

## Entrepreneurship Traits among Engineering Students: Instrument Development and Validation Procedure using Structural Equation Modeling

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### ABSTRACT

To meet the demand for a sustainable global economic development and challenges, it is crucial for engineers to possess entrepreneurship traits on top of their technical competency. In understanding the entrepreneurship traits specifically among the engineering students in Malaysia, limited studies are available as compared to the business students. In contrast, the European and western countries had long pursued the interest in measuring entrepreneurship traits among engineering students. In view of this situation in Malaysia, a measuring instrument was developed and assessed for reliability using the exploratory factor analysis procedure. Quantitative data was collected from 346 engineering students using structured survey. Based on the reliability testing, the final instrument obtained comprised of nine (9) items yielding two (2) dimensions that is perseverance (6 items) and social & cultural awareness (3 items). This study described the results of the exploratory factor analysis (EFA) process, the confirmatory factor analysis (CFA) and finally the structural equation model for entrepreneurship traits construct.

**Key words:** Entrepreneurship Traits, Entrepreneurship, Engineering Students, Engineering Education.

### 1. INTRODUCTION

The understanding of Entrepreneurship Trait “ET” and the ability to measure the factors are essential in determining the entrepreneurial level of the students specifically the engineering students. Identifying and monitoring entrepreneurship traits would provide a substantial interest among researchers. At the same time, policy makers can be enlightened on the condition and impact of entrepreneurship in education.

Engineers design and produce products that meet customer needs, that are safe, reliable, efficient and competitive in the global market [1]. A broad research conducted by scholars on new idea such as vehicle monitoring and tracking security system using GPS and IOT technology [36], study on increasing the efficiency of solar cells at a reduced cost [37] which are valuable in the 21<sup>st</sup> century. With the technical knowledge, engineering is valuable in solving technical problem but problem solving alone is however insufficient to create new products or disruptive technology. Engineers should also be able to incorporate the importance of customer

awareness and to focus on societal needs and values the lives of others. With this situation Kern Entrepreneurship Education Network “KEEN” worked on preparing more entrepreneurial engineers that is to train future engineers how to be entrepreneurially minded in order to be a key influencer in creating new products [2]. Consequently, there is a need to strengthen the engineering students with the appropriate mindset especially those with the entrepreneurial traits and characters.

A significant volume of research in the western and European countries on entrepreneurship has emerged over the past decade [3-6]. Theorist, academicians and policy makers discussed various topics of entrepreneurship such as entrepreneurship and small businesses [7-9], entrepreneurship education for business and non-business students [10-13], entrepreneurship intention [14-16], entrepreneurship characters [4, 17] and many more. Majority of the research works on entrepreneurship were carried out in developed countries including European, Organization for Economic Cooperation and Development “OECD” countries and the Western countries. Many researches were influenced by Kuratko [18], the OECD [19] and KEEN framework [20], where established guidelines serve as guidelines for measuring particularly entrepreneurship education and related areas.

Despite large volumes of studies on entrepreneurship among students in Malaysia, there remain a lack of adequate studies that lead to measuring entrepreneurship traits among the engineering students. This situation limits the ability to understand engineering students’ characters and capabilities. The lack of quantitative evidence also limits the ability to understand the engineering student’s entrepreneurship traits in promoting entrepreneurial minded engineers. Ministry of Higher Education has initiated the entrepreneurship education the last ten years and later strengthen the entrepreneurship education in the Action Plans 2011-2015 and Malaysian Education Blueprints “MEB” 2015-2025 for schools and higher education. The commitment continued with Entrepreneurship Action Plan 2016-2020. In these action plans and blueprints, the learning institutions is expected to enhance entrepreneurship education in order to transform and enhance the entrepreneurship programs including more practical components and incentives for excellence in entrepreneurial learning [21]. Therefore, the development of instruments measuring entrepreneurship traits is crucial, not only to address existing gaps in knowledge, but also to establish reliable education tools to gauge entrepreneurship mindset.

In this paper, entrepreneurship traits refer to abilities, attitude and characteristics of a person's experiences and actions which are the constructs that will be measured. Considering the implication of previous research in the related body of literature, the development of a research framework was self-developed to measure the entrepreneurship traits. The primary goal of this study is to provide empirical support on the validity and reliability as well as the identification of several factors for each construct.

## 2. RESEARCH INSTRUMENT

The survey instrument for the study was proposed and developed by the researcher to measure entrepreneurship traits. To ensure content validity, the instrument was presented to the field experts to eliminate any ambiguities from the questionnaire [22, 23]. A pilot test procedure was then carried out to 36 engineering students from public and private universities. The pilot test was conducted to monitor the level of understanding of respondents in answering the items of the instrument. From the feedback received, appropriate modifications and improvements on the spelling, clarity and structure were made and a final questionnaire was developed. The final questionnaire was developed for data collection to measure ET constructs which consists of nine (9) items measured using five-point Likert scale. The Likert-scale used was: 1 = "Strongly Disagree" and 5 = "Strongly Agree". Table 1 shows the items for Entrepreneurship Traits.

**Table 1:** Items for Entrepreneurship Traits

Constructs	Code	Items
<b>Initiative</b>	QI66	I belief I have a positive attitude
	QI67	I belief I am a self-starter
	QI68	I always get things done
<b>Perseverance</b>	QP69	I am determined to succeed at something and keep trying until I got it right
	QP70	I have high determination that push me to keep going and keep trying through times
<b>Adaptability</b>	QA71	I can adjust myself to different conditions
	QA72	I can make changes to response to new environment
<b>Social Awareness</b>	QS73	I am aware of the differences and similarities between people from other countries
	QS74	I know about cultural characteristics, history, values, beliefs and behaviors of other ethnic or group
	QS75	I am aware of other cultural attitudes
	QS76	I respect and value other cultures

There are four (4) constructs and eleven (11) newly developed items for this study. Among the 11 items of the construct, 3 items belong to initiative dimension, 2 items belong to perseverance dimension, 2 items belong to adaptability dimension and 4 items belong social and cultural awareness dimension.

## 3. METHODOLOGY

This study is to develop a valid and reliable measurement for entrepreneurship traits "ET" constructs. The population comprised of undergraduate students from engineering discipline. A total of 346 engineering students as the respondents from both public and private universities. Data was collected using online survey. Descriptive statistics was used to explore the data collected by calculating the mean [24]. EFA was conducted in the study, where the principal component analysis "PCA" was employed as the factor extraction method and a Promax rotation as the rotation method. The decision to determine the number of factors and items on the following principles: i) Kaiser-Meyer-Olkin values "KMO" test  $> 0.6$ , ii) Bartlett's Test Factor Significant value,  $p < 0.001$  and iii) Factor loading for items  $> 0.60$ . Next, reliability analysis was used to assess the measuring items under each construct and evaluate the degree to which they are error-free. The value of Cronbach's Alpha of more than 0.5 was used to measure the reliability of items [25]. Finally, this study employed Structural Equation Modeling "SEM" and the confirmatory factor analysis "CFA" procedure was executed to validate the measurement models of the ET construct. The level of acceptance for fitness indexes use in this study are RMSEA  $< 0.08$ , CFI  $> 0.90$  and  $p$ -value  $> 0.5$ .

## 4. RESULTS AND DISCUSSION

### 4.1 Descriptive Analysis

Table 2 shows a total of 11 items spread over four constructs to measure the Entrepreneurship Traits. The constructs are Initiative, Perseverance, Adaptability and Social Awareness. Initiative has three items, Perseverance has two items, Adaptability has two items and Social Awareness has four items. The respondents revealed that the importance of both Perseverance and Social Awareness (average mean score: 3.88) as conditions for them to succeed than Initiative (average mean score: 3.80) and Adaptability (average mean score: 3.81).

The mean score ranged from the lowest of 3.63 (item QI67) to the highest 3.89 (items QI66 and QI68) for the three items in Initiative construct. The standard deviation ranged from 0.846 (QI67:  $0.846/3.63 = 23.30$  percent) and QI68:  $0.846/3.89 = 21.75$  percent) to 0.848 (QI66:  $0.848/3.89 = 21.80$  percent) which indicate that the scores are packed around the mean. Perseverance has two items with similar mean scores of 3.88 (items QP69 and QP70). The standard deviation ranged from 0.797 (QP69:  $0.797/3.88 = 20.54$  percent) to 0.820 (QP70:  $0.820/3.88 = 22.59$  percent) which indicate that the scores are packed around the mean. The mean score ranged from the lowest of 3.79 (item QA71) to the highest 3.82 (item QA72) for the three items in Adaptability construct. The standard deviation ranged from 0.771 (QI72:  $0.771/3.82 = 20.18$  percent) to 0.785 (QA71:

0.785/3.79 = 20.71 percent) which indicate that the scores are packed around the mean.

**Table 2:** Descriptive Analysis for Entrepreneurship Traits

Code	Items	Mean	Std. Dev.
<b>ET1</b>	<b>Initiative</b>		
QI66	I belief I have a positive attitude	3.89	0.848
QI67	I belief I am a self-starter	3.63	0.846
QI68	I always get things done	3.89	0.846
<b>All items in Initiative</b>		<b>3.80</b>	
<b>ET2</b>	<b>Perseverance</b>		
QP69	I am determined to succeed at something and keep trying until I got it right	3.88	0.797
QP70	I have high determination that push me to keep going and keep trying through times	3.88	0.820
<b>All items in Perseverance</b>		<b>3.88</b>	
<b>ET3</b>	<b>Adaptability</b>		
QA7 1	I can adjust myself to different conditions	3.79	0.785
QA7 2	I can make changes to response to new environment	3.82	0.771
<b>All items in Adaptability</b>		<b>3.81</b>	
<b>ET4</b>	<b>Social Awareness</b>		
QS73	I am aware of the differences and similarities between people from other countries	3.90	0.800
QS74	I know about cultural characteristics, history, values, beliefs and behaviors of other ethnic or group	3.68	0.858
QS75	I am aware of other cultural attitudes	3.78	0.828
QS76	I respect and value other cultures	4.14	0.802
<b>All items in Social Awareness</b>		<b>3.88</b>	
<b>Mean</b>		<b>3.84</b>	

The mean score ranged from the lowest of 3.68 (item QS74) to the highest 4.14 (item QS76) for the four items in Social Awareness construct. The standard deviation ranged from 0.800 (QS73: 0.800/3.90 = 20.51 percent) to (QS74: 0.858/3.68 = 23.32 percent) which indicate that the scores are packed around the mean. High standard deviation for items were due to variation of background of the students, type of university attended and level of education.

All 11 items achieved more than 3.60 mean values. The lowest mean score is 3.6 (item QI67: *I belief I am a self-starter*) and the highest mean score is 3.89 (item QI68: *I always get things done*). The overall means score for the construct is 3.83. The data reveals that all the four constructs contribute towards explaining the Entrepreneurial Trait among engineering students. High standard deviation for

items were due to variation of background of the students, type of university attended and level of education.

## 4.2 Exploratory Factor Analysis

Exploratory factor analysis (EFA) is a widely used and broadly applied statistical technique in the social science [26]. EFA is a multivariate statistical procedure used to reduce large number of factors into smaller set of factors, establishes dimensions and provides construct validity to name a few [27, 28].

In this study, Kiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity were conducted to determine sampling adequacy. Bartlett's test of sphericity should be significant at ( $P < 0.05$ ) for the factor analysis to be appropriate [29]. The KMO ranges from 0 to 1, but the general acceptable index is over 0.6 [30, 31]. Total variance explained was also examined as an extraction process of items to reduce them into a manageable number before further analysis. In this process, items with eigenvalues exceeding 1.0 are extracted into different components [22]. Rotated component matrix was examined and only items with a factor loading above 0.6 were retained for further analysis. However, the process of EFA and reliability analysis was conducted and only items with Cronbach's Alpha closer to 1.0 for the items to have higher reliability.

## 4.3 Results of Exploratory Factor Analysis

Exploratory factor analysis is a statistical technique used to reduce data to a smaller set of variables. Table 3 shows that the EFA procedure has extracted two components. In this study, only factor loadings above 0.6 will be retained. The rotated component matrix shows that all 9 items having factor loading above 0.6 and therefore 9 items will be considered for further analysis under two dimensions of ET construct.

**Table 3:** Rotated Component Matrix for Entrepreneurship Trait

Code	Items	Factor	
		1	2
QI66	I belief I have a positive attitude	.809	
QA71	I can adjust myself to different conditions	.785	
QI67	I belief I am a self-starter	.781	
QP70	I have high determination that push me to keep going and keep trying through times	.725	
QP69	I am determined to succeed at something and keep trying until I got it right	.702	
QI68	I always get things done	.651	
QS75	I am aware of other cultural attitudes		.884
QS74	I know about cultural characteristics, history, values, beliefs and behaviors of other ethnic or group		.863
QS73	I am aware of the differences and similarities between people from other countries		.641

Extraction Method: Principle Component Analysis.  
Rotation Method: Promax with Kaiser Normalization.

After conducted the EFA, the results consist of two (2) dimensions and nine (9) items. Among the 9 items of the ET constructs, 6 items belong to perseverance dimension and 3 items belong to social and cultural awareness dimension. The KMO and Bartlett's Test results of the study is presented in Table 4.

**Table 4:** KMO and Bartlett's Test for the items of ET construct

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.878
Bartlett's Test of Sphericity	Approx. Chi-Square	1114.484
	df	36
	Sig.	.000

The general acceptance index of KMO is over 0.6. Table 4 shows the KMO value of 0.878 is excellent as it exceeds the recommended value of 0.6. The significance value of Bartlett's Test of Sphericity must be less than 0.05 for the factor analysis to be acceptable. The Bartlett's Test significance value is 0.000 which meet the required significance value of less than 0.05 [22]. Therefore, KMO value close to 1.0 and Bartlett's test significance value close to 0.0 suggest that data is adequate and appropriate to proceed further with the reduction procedure. Total variance explained is an extraction process of items to reduce them into a manageable number before further analysis. In this process, components with eigenvalues exceeding 1.0 are extracted into different components [22, 32].

Table 5 shows the EFA has extracted two dimensions of ET construct with eigenvalue 4.227 for component 1 and 1.173 for component 2. This indicates that the items are grouped into two dimensions and would be considered for further analysis. The table also shows the total variance explained is 59.990%.

**Table 5:** Total Variance Explained for ET Construct

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	<b>4.227</b>	46.962	46.962	4.227	46.962	<b>46.962</b>
2	<b>1.173</b>	13.029	59.990	1.173	13.029	<b>59.990</b>
3	.703	7.813	67.803			
4	.633	7.032	74.835			
5	.552	6.129	80.964			
6	.526	5.850	86.814			
7	.457	5.073	91.887			
8	.419	4.654	96.541			
9	.311	3.459	100.00			

**4.4 Reliability Analysis for Measuring Items Entrepreneurship Traits**

Reliability analysis is a technique used to measure all items under each construct and evaluate the degree to which they are error-free. Cronbach's Alpha is used to measure the reliability of items. However, the acceptance value of Cronbach's Alpha differs among the authors. Kerlinger and Lee [25] suggest a Cronbach's Alpha of more than 0.50 for valid internal consistency reliability. [23, 31] suggest Cronbach's Alpha of 0.60 or higher to measure internal

consistency while 0.70 reveals that the instrument possess a high reliability standard [33]. For this research, a Cronbach's Alpha of 0.60 is considered. Table 6 shows there are 6 items of component 1 which is perseverance (ET1) and 3 items of component 2 which is social and cultural awareness (ET2).

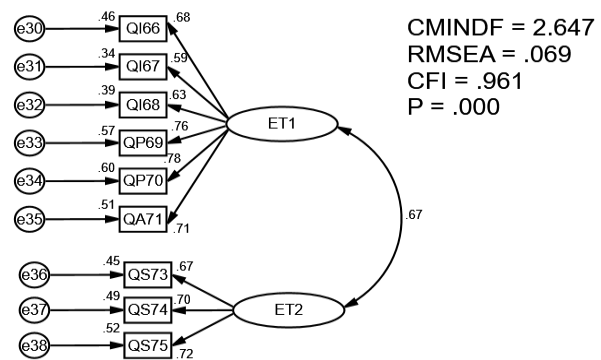
**Table 6:** Reliability Statistics for the four Components of Entrepreneurship Trait

Component	No of items	Cronbach's Alpha	Cronbach's Alpha based on standardized item
1	6	0.845	0.845
2	3	0.737	0.737

The Cronbach's Alpha for each component is computed and possesses a high reliability standard as 0.845 for component 1 and 0.737 for component 2. The results show that all reliability measures for the two dimensions of ET construct has exceeded the required value of 0.6. As a result, the extracted dimensions with respective items are reliable and appropriate to measure the ET construct. Therefore, this study recommended to employ those items for measuring ET constructs in the future researches.

**4.5 Confirmatory Factor Analysis "CFA"**

CFA enables the researcher to test how well the measured variable represent the intended constructs. CFA also allows the researcher to access the contribution of each scale item as well as how well the scale measures the related concept [34]. Figure 1 shows the initial path model for ET. The CFA results indicate that the measurement model did not achieve the required level of fitness indexes and modification on the model as required. Output of CFA also identified one factor loadings, item QI67 had low factor loading value of 0.59 in the direction to attain convergent validity. At the same time, item QI67 (0.34) had R<sup>2</sup> value lower than 0.4 as suggested by Awang [35]. However, there was no problem in terms of multicollinearity, as correlation between the two exogenous constructs did not exceed the threshold of 0.85 set by Awang [35]. The results of CFA in Figure 1 indicate the need for items deletion or to examine the Modification Indices "MI".



**Figure 1:** Initial Measurement Model for Entrepreneurship Traits

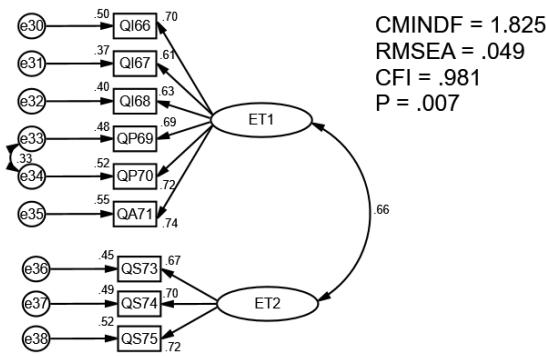
The results in Fig. 1 show CMINDF = 2.647, RMSEA = 0.069, CFI = 0.961 and P = 0.000. The Fitness Indexes do not meet the required level as recommended even though all factor loadings are above the threshold of 0.6. Thus, the researcher examined the MI as shown in Table 7 to identify

the correlated items and make an appropriate modification to the model to improve the fit.

**Table 7:** Identified redundant items in modification indices

M.I.	Par Change	Item
e33 ↔ e34	16.277	0.070
		CP69– CP70

From the examination of the MI, it was found that there is a pair of items that had high values (> 15) of modification indices [35]. The redundancies between these items have caused the measurement model to have a poor fit. The researcher set the correlated measurement errors of redundant items as “free parameter” and run the new measurement model. After the two pairs of items were constrained in the model, the results showed an improvement and the minimum recommended indexes were achieved with RMSEA = 0.049, CMINDF = 1.825, CFI = 0.981 and P = 0.007. The Fitness Indexes in Figure 2 achieved the required level after the modification was made.



**Figure 2:** Final Measurement Model for Entrepreneurship Traits

**5. CONCLUSION**

This study contributes to the measurement of ET construct, particularly in the context of entrepreneurship traits among the engineering students in Malaysia. The EFA results of the study produced a structure that extracted two dimensions of ET. The dimensions of ET are perseverance and social and cultural awareness. These dimensions perseverance and social and cultural awareness can be measured by 9 items developed in this study. The reliability measures for the two dimensions of ET construct showed high Cronbach’s Alpha value, Bartlett’s Test achieved the significance value, KMO is above 0.6, factor loadings exceed the minimum threshold of 0.6. This reflects that the items are applicable in this study. The scale development and validation procedures of the present study have ensured that the new ET instrument is internally consistent and stable across samples. The results of the measurement model assessment through CFA was presented. The goodness of fit index for the ET measurement model illustrated that the model fit the data well and CFA results of the study produced a path model that achieved the required fitness index.

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