment is least affected by the processes (Brunhaver et al., 2018). We know that different industries and manufacturing units excrete different waste products that are harmful for the environment and add to the air and water pollution. This decreases the environmental performance of an organization. There are various environmentally friendly processes that can be adopted by these industries in order to reduce the waste and its harmful effects on the environment. Organizations use a lot of management systems for the increase in their organizational performance such as quality management system and environmental management system (Bucciarelli & Kuhn, 2018). These systems improve the performance of their respective area such as quality management system will increase the quality performance while environment management system will increase the environmental performance of that organization. Sometimes, some organizations consider applying more than one management system at a time. There are two modules to apply more than one management systems; one management system can be applied first and then after some time the other management system is also applied (Chin, Tat, & Sulaiman, 2015; Published by: The Mattingley Publishing Co., Inc.

Devadiga, 2017). The other module is that both the management systems are applied at the same time simultaneously, which requires more expertise and skills of the managers. This module of applying both the systems at the same time is called as integration. In our study, there are two management systems i.e. quality management and environment management system. When these systems are jointly applied in an organization, it will be called as integrated quality and environmental management practices IQEMP (Dubey, Gunasekaran, & Ali, 2015). The independent variable of our study, engineering education has a broader scope. It covers many different sectors such as industry, manufacturing, construction, healthcare etc. Engineering education provides special skills and knowledge about different was to bring innovations and to use latest technology in the above-mentioned sectors in order to increase their performance and organizational development.

Engineering education provides proper knowledge and managerial skills to apply IQEMP in an organization, which increases the firm, quality and environmental performance of that organization (Edwards, 2017). But unfortunately, in Malaysia there have not been enough reforms and advancements in the engineering education system, due to which they lack the important managerial skills and knowledge. As a result, their managers are unable to successfully implement IQEMP which decreases the firm, quality and environmental performance of organizations and also affect the overall organizational performance of firms in Malaysia (Epstein, Buhovac, & Yuthas, 2015). Other than Malaysia, other developing and underdeveloped countries are also facing the same situation. If this problem is not sorted out soon, it will have serious outcomes in regard or organizational performance and overall economic development in the country. Therefore, is is very important to take care of this issue and make improvements in engineering education system so that organizations of Malaysia can show better performance.

There are several researches that have studied the concepts of firm, quality and environmental performance and some studies also have shown the impact of educational engineering on these types of performances. But there is no study that has studies the mediating role of IQEMP between engineering education and firm, quality and environmental performance. A research paper has recommended conducting research to study the mediation role of IQEMP in this regard (Arda, Bayraktar, & Tatoglu, 2019). The important objectives of this research are as follows:

- To analyze the significant impact of engineering education on firm performance in firms of Malaysia

- To analyze the significant impact of engineering education on quality performance in firms of Malaysia
- To analyze the significant impact of engineering education on environmental performance in firms of Malaysia
- To analyze the significant mediating role of IQEMP between engineering education and firm performance in firms of Malaysia
- To analyze the significant mediating role of IQEMP between engineering education and quality performance in firms of Malaysia
- To analyze the significant mediating role of IQEMP between engineering education and environmental performance in firms of Malaysia

As we know that Malaysia has been trying to change its image as an agricultural country to a technological country and has many national and international organizations and companies. The economic development and growth of Malaysia depends upon the organizational performance of these companies. The scope of this research revolves around the impact of engineering education on firm, quality and environmental performances of organizations and firms in Malaysia and the mediating role of IQEMP between them (Fritsch, 2017; Griffin, 2016; Karabulut- Ilgu, Jaramillo Cherez, & Jahren, 2018). The theoretical significance of this research is based on the fact that it contains all the information and references of different aspects of firm, quality and environmental performances. Practically, it assists the firms in Malaysia to give preference to engineering oriented people in their firms so that the firm, quality and environmental performance of these firms can be increased. This paper also helps them to apply the IQEMP in their firms that plays an important mediator between the above variables (Kosa, Yilmaz, O'Connor, & Clarke, 2016). This research will also guide the Malaysian govt. officials to devise policies favorable for betterment of engineering education, so that engineers can take part in the economic development of Malaysia by improving firm, quality and environmental performance of the firms in Malaysia.

II. LITERATURE REVIEW

Theory of Economic Development

Theory of economic development that was introduced by John Schumpeter revolves around the idea that the equilibrium or no development condition of any organization can be disturbed by introducing innovation and technological processes in that organizations that are capable of improving certain processes and practices used by that organization to produce products and provide services (Lewis, Frazee, Fisher,

Shortell, & Colla, 2017). This process starts with a condition called circular flow just like the blood flow in our body. The circular flow shows a state of equilibrium where all the activities in a particular organization are taking place in a regular and repetitive manner. There is no room for development in any aspect in that organization. This circular flow can be effectively disturbed by using some innovative and technological processes in that organization (Lievens, Jacchia, Kagkli, Savini, & Querci, 2016). These innovations revolve around the processes and practices that are used for the production of products or for the provision of different services by any organization. The basic purpose of these innovations is to increase profits, reduce costs and to increase development and growth of the organization or company (Lins, Servaes, & Tamayo, 2017). These innovations are not restricted to the production processes, but they are also incorporated into the selection of raw materials, distribution of products to new and efficient markets. All these innovations increase the firm, quality and environmental performance of an organization leading towards the economic development of the overall country. An entrepreneur plays a crucial role in the innovation process because he is more determined to do something new as compared to the managers that go with the already existing practices in a particular organization (Martos, Pacheco-Torres, Ordóñez, & Jadraque-Gago, 2016). We can study the impact of engineering education on form, quality and environmental performance and the mediating role of IQEMP between them by using this theory of economic development.

Impact of Engineering Education on Quality Performance

Quality performance is actually related to the products produced or services provided by any organization or company. Overall productivity and profitability are the basic pillars of quality performance. The ability of an organization to produce quality products and provide quality services better than the competitors, shows the quality performance of the particular organization (Mauricio, Veado, Moreira, Figueiredo, & Costa, 2018). A company or organization that provides exceptional after sales services also show better quality performance. All these factors provide customer satisfaction in an effective way. The cost of products must also be minimized in order to show exceptional quality performance by an organization. All these indicators are very important for any organization to increase the quality performance of that organization. Engineering education provides various skills to the engineers that can be used by organizations in order to increase their quality performance. These skills are usually technical and innovative, and these technologies and innovative ideas can be used by organizations to improve the

quality of their products and services effectively (Myrdal, 2017). These technical skills and innovative ideas are very crucial in order to compete with the competitors of that organization. Other than that engineering also provides proper knowledge of quality management to be applied in the organization which ultimately results in the improvement of quality performance of that organization in accordance with the theory of economic development (Noe, Hollenbeck, Gerhart, & Wright, 2017; Papp, 2018). From all the above discussion we can say that engineering education has significant impact on the quality performance of firms in Malaysia. We can generate the following hypothesis in this regard:

H 1: Engineering Education has significant impact on the Quality Performance of Firms in Malaysia.

Impact of Engineering Education on Firm Performance

Firm performance of an organization is actually the overall performance shown by that organization in terms of finance, development and growth (Jermisittiparsert&Boonratanakittiphumi, 2019; Sriviboon&Jermisittiparsert, 2019). When an organization produces quality products and provides quality services, the sales and market share of that organization are effectively increased. Due to increase in sales, obviously the sales revenue and net revenues are also increased which positively affects the growth and development of that organization. In order to increase the profits, it is very important to minimize the costs of these products (Parvadavardini, Vivek, & Devadasan, 2016). All these factors ultimately increase the competitiveness of a particular organization as compared to others. The increase in the performance of supply chain is also an important factor in the measurement of firm performance. All these factors have a common effect that the employees remain loyal to the organization and show more involvement in their jobs. This ultimately reduces the employee turnover in that organization. Increase in firm performance also increases the capacity of new products and services development (Perroux, 2017). Engineering education plays important role in the increase in firm performance. It provides technical and innovative skills to the engineers who use them in their respective organizations or companies and contribute in the development of products and services provided by that particular organization. Engineering education also provides managerial skills that can be used in organizations to improve and speed up certain processes involved in its operations according to economic development theory (Psomas & Jaca, 2016). From the above discussion we can conclude that engineering education has significant impact on firm performance of an organization in Malaysia. We can generate the following hypothesis:

H 2: Engineering Education has significant impact on Firm Performance of an Organization in Malaysia.

Impact of Engineering Education on Environmental Performance

Environmental performance of an organization shows the impacts of various activities going on in an organization, on the environment. Every organization takes several steps in order to contribute towards the increase in environmental performance. The raw materials used in the production of several products consist of recycled components. Similarly, these products must be made in such a way that they can also be recycled. The technology and machinery used for the production of these recyclable products must also be environment friendly (Ross, 2017). These various steps result in the preservation of environment by reducing harmful wastes and toxic emissions. This results in the increase in the environmental performance of that particular organization. Engineering education plays an important role in the improvement of environmental performance of an organization. Engineering education provides enough skills and knowledge about different processes and practices to preserve the environment (Rumane, 2017). These practices and processes reduce the environmental waste that is in the form of harmful chemicals and toxic materials. Environmental performance also increases the level of a particular organization as compared to the other organizations of similar sector. The technical and innovative skills of engineers also help the organization to develop certain processes for the production of products and provision of services in such a way that there is minimum harm to the environment (Saeidi, Sofian, Saeidi, & Saeidi, 2015). So we can conclude that engineering education has significant impact on environmental performance of firms in Malaysia. So we can generate the following hypothesis:

H 3: Engineering Education has significant impact on Environmental Performance of Firms in Malaysia.

Mediating Role of Integrated Quality and Environmental Management between Engineering Education and Quality Performance

Quality and environmental management are two different management systems that are applied in any organizations either one after the other or simultaneously. The purpose of applying these management systems is to enhance the performance and growth of an organization. When both these systems i.e. quality and environmental management systems are applied simultaneously, it supports the objectives and aims of that particular organization (Schumpeter, 2017). Every

company sets goals and objectives for the enhancement of their organization. IQEMP practices are involved in the goals setting process. In addition, IQEMP is also used while making strategies and plans to achieve those particular goals and objectives. This is made sure that all the conditions and principles of IQEMP must be acknowledged by all the employees and managers of that organization. The reviews of managers and employees about IQEMP are also considered so that required improvements must be made accordingly (Song, Fisher, Wang, & Cui, 2018). The application of IQEMP usually involves many managerial and technical skills and knowledge that can be obtained from engineering education. The organization can hire people with more effective engineering knowledge so that they can bring their skills and talents related to management of quality and environment into that organization. The application of IQEMP results in the improvement of quality of products produced and services provided by that organization. These factors indicate the improvement in quality performance of that organization that can be studied under theory of economic development (Tejedor, Segalàs, & Rosas-Casals, 2018). From the above discussion, we can conclude that integrated quality and environmental management has significant mediating role between engineering education and quality performance. We can generate the following hypothesis:

H 4: Integrated Quality and Environmental Management has significant Mediating Role between Engineering Education and Quality Performance in firms of Malaysia.

Mediating Role of Integrated Quality and Environmental Management between Engineering Education and Firm Performance

Studies have shown that quality management and environmental management are different management systems that are applied in any organization in order to promote quality and environmental performance. When these systems are applied at the same time they are said to be integrated quality and environmental management systems IQEMP (Wamba et al., 2017). Engineering education plays a very important role in the implementation of IQEMP in an organization as it provides necessary skills and knowledge required for implementation of IQEMP. These skills can be used by any organization in order to improve overall performance of the company. The profits and revenues can be increased, sales can be enhanced, and productivity can be improved by using IQEMP (Wiengarten, Humphreys, Onofrei, & Fynes, 2017). These factors show the increase in the firm performance in an organization. From the above discussion we can conclude that integration of quality and environmental management practices has significant

mediating role between engineering education and firm performance of a Malaysian firm. We can generate the following hypothesis in this regard:

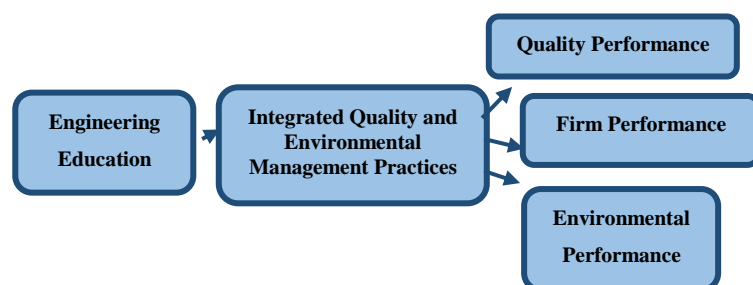
H 5: Integrated Quality and Environmental Management Practices have significant Mediating Role between Engineering Education and Firm Performance of a Malaysian firm.

Mediating Role of Integrated Quality and Environmental Management between Engineering Education and Environmental Performance

Environmental management practices involve the use of various processes and practices that are used in order to minimize the negative impact of production of products in an organization on the environment. These practices include the use of recycled raw materials in order to produce recyclable products. In addition, clean and environmentally friendly equipment is used in order to make such products (Zeng, Phan, & Matsui, 2015). All these factors indicate the increase in environmental performance of an organization. These environmental management practices, when used with the integration of quality management practices, in the form of IQEMP, it results in the increase of environmental performance of that particular organization. Engineering education plays an important role in this regard. Engineering education enables the organizations to introduce environment friendly technology in order to reduce wastes and toxic secretions from the industry. Engineering education also provides knowledge about other ways to improve environmental performance of an organization according to theory of economic development (Francks, 2015). From the above discussion, we can say that integrated quality and environmental management practices have significant mediating role between engineering education and environmental performance of firms in Malaysia. We can generate the following hypothesis in this regard:

H 6: Integrated Quality and Environmental Management Practices have significant Mediating Role between Engineering Education and Environmental Performance of firms in Malaysia.

Research Model



III. RESEARCH METHODOLOGY

A. Population and Sample

This proposed study has been conducted for the examination of impact of engineering education on quality, firm and environmental performance, in mediating role of integrated quality and environmental management. The data has been collected from top ten construction companies of Malaysia, because they can better explain that if latest engineering education provided to firm's employees and managers then what will be the impact on quality, firm and environmental performance. The sample such as senior managers and middle level managers have been selected by using simple random techniques in order to maintain the balance among these companies. Researcher has to be vigilant while selecting the sample size because size has to be in accordance to the sampling technique such as if structure equation modeling has been used in the analysis then sample size has to be large enough. Due to this reason, researcher decided to use the Klein (2015) idea for calculation of sample size, which elaborate that number of questions*10 provide more accurate sample size. In the proposed study sample size is $40 \times 10 = 400$ that's why 400 questionnaires have been handed out to the respondents, out of which only 345 filled questionnaires have been received. Some of these questionnaires has also been discarded due to the invalid data that's why only 311 responses have been considered valid.

DATA COLLECTION PROCEDURE

Questionnaire has been used by the researcher as a data collection procedure. This method is more appropriate for collecting quantitative and numeric data from respondents. Questionnaire initially written in English language then translated into native language. After collecting responses questionnaire again translated back into English because evaluation of data can be performed more easily by using English language. For the verification of the wording, the format and understandability of the questionnaire items, researcher performed pilot study. In pilot study, feedback has been collected from 20 respondents, after that questionnaire has been rephrased according to the suggestions of respondents. Researcher has been collected the responses from respondents by using both self-administered and online questionnaire techniques because it helps respondents to respond more accurately and conveniently.

RELIABILITY AND VALIDITY OF MEASURES

In the measurement model, reliability and validity has been assessed by SPSS and AMOS respectively by examining different criteria. Criteria administered for the assessment of

Published by: The Mattingley Publishing Co., Inc.

reliability are Cronbach's α , whose threshold range is greater than 0.70 because it confirmed the internal consistency and second criteria is composite reliability, its threshold range is greater than 0.70 because it ensured the desirable level of items reliability. Coming towards validity, convergent validity has been assessed by three criteria such as (1) composite constructs reliability, it must be exceed the threshold range 0.80 because its values stronger at above 0.80, (2) items loading λ its threshold range is greater than 0.70 and (3) average variance extracted (AVE) it has to be greater than 0.50 because its values were stronger at above this specified limit. As far as discriminant validity is concerned, it has been measured by measuring the convergence of constructs on corresponding values. Discriminant validity of constructs has been ensured when square root of AVE is greater than all other correlated constructs.

Common bias method has been compounded due to the social desirability, vague wording and length of scale. It was difficult to identify the common bias method because due to corruption of measures in same direction, contaminates the outcomes of the study. Researcher used Harman's single factor test for identifying the risk of common bias method in the proposed study. All the variables of study such as environmental management, integrated quality, engineering education, quality, firm and environmental performance have been takes into account for the evaluation of common bias method. Researcher checked that whether all the constructs accounted for by single factor or not by single factor. According to the outcomes of the test, not all the constructs accounted for by single factor, almost 89% of variance accounted for by factor solution and almost 15% of variance accounted for by single factor. Hence, it has been confirmed that proposed study not observed risk of common method bias because single factor not used for the counting of 50% of variance.

MEASURES

Different variables of the study have been evaluated on the bases of the measures which have already been used by different authors. These measures are as follow:

B. Engineering Education

12-items scale has been used by researcher for the evaluation of engineering education (independent variable). This scale has been adapted from the much similar study of (Jarrar & Anis, 2016). Researcher asked the respondents to record their responses in 1-5 range of 5-point Likert scale, in which 1 stands for strongly disagree and 5 stands for strongly agree. Out of the 12 questions of this variable, one survey question is

"I have learned that engineering education have positive impact over the economics and project management".

C. Integrated Quality and Environmental Management practices

Independent variables such as integrated quality and environmental management practices has been measured on the bases 11 items scale. These items have been adapted from earlier studies of (Karapetrovic & Jonker, 2003&Simon, Bernardo, Karapetrovic, & Casadesús, 2011). Integration level of quality and management practices have been measured simultaneously from these items, out of these survey items, one is "The QM and EM system work coherently to support the overall objectives of the firm". 5-point Likert scale has been adapted, which ranges from 1 (strongly disagree) to 5 (strongly agree).

D. Quality performance

The dependent variable such as quality performance has been measured on the bases of 6 items- scale, which has already been used in earlier studies of (Curkovic, Vickery, & Dröge, 2000) for the evaluation of such variables. These survey items have been measured by using the 5-point Likert scale, in which responses are categorized in range 1-5, 1 stands for strongly disagree and 5 stands for strongly agree. One of survey item is, "The engineering education help in improving our overall productivity".

E. Firm Performance

Researcher measured the dependent variable in survey questionnaire on the bases of these items which have already been utilize by other authors in previous literature. 9 items scale has been adapted from (Boyd, 1991; Li, Huang, & Tsai, 2009 & Rao et al., 2006) for the measurement of variable firm performance, out of these 9 items one items is, "Our operational profit has increased". The scale is 5-point Likert scale, in which responses has been collected in the range from 1 (strongly disagree) to 5 (strongly agree).

F. Environmental Performance

Environmental performance (dependent variable) has been evaluated in questionnaire on the bases of 6-items, which have been adapted from the work of (Melnik, Sroufe, & Calantone, 2003 & Srivastava, Fahey, & Christensen, 2001). The items scale is 5-point Likert scale which ranges from 1-5, in which 1 stands for strongly disagree and 5 stands for strongly agree. One of survey item is, "Our firms used recycled components and input as much as possible".

HYPOTHESIS TESTING

Hypothesis testing has been performed by using structure equation modeling, which has been run on AMOS. Researcher

checked that hypotheses of study such as impact of engineering education on quality, firm and environmental performance, in mediating role of integrated quality and environmental management, were positively related or negatively related. Covariance-based approach has been used for running the characteristics of the SEM. Under this approach, researcher checked the direct, indirect and total effect and significance of hypotheses, in order to report the acceptance or rejection status of hypotheses.

IV. FINDINGS

This study examined the effects of engineering education (EE) on quality performance (QP), firm performance (FP) and environmental performance (EP) with the mediation of integrated quality & environmental management practice (IQEMP). There were 311 responses that were in the position to be used for analysis after screening. The demographic analysis of respondents showed that out of 311 responses received, there were 130 responses that were filled by males and 181 responses that were filled by females. It means that more than 50 percent representation in the current sample was of female respondents. The demographic factor of age was also analyzed for the current sample which showed that there were 82.6 percent respondents in the sample who were of age ranging from 21 to 30 years while 13.8 percent respondents were of age between 31 and 40 years. Out of 313 respondents, only 2.9% respondents reported their age ranging between 41 and 50 years however, respondents with age more than 50 years were only 0.6 percent of total sample used for analysis. The third demographic factor which was tested in the current study is educational qualification the results of which demonstrated that 48.6% respondents in the sample were post-graduated and 40.8% respondents in the sample were having Masters' degree. The proportion of graduated respondents in the sample was 7.4 percent while remaining respondents were having other educational qualifications.

1) Descriptive Statistics

The data used by 313 respondents was analyzed in terms of its descriptive characteristics the results of which demonstrated that the current data is in its normal and acceptable condition. Resulting descriptive statistics for the current data have been presented in table 1.

Table 1
Descriptive Statistics

N	Minim um	Maxim um	Mean	Std. Deviation	Skewness
---	-------------	-------------	------	-------------------	----------

	Statistic	Statistic	Statistic	Statistic	Statistic	Standard Error
QP	311	1.00	5.00	3.4952	1.14819	-.6638
FP	311	1.00	5.00	3.5766	1.06872	-.8588
EP	311	1.00	6.33	3.4234	1.05746	-.2228
IQEMP	311	1.00	5.00	3.4525	1.11224	-.5778
EE	311	1.17	5.00	3.4740	1.06457	-.6958

It is indicated from table 1 that the mean values of engineering education, IQEMP, quality, environmental, and firm performance are all between 1 and 5 which was the rating scale of these variables. It means that there is no extreme value in the data of any of these variables. The standard deviation is indicating that there is acceptable variation in the data of these variables because there is not too much variation. Furthermore, the skewness against engineering education, IQEMP, quality, environmental, and firm performance is ranging from -1 to +1 which is further proving the normality of the data. Hence, the current data is acceptable and normal. The suitability of the data has also been proved by "KMO and Bartlett's Test".

Table 2
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.942
Bartlett's Test of Sphericity	Approx. Chi-Square df	18302.117
	Sig.	.000

Results of "KMO and Bartlett's Test" are indicating that KMO for the present data is 0.942 which is definitely more than 0.6 and p-value in this test is less than 0.05. Hence, the normality, adequacy and suitability of the current data are confirmed.

2) Convergent validity and Discriminant validity

The convergent validity was tested to check the internal consistency while the discriminant validity was tested to check the multicollinearity of the data. Results given in table 3 are showing the discriminant as well as convergent validity of the data.

Table 3 Convergent Validity and Discriminant Validity

	CR	AVE	MSV	MaxR (H)	QP	EE	IQEMP	EP	FP
QP	0.955	0.780	0.292	0.976	0.883				
EE	0.922	0.678	0.285	0.985	0.534	0.823			
IQEMP	0.915	0.784	0.347	0.991	0.356	0.372	0.885		
	0.912	0.640	0.347	0.998	0.278	0.326	0.589	0.800	
FP	0.921	0.733	0.292	0.998	0.540	0.475	0.498	0.478	0.856

All indicators of convergent and discriminant validity for the current data are acceptable because the CR against QP, FP, EP, EE, and IQEMP are all more than 0.7 which are confirming the composite reliability of the data. The values of AVE against all of them are >0.50 while MSV for all of them is smaller than its respective AVE. Hence, the convergent validity of all variables is confirmed. The discriminant validity is also proved because the correlation of each variable with itself was highest than its correlation with any other variable.

3) Model Fitness (CFA)

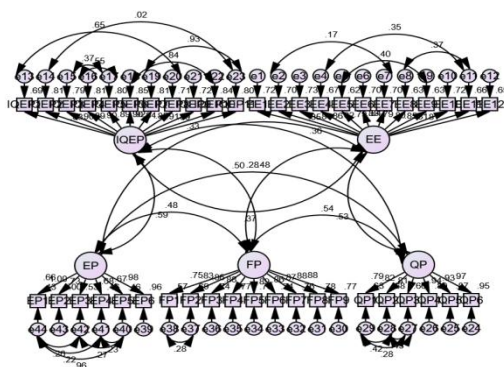
The model fitness of the current model has been assessed through CFA indicators that are presented in table 4.

Table 4

Indicators	Threshold range	Current values
CMIN/DF	Less than or equal to 3	2.416
GFI	Equal or greater than .80	.800
CFI	Equal or greater than .90	.933
IFI	Equal or greater than .90	.933
RMSEA	Less than or equal to .08	.068

The value of CMIN/DF is 2.416, GFI is 0.8, CFI is 0.933, IFI is 0.933 and RMSEA is 0.068 so, the current model containing QP, FP, EP, EE, and IQEMP has the good fit.

Figure 1
CFA



4) Hypotheses Testing

To test the hypotheses of the study, structural equation modeling (SEM) has been performed through EViews 10 which produced results given in table 5.

Table 5 SEM Results

Total Effect	EE	IQEMP
IQEMP	.357***	.000
EP	.353***	.604***
FP	.461***	.369***
QP	.555***	.189***
Direct Effect	EE	IQEMP
IQEMP	.357***	.000
EP	.137**	.604***
FP	.329***	.369***
QP	.487***	.189***
Indirect Effect	EE	IQEMP
IQEMP	.000	.000
EP	.216***	.000
FP	.132**	.000
QP	.067**	.000

Note: *** indicates p-value <0.001, ** indicates p-value <0.01, * indicates p-value <0.05.

It can be seen in table 5 that engineering education significantly positively influences the quality performance, firm performance and environmental performance but the total impacts of EE on QP, FP, and EP are not equal to direct impacts of EE on QP, FP, and EP. It is indicated from table 5 that EE has significant indirect positive impacts on QP, EP, and FP which are caused due to IQEMP. It is further indicated from table 5 that IQEMP has significant positive effects on QP, EP, and FP. Hence, the effect of EE on QP, EP, and FP as

well as the mediation of IQEMP in these relationships is significantly supported through results.

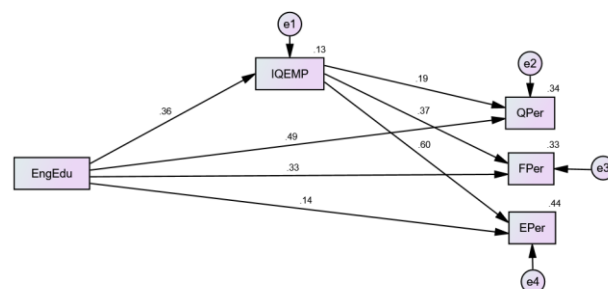


Figure 2 SEM

V. DISCUSSION

The purpose behind the need of the study was to check out the impact of engineering education on three different kinds of performances which included quality performance, firm performance, and the environmental performance (Abele et al., 2015). This study importantly focused on the mediating role of integrated quality and environmental management practices between the engineering education and the three various kinds of the performances as mentioned before. After the detailed literature review all the mentioned variables the theoretical frame work and the few hypothesis derived from the study. These hypotheses were exposed different testing and analytical techniques. The results of the analysis will be discussed in this section (Bucciarelli & Kuhn, 2018). The very first hypothesis which this study proposed was, “engineering education has a significant and a positive impact on quality performance.” According to the study of (Chao, Chen, & Chuang, 2015), engineering education enhances the performance of the organization according to the need of the modern era because of this the quantity of the worker and the capital spent decreases while the quality the output of the firm increases. The second hypothesis proposed by this study was that “engineering education has a significant and a positive impact on the performance of the organization.” According to the study of (Devadiga, 2017), Engineering education and its implementation through the employees of the organization are considered as a very vital part of the success and the growth of an organization in the era of modern technology so, as per the data from the past study and the results of the analysis of the current study it can be concluded that engineering education and firm performance has a significant and positive relation between them. The third hypothesis proposed was that

the “engineering education has a positive and significant impact on environmental performance.” According to the study of (Horváth, 2016), modern engineering involves innovative ideas and their application which are environment friendly and which caused minimum harm in the environment. today the engineering education helps in the implication of environment friendly business technique which grows the business in an environment friendly and sustainable way (Newstetter & Svinicki, 2015). The business is being engineer in a sustainable way. The fourth hypothesis which is suggest by this study was that, “integrated quality and environmental management practices have a significant and positive mediating role between the engineering education and the quality performance”. The hypothesis is accepted, according to the study of (Karabulut- Ilgu et al., 2018; Lima, Andersson, & Saalman, 2017), integrated quality means integrating all of the processes and the systems of a business and monetarizing those processes by mutely to check whether they are contributing in the achieving the goals or not. In the modern era environmental management practices involved running the business in the sustainable and environment friendly way. It is a sure short thing to that with the implementation of such practices through the engineering education enhances the quality performance of the firm.

The hypothesis is accepted, according to the study of (Martin, 2015), integrated quality means integrating all of the processes and the systems of a business and monitoring those processes by mutely to check whether they are contributing in the achieving the goals or not. In the modern era environmental management practices involved running the business in the sustainable and environment friendly way. It is a sure short thing to that with the implementation of such practices through the engineering education enhances the quality performance of the firm. Sixth hypothesis proposed by the study was that, “integrated quality and environmental management practices have a significant a positive mediating role between the engineering education and the environmental performance”. This hypothesis is accepted as when a firm implements and environment friendly and sustainable environment way it is definite thing that the performance according to the environment will enhance (Martínez-Núñez, Fidalgo-Blanco, & Borrás-Gené, 2015).

VI. CONCLUSION

The purpose behind the need of the study was to check out the impact of engineering education on three different kinds of performances which included quality performance, firm performance, and the environmental performance. This study importantly focused on the mediating role of integrated quality and environmental management practices between the engineering education and the three various kinds of the performances as mentioned before. The target for the data

collection was two hundred and eight Turkish firms. The method adopted was the collection of data through questionnaires which were initially designed in English but then they were translated into the Turkish language. The respondents from the firm were also interviewed and the collective data was exposed to confirmatory factor analysis and that was examined through structural equation modeling procedure. The results showed that engineering education positively and significantly impacts the quality, firm and the environmental performance. While integrated quality and environmental management practices significantly mediates between all these variables.

VII. IMPLICATIONS OF THE STUDY

This study has enhanced the importance of integrated quality an environmental management practices according to the literature, it is well known that environment management practices is a hot topic these days as every company is running a campaign to promote the business that are sustainable for the environment but this study has calculated its impacts and provided its relation with three different kinds of performances. In the case of the practical implication, this study is promoting an idea which will be satisfying every kind of stakeholder of the company including the environment of the company. While, in the policy making section of the company quality integrated systems involving environment friendly and sustainable business running systems implemented through the engineering education will enhance the firm’s performances, quality and its extension of benefits towards the environment in which it is running its business.

VIII. LIMITATIONS AND FUTURE RESEARCH INDICATIONS

Like other studies this study also involves some limitations first limitation is regarding its variables, moderating variables such as internationalization, global strategic intentions, innovation performance and market orientation is recommended to the future researchers to incorporate in their studies. Moreover, the study has conducted relational research in the setup of a single country so the findings cannot be generalized to another country. Thirdly, the data is gathered from the key positions of the firm so, biases might be present in the data.

IX. REFERENCES

- [1] Abele, E., Metternich, J., Tisch, M., Chrysosouris, G., Sihn, W., ElMaraghy, H., . . . Ranz, F. (2015). Learning factories for research, education, and training. *Procedia Cirp*, 32, 1-6.
- [2] Arda, O. A., Bayraktar, E., & Tatoglu, E. (2019). How do integrated quality and environmental management practices affect firm performance? Mediating roles of quality performance and environmental proactivity. *Business Strategy and the Environment*, 28(1), 64-78.

- [3] Barrick, M. R., Thurgood, G. R., Smith, T. A., & Courtright, S. H. (2015). Collective organizational engagement: Linking motivational antecedents, strategic implementation, and firm performance. *Academy of Management Journal*, 58(1), 111-135.
- [4] Bennett, B., Bettis, J. C., Gopalan, R., & Milbourn, T. (2017). Compensation goals and firm performance. *Journal of financial economics*, 124(2), 307-330.
- [5] Bernard, A. B., Moxnes, A., & Saito, Y. U. (2019). Production networks, geography, and firm performance. *Journal of Political Economy*, 127(2), 639-688.
- [6] Blakely, E. J., & Leigh, N. G. (2017). *Planning local economic development: theory and practice*: SAGE.
- [7] Boyd, B. K. (1991). Strategic planning and financial performance: a meta-analytic review. *Journal of management studies*, 28(4), 353-374.
- [8] Braam, G. J., de Weerd, L. U., Hauck, M., & Huijbregts, M. A. (2016). Determinants of corporate environmental reporting: The importance of environmental performance and assurance. *Journal of Cleaner Production*, 129, 724-734.
- [9] Brunhaver, S. R., Korte, R. F., Barley, S. R., Sheppard, S. D., Freeman, R., & Salzman, H. (2018). Bridging the gaps between engineering education and practice. *US engineering in a global economy*, 129-163.
- [10] Bucciarelli, L. L., & Kuhn, S. (2018). ENGINEERING EDUCATION AND ENGINEERING PRACTICE: IMPROVING THE FIT. *Between Craft and Science: Technical Work in the United States*, 210.
- [11] Chao, C. Y., Chen, Y. T., & Chuang, K. Y. (2015). Exploring students' learning attitude and achievement in flipped learning supported computer aided design curriculum: A study in high school engineering education. *Computer Applications in Engineering Education*, 23(4), 514-526.
- [12] Chin, T. A., Tat, H. H., & Sulaiman, Z. (2015). Green supply chain management, environmental collaboration and sustainability performance. *Procedia Cirp*, 26, 695-699.
- [13] Curkovic, S., Vickery, S., & Dröge, C. (2000). Quality-related action programs: their impact on quality performance and firm performance. *Decision Sciences*, 31(4), 885-902.
- [14] Devadiga, N. M. (2017). *Software engineering education: Converging with the startup industry*. Paper presented at the 2017 IEEE 30th Conference on Software Engineering Education and Training (CSEE&T).
- [15] Dubey, R., Gunasekaran, A., & Ali, S. S. (2015). Exploring the relationship between leadership, operational practices, institutional pressures and environmental performance: A framework for green supply chain. *International Journal of Production Economics*, 160, 120-132.
- [16] Edwards, M. E. (2017). *Regional and urban economics and economic development: Theory and methods*: Routledge.
- [17] Epstein, M. J., Buhovac, A. R., & Yuthas, K. (2015). Managing social, environmental and financial performance simultaneously. *Long range planning*, 48(1), 35-45.
- [18] Francks, P. (2015). *Japanese economic development: theory and practice*: Routledge.
- [19] Fritsch, M. (2017). The theory of economic development—An inquiry into profits, capital, credit, interest, and the business cycle. *Regional Studies*, 51(4), 654-655.
- [20] Griffin, R. D. (2016). *Principles of air quality management*: CRC Press.
- [21] Horváth, I. (2016). *Innovative engineering education in the cooperative VR environment*. Paper presented at the 2016 7th IEEE International Conference on Cognitive Infocommunications (CogInfoCom).
- [22] Jarrar, M., & Anis, H. (2016). The impact of entrepreneurship on engineering education. *Proceedings of the Canadian Engineering Education Association (CEEAA)*.
- [23] Jermstittiparsert, K. & Boonratanakittiphumi, C. (2019). The Mediating Role of Knowledge Management and the Moderating Role of Additive Manufacturing (Industry 4.0) in the Relationship between Knowledge Management Capability and Firm Performance: A Case of KPMG Thailand. *International Journal of Innovation, Creativity and Change*, 8(8), 430-449.
- [24] Karabulut-Ilgu, A., Jaramillo Cherrez, N., & Jähren, C. T. (2018). A systematic review of research on the flipped learning method in engineering education. *British Journal of Educational Technology*, 49(3), 398-411.
- [25] Karapetrovic, S., & Jonker, J. (2003). Integration of standardized management systems: searching for a recipe and ingredients. *Total Quality Management & Business Excellence*, 14(4), 451-459.
- [26] Kosa, M., Yilmaz, M., O'Connor, R., & Clarke, P. (2016). Software engineering education and games: a systematic literature review. *Journal of Universal Computer Science*, 22(12), 1558-1574.
- [27] Lewis, V. A., Frazee, T., Fisher, E. S., Shortell, S. M., & Colla, C. H. (2017). ACOs serving high proportions of racial and ethnic minorities lag in quality performance. *Health affairs*, 36(1), 57-66.
- [28] Li, Y.-H., Huang, J.-W., & Tsai, M.-T. (2009). Entrepreneurial orientation and firm performance: The role of knowledge creation process. *Industrial marketing management*, 38(4), 440-449.
- [29] Lievens, A., Jacchia, S., Kagkli, D., Savini, C., & Querci, M. (2016). Measuring digital PCR quality: performance parameters and their optimization. *PLoS ONE*, 11(5), e0153317.
- [30] Lima, R. M., Andersson, P. H., & Saalman, E. (2017). *Active Learning in Engineering Education: a (re) introduction*: Taylor & Francis.
- [31] Lins, K. V., Servaes, H., & Tamayo, A. (2017). Social capital, trust, and firm performance: The value of corporate social responsibility during the financial crisis. *The Journal of Finance*, 72(4), 1785-1824.
- [32] Martin, L. (2015). The promise of the maker movement for education. *Journal of Pre-College Engineering Education Research (J-PEER)*, 5(1), 4.

- [33] Martínez-Núñez, M., Fidalgo-Blanco, Á., & Borrás-Gené, O. (2015). New challenges for the motivation and learning in engineering education using gamification in MOOC.
- [34] Martos, A., Pacheco-Torres, R., Ordóñez, J., & Jadraque-Gago, E. (2016). Towards successful environmental performance of sustainable cities: Intervening sectors. A review. *Renewable and Sustainable Energy Reviews*, 57, 479-495.
- [35] Mauricio, R. d. A., Veado, L., Moreira, R. T., Figueiredo, E., & Costa, H. (2018). A systematic mapping study on game-related methods for software engineering education. *Information and software technology*, 95, 201-218.
- [36] Melnyk, S. A., Sroufe, R. P., & Calantone, R. (2003). Assessing the impact of environmental management systems on corporate and environmental performance. *Journal of operations management*, 21(3), 329-351.
- [37] Myrdal, G. (2017). *The political element in the development of economic theory*: Routledge.
- [38] Newstetter, W. C., & Svinicki, M. D. (2015). Learning theories for engineering education practice *Cambridge handbook of engineering education research* (pp. 29-46): Cambridge University Press.
- [39] Noe, R. A., Hollenbeck, J. R., Gerhart, B., & Wright, P. M. (2017). *Human resource management: Gaining a competitive advantage*: McGraw-Hill Education New York, NY.
- [40] Papp, J. (2018). *Quality Management in the Imaging Sciences E-Book*: Elsevier Health Sciences.
- [41] Parvadavardini, S., Vivek, N., & Devadasan, S. (2016). Impact of quality management practices on quality performance and financial performance: evidence from Indian manufacturing companies. *Total Quality Management & Business Excellence*, 27(5-6), 507-530.
- [42] Perroux, F. (2017). The pole of development's new place in a general theory of economic activity *Regional economic development* (pp. 48-76): Routledge.
- [43] Psomas, E. L., & Jaca, C. (2016). The impact of total quality management on service company performance: evidence from Spain. *International Journal of Quality & Reliability Management*, 33(3), 380-398.
- [44] Rao, M. P., Dwivedi, U., Datta, B., Vyas, N., Nandy, P., Trivedi, S., & Singh, P. (2006). Post caesarean vesicouterine fistulae-Youssef syndrome: our experience and review of published work. *ANZ journal of surgery*, 76(4), 243-245.
- [45] Ross, J. E. (2017). *Total quality management: Text, cases, and readings*: Routledge.
- [46] Rumane, A. R. (2017). *Quality management in construction projects*: CRC Press.
- [47] Saeidi, S. P., Sofian, S., Saeidi, P., Saeidi, S. P., & Saeidi, S. A. (2015). How does corporate social responsibility contribute to firm financial performance? The mediating role of competitive advantage, reputation, and customer satisfaction. *Journal of Business Research*, 68(2), 341-350.
- [48] Schumpeter, J. A. (2017). *Theory of economic development*: Routledge.
- [49] Simon, A., Bernardo, M., Karapetrovic, S., & Casadesús, M. (2011). Integration of standardized environmental and quality management systems audits. *Journal of Cleaner Production*, 19(17-18), 2057-2065.
- [50] Song, M.-L., Fisher, R., Wang, J.-L., & Cui, L.-B. (2018). Environmental performance evaluation with big data: Theories and methods. *Annals of Operations Research*, 270(1-2), 459-472.
- [51] Srivastava, R. K., Fahey, L., & Christensen, H. K. (2001). The resource-based view and marketing: The role of market-based assets in gaining competitive advantage. *Journal of Management*, 27(6), 777-802.
- [52] Sriviboon, C. & Jermittiparsert, K. (2019). Influence of Human Resource Practices on Thai Pharmaceutical Firm Performance with Moderating Role of Job Involvement. *Systematic Reviews in Pharmacy*, 10(2), 234-243.
- [53] Tejedor, G., Segalàs, J., & Rosas-Casals, M. (2018). Transdisciplinarity in higher education for sustainability: How discourses are approached in engineering education. *Journal of Cleaner Production*, 175, 29-37.
- [54] Wamba, S. F., Gunasekaran, A., Akter, S., Ren, S. J.-f., Dubey, R., & Childe, S. J. (2017). Big data analytics and firm performance: Effects of dynamic capabilities. *Journal of Business Research*, 70, 356-365.
- [55] Wiengarten, F., Humphreys, P., Onofrei, G., & Fynes, B. (2017). The adoption of multiple certification standards: perceived performance implications of quality, environmental and health & safety certifications. *Production Planning & Control*, 28(2), 131-141.
- [56] Zeng, J., Phan, C. A., & Matsui, Y. (2015). The impact of hard and soft quality management on quality and innovation performance: An empirical study. *International Journal of Production Economics*, 162, 216-226.