An Approach to Develop an Engineering Employability Skill Framework: A Methodological Proposal Based on Quantitative Study

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Abstract
Purpose of the study is to identify what are the relevant research activities in investigating engineering employability skills for Malaysian engineering graduates using the Design and Development Research (DDR) through the Malaysian Engineering Employability Skills (MEES). This article finds the issues of research method development comprise of philosophical research, approach, design and strategy inside the field of prospects contemplates. The article dissects orderly methodology for fostering an exploration philosophy in engineering education – the "research onion" model and inspects the pertinence and propriety of this model for possibilities considers.

Keywords: employability skill, quantitative approach, design and development research, methodological strategy

1. Research Philosophy

Philosophy of the study is attempted to develop, validate and evaluate skills the factor structures of a model of engineering employability skills, based on the Malaysian Engineering Employability Standard (MEES) framework, for strengthening the quality of human resource in engineering industry in Malaysia. This study involved the exploration, description and explanation of essential engineering employability skills in engineering industries. The purpose of the study is to develop an engineering employability skills framework to enhance engineering graduate employability skills build up upon the Malaysia Engineering Employability Skills (MEES) model developed by Zaharim et al. (2009). Data will be needed from a relatively large number of respondents at one point of time in model development and validation. The researcher needs to obtain the results from the data analyses relatively quickly, so the model can be developed and validated according to the predetermined stages.

This study adopted Richey and Klien (2007) idea in developing Design and Developmental Research (DDR) which asserted that the model employs a systematic process of designing, developing and evaluating a product being produced. Accordingly, this study will be implemented through three phases: (1) Phase I: Need analysis (2) Phase II: Model development and validation, and (3) Phase III: Model usability evaluation. The DDR approach allows researchers to obtain a systematic study of developing, validating and evaluating the framework which met the objectives of the current research. In design and developmental research framework, it is a typical strategy that all researchers ought to play out a ceaseless scholarly movement (e.g., observation, interview, focus group discussion, consultation, or seminar) to foster their exploration models, yet for validating the proposed model, the reality stays that the exercises are infrequently communicated

instead of the statistical assessment (Subiyakto et al., 2015) to investigate the associations between several factors using statistical approaches. Thus, a quantitative research design will be employed to serve the purpose of the study.

2. Research Approach

To address the previously mentioned research questions, this study utilized an instrumental research approach. In particular, this hypothesis planned a deductive reasoning that utilized the completely quantitative examination directed inside the setting of the errand assessment (Stake, 1995). Given the absence of theoretical advancement in the field of quantitative examination, deductive reasoning gives rich depictions and contextualized encounters about the cycle of consolidated information investigation. This section explains the research approach and methods used in assessing the technique stated the structure of the research, which comprised the research philosophy and approach (Poth, 2019). The research approach explained the data generalization through survey questionnaire and gathering the data based on human capital theory. Therefore, to achieve the objective of this research, data were measured during the field survey. Then, all data were analysed separately using Fuzzy Delphi method (FDM), Nominal Grouped Technique (NGT) and Structural Equation Modelling (SEM): this generated the results, which were then interpreted (see Table 1).

Table 1: Research approach

Method of Data Collection	Approach
Expert Consensus (FDM)	Inductive
Survey Questionnaire (NGT, SEM)	Deductive

In the literature of design and development research, mix-methodology research design is widely used by researchers to develop a new research model for its representatives in providing complementary completeness, expansion and confirmation of the model. Notwithstanding, execution of quantitative techniques is not required in the approval stages (Subiyakto et al., 2015). The constraints of qualitative methods are the significant reasons why contemporary researchers have progressively gone to Messick's (1989) proof get-together way to deal with validation test. Messick (1989) characterized validity as an incorporated evaluative assessment of how much experimental proof and hypothetical reasoning support the ampleness and activities dependent on test scores or other model consideration in interpretive methodological approval. As per Messick (1989) coordinated implies that validity is a unitary idea to incorporate emotional assessment dependent on qualities (for example finding assess). The degree implies that validity involves degree needed to give experimental proof and hypothetical reasoning to help the sufficiency of deductions and activities (for example engineering graduates' employability skill test). The use of quantitative approach in this study will help to validate the quantitative results of the MEES system in this manner possibly empowers the examination to address various parts of a similar research questions and expanding the component of the investigation (Kaplan, 2001). Quantitative method gives potentials that counterbalance the shortcomings of qualitative exploration (Jick, 1979). This is upheld by Kaplan (2001) that quantitative examination technique can prompt new bits of knowledge and methods of investigation. This methodology empowers the investigation to address various parts of a similar research questions along these lines expanding the component of the study. This research is a descriptive study that aims to analyze and explore the error of source in measurement. The survey using the questionnaire instrument and parallel-tests were performed to obtain the information from the respondents. The approach of this study also uses double-blind experiment sampling testing where researchers and respondents are not exposed to the expected results of this study (Robertson et al., 2016). Sampling selection is purposive and convenience technique to avoid bias or conflict of interest of any party.

3. Research Design

Quantitative research method is a methodological choice that includes philosophical hypotheses that guide the bearing of the assortment and investigation of information. It centers on gathering and examining information in an introverted report. The utilization of quantitative methodology in this investigation is introducing a

preferred comprehension of exploration issues over utilizing either approach. It assists with approving the quantitative outcomes for past investigation in creating Malaysian Engineering Employability Skills (MEES) framework which utilized quantitative strategy research design. Action research includes cycle to comprehend a technique as a limited framework (Stake, 1995), which infers that a procedure exists inside limits. Frequently, attempting to comprehend an interaction involves attempting to comprehend its unique context. As Figure 1 delineates, one part of planning an action research is to decide how to characterize the investigation within its context. Research onion model aides and reveals the importance and appropriateness of this model to legitimize three potential designs to discovering a research: method choice, strategy and time horizon.
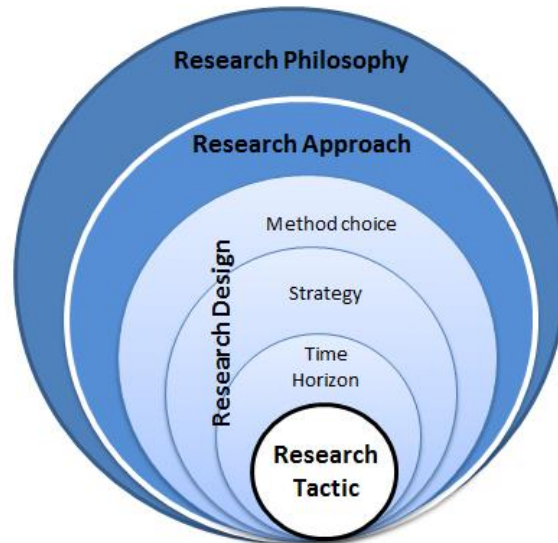

Figure 1: Research Onion Model

The research methodological framework and design procedure describes the measurement strategy, data analysis, findings and analysis at various stages of the research. Finally, the research methodological framework design and procedure regarding the process of developing an engineering employability skill framework (see Figure 2). The figure displays a summary of the methodological choice procedure involved in the quantitative method and research strategy used to initiate employability skill and time horizon exercised in designing strategies for the research objective. Consequently, this study will employ time horizon survey research method using cross-sectional survey design (Floyd & Fowler, 2013) to develop and assess the validity and reliability of the model. Surveys are the preferred approach for collecting data from large numbers of respondents about their perceptions and opinions (students about their college experiences (Cox & Cox, 2008). No attempt will be made to investigate the correlation between graduate level of soft skills with their employability status after several years of graduation that need longitudinal survey design, nor does it attempt to investigate the effectiveness of engineering programs that the graduates underwent that need experimental interventions. As such, the researcher perceived the cross-sectional survey design was more practical than other time horizon methods for conducting this study.
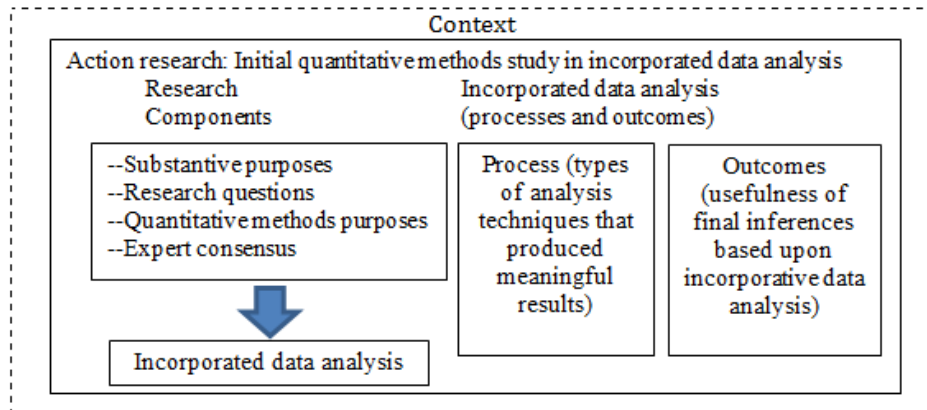
Figure 2: Diagram of the action research design

3.1 Method Choice (Quantitative)

Comprehensively, there are three methodologies or method choices in leading investigation: qualitative methods, quantitative methods and mixed methods (Creswell, 2003; Green et al., 2007; Teddlie and Tashakkori, 2009). As this exploration study includes collecting and analyzing completely, quantitative data approach is carried out to address the research questions. A quantitative technique includes an exploration and numerical investigation in a solitary report where the information is gathered indiscriminately, given a priority, and include the incorporation of the data at least one phases in the research process (Gutmann et al., 2002). Quantitative method choices give a more extensive picture by taking note of patterns and speculations in-depth knowledge of participants' perspectives. The findings on the quantitative sampling frame must be representative of the population.

The employability skill model illustrates in detail how the study was conducted as an action research strategy in the research design. It fills in as a guide during the data collection, data analysis and decision-making process (Chandel et al., 2006). The design for this research is additionally a model to make inductions of the factors contemplated. The advancement of this study is about human resources content information required the improvement of another arrangement of meaningful purposes, research questions, quantitative techniques purposes, and design. The program assessment utilized quantitative strategies to address key assessment questions, and utilized a solitary strategy in this exploration. Consequently, this examination study gave the chance to make a model of quantitative investigation occupied with information investigation, just as the chance to consider the cycles and results of executing incorporated data analysis. To help catch the expected complexity, this study depended on two significant kinds of information assortment; survey questionnaire and expert consensus. The aims and process of every one of these information assortment sources are examined straightaway.

3.2 Research Strategy (Action research)

This action research empowers the investigation to address various parts of similar research questions subsequently expanding the element of the investigation. Employability, as it is found in the figure 3 beneath, is affected by four expansive and interconnected elements or parts. These segments are Personal Attributes, Personal Skills and Knowledge, giving all together the name of the model ASK. The ASK model sums up the portrayal of employability. It tends to be seen from the model that the S segment covers over different elements in the model to summarize all together to the employability. It is as yet critical to remember that every one of these parts is fundamental for accomplishing the last mentioned (Knight & Sims-Knight, 2003).

The last letter K alludes to the arrangement and besides to the information that the individual has. This segment is for the most part a key result acquired from advanced education and obviously has a pivotal

influence in being employable. Skills being the second segment in the model exhibit that the skills of the individual are moreover a significant component of employability. In this model they are viewed as a part of employability rather than determinate accomplishments. Skills can be promptly estimated and with no issues moved from a setting to a setting. To be more rearranged, skills are viewed as a part with the goal that further prologue to expound them more exhaustively is not required (Knight and Sims-Knight, 2003). Skills and understanding are as yet insufficient to acquire employability. Despite the fact that many may feel that their prosperity comes from luck and being wise, while disappointments come from destructive powers and nonappearance of abilities. This perspective may be an outcome in deficiency of steadiness and surrendering when there is no definite rapid determination for attaining employment. Personal skills, the primary part of the model, are covering one's self hypotheses and individual characteristics. These have critical significance, as they are being degree to the purpose of influencing on one's thought about themselves and their capacities. Obviously, this is not the case without fail and with each individual yet it can likewise hinder seeing the genuine capacity that the individual has (Knight and Sims-Knight, 2003). Donabedian (1988) has gathered that designing engineering students put more weightage in interpersonal skills in their assessment and fulfillment with employability. Moira A. Stewart, (1995) found that effective communication which is an intuitive interaction applies a positive impact not just on the motional belief of the students yet additionally indication goal.
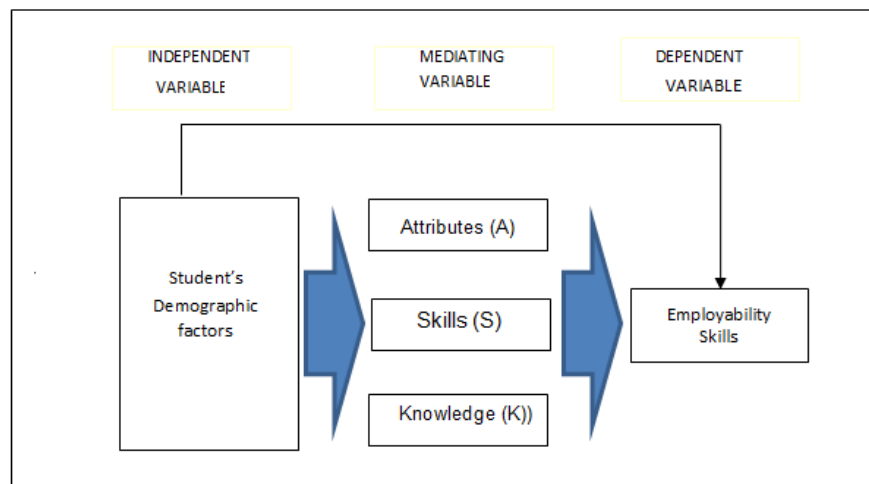

Figure 3: Conceptual Framework of this study

3.3 Sampling and Time horizon (Cross-sectional)

As to date, there are 552,720 number of students currently enrolled in public universities and colleges in (Department of Statistics Malaysia, 2020). Out of this number 127,697 enrolled in engineering, manufacturing and construction type of programs (Department of Statistics Malaysia, 2020). Sampling is essential to attain the sample size to represent the population size from which the sample was occupied. While there are quite a number of private universities offering engineering courses in Malaysia, this study will obtain data from the undergraduate students, alumni who are being employed and academicians of public universities to serve its purposes. According to QS World University Rankings by Subject 2019, 8 top public universities for engineering programs in Malaysia are University Malaya, University Technology Malaysia, University National Malaysia, University Science Malaysia, University Tenaga Nasional, University Putra Malaysia, University Technology Petronas and University Malaysia Pahang. Respondents representing these universities will be selected using two sampling methods: purposive and cluster random sampling methods.

a)   *Purposive sampling method*.
       Purposive sampling method is used to serve two purposes:
       (i) to obtain employers opinions regarding the importance of engineering employability skills for the work place. The information gathered will be used to generate an item pool for the initial development of the framework and

(ii) to select academicians and engineering graduates from selected engineering industries and universities to assess the validity of the final framework of engineering employability skills derived from the NGT and SEM analyses. Purposive sampling method was recommended by measurement experts (Gay, 1986, Gay & Airasian, 2003; Wallen & Fraenkel, 2013) to choose an example whenever dependent on past information on a population and the particular motivation behind the study, the analyst conviction that the sample would be illustrative of the population and the researcher accept the sample have the skill in regards to the data required (Wallen & Fraenkel, 2013). Previous research studies in this area (Zaharim et al., 2009; Tejan & Sabil, 2019) provide evidence that employers have solid opinions on essential employability skills expected from engineering graduates. Furthermore Cristina Sin, Tavares O. and Alberto Amaral (2016) found that there are no significant differences in the opinion of engineering academicians and employers on the employability skills that are important for the workplace. Thus, the researcher believed that both employers and academicians who will be purposively selected to participate in this study would yield information regarding essential engineering graduates' employability skills. In the case of selecting academicians representing different engineering programs, statistics from the Ministry of Higher Education (2021) indicates that different public universities are offering different engineering program, thus selecting sample using random sampling method was not possible. As such, purposive sampling method was the most appropriate method to select respondents representing the different type of engineering programs.

b) *Cluster random sampling method.*

Cluster random sampling method will be used to select respondents to assess the validity and reliability of the final list of the employability skills. Since the respondent for this study was spread out in the 8 universities throughout Malaysia, cluster random sampling will be used because it is the most constructive sampling method when the population is very large to represent a wide range geographical area (Gay & Airasian, 2003). In this study, two-stage random sampling method (Gay & Airasian, 2003; Wallen & Fraenkel, 2013) will be used to select samples. This method involved selecting clusters within clusters (Gay, 1986; Gay & Airasian, 2003; Tejan & Sabil, 2019). Using this method, the data selection procedures involved selecting universities within the four geographic regions in the Malaysia randomly and then selecting engineering programs from each selected university randomly. The procedures used in selecting the classrooms within each selected teacher training college involved the following steps as suggested by Gay and Airasian (2003):

(i) Identification of the population. In this study, a list of students majoring in various engineering programs in the selected universities will be obtained from the Office of Student Affairs, from each University.
(ii) Determination of desired sample size. Generally, there are several methods of classification in determining the sample size of the study for known or unknown populations.

Yamane's techniques had gained popularity for its ability to reflect the basic trade-offs between precision, accuracy and sample size. In this study, Yamane's technique will be used to determine size of the sample in undergraduate engineering student's selection to be carried out throughout Malaysia. This technique was created in 1967 where a simple formula was introduced in determining the size of the sample if the size of the population was known (Levy & Lemeshow, 2013). In this situation, a 90% confidence interval is used to describe a 0.1 margin of error (Westland, 2010). For the calculation of the minimum sample size under the limited population method, convenience clustering sampling, *n* is 100. Through this Yamane method, 100 engineering employers will be identified for research purposes.

4. Research Tactic

As previously mentioned, data collection is based on survey questionnaires. Data from the questionnaire were stored in computers using SPSS software. After the test data and questionnaire were included in the software,

researchers analyzed data based on two phases. Phase I involves an analysis using the Microsoft excel software to obtain a defuzzification process via Fuzzy Delphi Method (FDM). The purpose of the study is to develop an employability skills framework to enhance engineering graduate employability skills based on the Malaysia Engineering Employability Skills (MEES) model developed by Zaharim et al. (2009) and to validate the MEES model in Malaysia using Fuzzy Delphi Method (FDM) via experts' consensus. Ten experienced individuals in engineering industry such as contractor, consultant, manufacturer, service provider and developer will be involved in this study. Three indicators of the experts' agreement which are threshold *(d)* value, percentage of expert agreement and the value of *Fuzzy* Score (A) are employed Fuzzy Delphi Method (FDM) to identify, evaluate and confirming all the key components and contents of the MEES Module accordingly. Average of *fuzzy* numbers indicates analysis of data. To ensure the third condition is observed, this kind of analysis is aimed to get the *fuzzy* score (A), with the condition must be greater than or equal to the median value (α - cut value) of 0.5 (Wu & Tan, 2006; Bodjanova, 2006). This specifies that the component is recognized by an expert agreement. Alternatively, the value of *fuzzy* scores (A) can be used as a factor and priority of an element according to expert consensuses. Phase II involved Nominal Group Technique (NGT) and Structural Equation Model (SEM) analysis process using the Amos software to analyze and validate the proposed model.

5. Conclusion

The methodology used during the data collection phase includes the reasons behind the descriptive theory approach used in this study as well as the constructivist paradigm. The limitations of this approach are also discussed, as well as detailed descriptions of how the sample was selected and semi-structured interview questions for the expert participants. Data collection will be conducted consecutively through a quantitative survey questionnaire. The employability skill design of the study is the method of analysis applied to formulate a model. Data will be analyzed concurrently as a double-blind exploratory analysis to eliminate bias. Prior to the actual data gathering, a pilot study using survey questionnaire was conducted to certify the validity and reliability of the instruments used. By virtue of this exercise, the study is purposely to develop an employability skills framework to enhance engineering graduate employability skills build up upon the Malaysia Engineering Employability Skills (MEES) model. The methodology used in developing and validating the engineering employability framework, which will involve three phases of study: Phase I concerned with analyzing the need to conduct the study. Phase II will be the design and developing the framework build upon the data derived from phase I and Phase III concerned with the usability assessment of the engineering employability framework. The research philosophy, approach, design, and tactic were explained in detail for the implementation of the study. Furthermore, as a consequence of this exercise, in obtaining the desired objectives, the important finding is that this study strengthens the research done by Hanasyha J. et al. (2013) as to incorporate the employability skill as a dimension of engineering graduates.

Acknowledgement

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