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# The Use of Modified Delphi Technique to Develop the Instrument for Factors of Career Satisfaction among Female Engineers

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**Abstract:** Women, especially married women are often associated with the dilemma of juggling the balance between career and family and there are statistics showing a declining number of female engineers. This study aims to obtain experts' conformity on the instrument of Career Satisfaction among female engineers with families. The purpose of such instrument is to determine the factors that influence the level of career satisfaction among female engineers with families using the Modified Delphi technique. The technique is used to gather mutual agreement among experts in developing the items pertaining to Career Satisfaction. The development of instrument involved seven experts with relevant expertise, experience, and knowledge in the field of career and engineering. Findings from the first round (interviewing the experts) report for four main factors in achieving career satisfaction namely mentor, relationship with colleagues, gender equality, and salary. The study also suggests a method to determine the interquartile range via the Modified Delphi technique, which was conducted on the second round until a mutual agreement was achieved. Interquartile range refers to the value obtained from the questionnaire which was answered by the experts in order to determine the mutual values of the construct items and were analysed using the Microsoft Excel. The side factors have the potential to motivate and prompt individuals in achieving high satisfaction and inspiration in their career are Mentor, relationship with colleagues, gender equality, and salary.

**Keywords:** Career satisfaction, modified delphi technique, interquartile range, female engineers

## 1. Introduction

Despite recording constant increment every year, the number of female engineers is depleting along with their age. According to the Women Assistance Organisation (2013), the amount of female labour in the field of technical and engineering only comprises 31% from the total number of graduates in the respective fields. Balamuralithara et al., (2014) report that the number of female engineering graduates in 2010 did not tally with the number of engineers in the following year. Moreover, statistic by the Board of Engineers Malaysia (2017) posits a total of 745 female engineers as opposed to 10,413 registered engineers in Malaysia. Such statistic indicates a significant gap in comparison to 7005 female graduates in the field of technical in the year 2016.

The report by the National Science Foundation (2017) also found that there are significant number of female students in the field of chemical engineering, material engineering, industrial engineering, and civil engineering as opposed to aerospace engineering, electrical engineering, and mechanical engineering. However, only 14.5% engineers in the industry are women. This indicates the low tendency among female engineering graduates in making engineering as their long-term career.

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Women, especially married women, are often associated with the dilemma of juggling the balance between career and family. As reported in the Economic Transformation Programme (2014), their personal commitment towards marriage and family has created a major tendency for women to leave the working sector despite having adequate experience and duration of service to receive promotion. The Women Assistance Organisation (2013) also reports that among the factor that influences women towards unemployment is their sense of responsibility to manage the household. There are also professional women who resort to a career that differs from their field of studies, such as law or medical graduates who work as a lecturer (Balamuralithara et al., 2014) or those who resort to working from home due to family demands (Webster, 2013). Such a career transition has resulted in a depletion among female engineers and female mentors (Fouad et al., 2012). Thus, such an issue needs to be explored and rectified in order to avoid women from being deprived in the working sector.

Based on career theory by Mainiero and Sullivan (2006), it is clear that individuals can evaluate and make choices in deciding between the most important things in life and appropriate between the demands of work, constraints, and opportunities (that they want to fulfil) and the relationship of values and interests personal. From this theory, a Kaleidoscope Career Model (KCM) was developed by Mainiero and Sullivan according to the 21st century, which emphasises the three basic aspects of working individuals' lives, Authenticity, Life Balance, and Challenge. This model is designed to attract organisations to understand and consider the current situation of female workers so that they can continue to work in the organisation.

Aligned with the issue, the items constructed in this instrument are incorporated with the elements of career satisfaction that suit the situation and working schedule of female engineers in Malaysia. Louca, Kougoulos, and Kamsaris (2013) suggest that every organisation should create an environment that is conducive and promotes satisfaction and long-term career retention among employees. According to Das and Baruah (2014), apart from being dedicated to their work, employees who are happy and satisfied with their career will invest their effort and loyalty to the organisation. This justifies the need for researchers to consider the organisational and personal influences among female employees in achieving excellent career satisfaction.

The main objective of this study is to confirm the career satisfaction instrument that determines the passion of career professionals in the engineering industry. This is achieved with the help of several experts in every round of the questionnaire in order to obtain items with high conformity level through the use of the Modified Delphi Technique. It comprises for main aspects of a mentor, relationship with colleagues, gender equality, and salary. This study employs the Modified Delphi technique as its instrument for data analysis that comprises several research phases. The findings shall provide an insight into the items related to the Career Satisfaction construct, which was conducted upon several experts in the area of career and engineering.

## 2. Related Works

The Career Satisfaction Instrument is developed based on the factors that influence career retention among female engineers. According to Tietjen et al. (2013), previous studies have referred to employees' biography (demography), which include gender, age, level of education, and marital status and its effect to their level of career satisfaction in respective organisations. Existing findings report that the factor of gender influences the attitude towards the physical differences between men and women as well as being a prominent factor in career satisfaction (Tietjen et al., 2013). Thulaseedharan and Nair (2015) state that the differences in the attitude and physical characteristics between men and women possess the potential of influencing their satisfaction towards a specific situation. Nevertheless, companies tend to overlook such difference and only regard factors that influence employees' satisfaction as equal between both genders (Lyonette, 2015). Hence, it will be fair for organisations to plan on relevant methods that can be employed to address the needs of its employees, particularly female employees.

Career satisfaction refers to the positive attitude among employees that has a major influence on their career. The feeling of satisfaction in their career shall prompt employees to remain in their position on the basis of several side factors. Mafini and Dlodlo (2014) explain that employees' satisfaction can be determined from the aspect of perception, evaluation, and happiness in accomplishing an important task. Furthermore, such satisfaction is also influenced by several factors, including the organisations' background, working environment, and personal factors. According to Saleem, Mahmood, and Mahmood (2010), career satisfaction acts as a motivation for one to work. Apart from obtaining self-satisfaction and happiness, career satisfaction also combines the effects of psychology and the environment of the community in shaping the happiness towards their career. In this regard, employees are likely to be satisfied with their career if such motivation exists in them and possesses prominent impact towards their life (Singh & Vivek, 2011; Ahmed & Islam, 2011; Tan, Wan Fauziah, & Sivan, 2014). Therefore, side factors have the potential to motivate and prompt individuals in achieving high satisfaction and inspiration in their career.

A mentor is the action of supervising and providing emotional or technical guidance to employees in conducting a task. According to Sosik and Godshalk (2010), female mentors are capable of being a role model to subordinate engineers. A study by Kodate, Kodate and Kodate (2014) reports that most female engineers agree that aside from improving their understanding on the knowledge related to their field of work, mentoring also provides them with a better picture of their responsibilities, which subsequently boosts their performance. Moreover, Salisu, Chinyio and Suresh (2015) also report that a majority of construction engineers believe that good mentoring has the potential to encourage friendship, trust,

respect, and increase career satisfaction. The exchange of knowledge and experience between leaders and their subordinates may also assist in boosting the level of career satisfaction in order to protect the interaction within the organisation (Neal, Boatman & Miller, 2013). Therefore, organisations can play their role by initiating formal mentoring programmes as well as practising the mentoring culture.

Aside from having technical knowledge, female engineers should also possess the skills to interact with professional and non-professional colleagues. Relationship with colleagues can be defined as the personal and work-based interactions that one has with their colleagues (Ganiron Jr., 2017). According to Lin and Lin (2011), such quality can be seen from characteristics such as cooperation, teamwork, support, trust, exchange, and the environment between friends. These characteristics are necessary for expanding the positivity and commitment to work as a team. In a study that investigated on the level of satisfaction among professionals in the construction industry, Niemeier and Gonzalez (2014) found that there is a prominent need in the development of a flexible communication system that will improve the employees' satisfaction level towards their relationship with colleagues and employers. Moreover, findings by Fouad et al., (2012) indicate that one of the factors that influence the level of career satisfaction among female engineers is the establishment of a good relationship with their colleagues. This shows that the majority of female engineers regard such quality as having high significance for them to be able to complete their daily chores smoothly as well as producing positive emotion in their career.

Gender equality is an important factor that determines employees' physical and mental happiness. Nawaz et al. (2013) explain that there are employers who assign female employees with passive duties. This is because they regard women as being less aggressive and having less emotional when assigned with additional duties as opposed to men. As a result, most female employees will only be assigned to managerial duties despite having the competency to compete in male-dominated fields (Elson, 2012). A study by Stoet and Geary (2018) shows that a majority of female employees are expecting positive and equal perception from others as they attempt male-dominated duties. Furthermore, Powell, Bagilhole, and Dainty (2009) suggested that assigning female employees with responsibilities that are gender equal shall improve their competency and working experience and subsequently increase their career satisfaction. In addition, female engineers will feel appreciated if they are trusted by their supervisors to co-manage projects with male engineers (Smith, Arlotta, Watt, & Solomon, 2015). This is further supported by several studies (Casad et al., 2018; O'Brien, Stein, & Charles, 2018) which found a high level of career satisfaction among female engineers who received gender equality at their workplace. Therefore, it is important for employers to provide female engineers with equal opportunities in order for them to prove their potential, ability to achieve task completion, and subsequently obtain the sense of satisfaction in their career.

Salary is the monetary reimbursement that one receives upon completing a task. Ayre, Mills, and Gill (2011) believe that the payment of equal salary between male and female engineers shall increase the level of career satisfaction among female engineers. A study by Tiwari and Awasthi (2018) shows that the scope of work has prominent effects on the amount of salary received by male and female engineers. Such quality is then translated into their level of career satisfaction and job retention. This indicates that female engineers will be satisfied if they receive a salary that is equal or more than male engineers despite being assigned with roles and duties that are equal or more than male engineers (Griffith & Dasgupta, 2018; Laurison & Friedman, 2016). Therefore, employers should entrust female engineers with important assignments that can lead to the increment of their salary to be comparable with those received by male engineers.

### 3. Methodology

This study employs the Modified Delphi technique to obtain the experts' consensus on the Career Satisfaction items which were developed based on the findings from the interviews. The interviews were conducted by administering a needs analysis of Career Satisfaction upon each expert. However, this paper shall not discuss the interviews but rather focusing on the findings obtained from the interviews using the Modified Delphi technique. A total of seven experts were selected as the respondents of the study, which comprises engineering experts and lecturers from higher education institutions in Malaysia. Their areas of expertise include career, engineering, technical and vocational education (TVE), and industrial management. The research instrument in this study is a questionnaire that contains 42 items under four sub-constructs of career satisfaction. These items were developed based on prior interviews.

For the Modified Delphi technique to be developed, the researcher needs to derive and decide on appropriate items obtained from the interviews and arrange it in a systematic manner for it to be comprehended by the panel of experts. The researcher then selects a group of experts who are willing to offer their expertise, ideas, and critiques in order to improve the content of the items. Verbal consents were obtained from these experts before they were given with an appointment letter which was delivered by hand, postage, or electronic mail. A total of three rounds of the questionnaire were administered to the experts. During the first round, the experts were interviewed to elicit their verbal agreement to the items. The data were analysed using a qualitative software known as Atlas.Ti. In the second round, the experts were asked to state their level of agreement towards each item using a Likert Scale with the anchor of Strongly Agree, Agree, Disagree, and Strongly Disagree. This was followed by several open-ended questions for them to suggest additional items in every construct. The second round allows the experts to provide their views on every item. Data from the Likert Scale was translated into quartile numbers and analysed using the Microsoft Excel software.

The data obtained from the Likert Scale was translated into Modified numerical data before it was analysed using the Excel software. Such an analysis method is known as the Modified Delphi technique. All comments and suggestions offered by the experts were taken into consideration in order to improve the items. The process of data collection and analysis using the Modified Delphi technique was conducted in three rounds. The first round involves the process of obtaining the constructs and items through interviews. Meanwhile, the second and third round was conducted until a significant level of agreement was achieved among the experts. In every round, the experts were provided with a list of items along with the Likert Scale on its side as well as empty spaces for the experts to provide their comments and suggestions.

#### 4. Findings and Discussion

An important aspect of the Modified Delphi technique is the interquartile range. It is used to produce the Modified scale that translates the linguistic variable into modified numbers. The level of agreement for the Modified scale ranges between 0 to 1.00, 1.01 to 1.99, and 2.00 and above (Peck and Devore, 2007). The interquartile range between 0 to 1.99 indicates uniformity among the experts while the interquartile range of 2.00 and above indicates the absence of uniformity among the experts and that the item should be omitted. During the second round, the obtained data were analysed using the Microsoft Excel software for a better and more systematic scheduling. All data were reverted into the interquartile range. An example of the Modified scale is the three-point Modified scale. As illustrated in Table 1, the three-point Modified scale shows that lower value in range indicates higher uniformity of the obtained data. In order for the study to determine the experts' uniformity and agreement to every item, the interquartile value should never exceed 2.0.

**Table 1 - Three-point modified scale.**

Level of Agreement	Modified Scale	Result
High Agreement	0 to 1.00	Item accepted
Average Agreement	1.01 to 1.99	Item accepted
No Agreement	2.00 and above	Item rejected

The rationale of using this technique lies on the ability to obtain experts' agreement and views towards the items without having to conduct a face-to-face meeting. The identity of each expert also remains anonymous, which provides them with the freedom to offer suggestions and answer the modified scale based on their personal opinion. The Modified Delphi technique also obtains the experts' uninformed opinions and ideas towards the elements without knowing their identity (Nashir, Mustapha, & Yusoff, 2015).

Below are examples of several analyses that verify the items for each construct. The example of interquartile range analysis is for construct of relationship with colleagues and salary. According to Ummu Sakinah, Ridzwan, Ramlee and Zaliza (2019), the calculation of interquartile range is based on the interquartile range formula in Table 2.

**Table 2 - The interquartile range formula.**

Steps to identify the interquartile range values:
1. The Value of Experts' Agreement Scale should be arranged from small to big for every item.
2. Use the formula in the Excel software to find the value of Quartile 1 (Q1) and Quartile 3 (Q3).
3. IQR value = Q3 - Q1

Table 3 shows the list of 13 items in the construct of relationship with colleague prior to being distributed to the experts and the interquartile range value of experts' agreement for the item construct in the second and third round. Based on the table, item KR16 and KR17 are omitted as its interquartile range values were 2.3 and 2.1 on the second round. As suggested by Peck and Devore (2007), the interquartile range value of  $\geq 2.00$  indicates no uniformity and agreement among the experts towards the item. Meanwhile, all items have obtained interquartile range values of  $< 2.00$  on the third round. Hence, all 11 items were accepted and included into the questionnaire.

**Table 3 - Items for 'relationship with colleagues'.**

Item	Round 2	Round 3
I obtain satisfaction in my career when I have colleagues who...		
KR10 always share useful information to everyone.	0.0	0.0
KR11 care about others.	0.3	0.3
KR12 share their career issues.	0.3	0.3
KR13 convey information through clear communication.	0.3	0.3
KR14 can be easily contacted through designated communication line.	0.0	0.0
KR15 advise each other.	0.0	0.0
KR16 constantly provide positive encouragements.	2.3	-

**Table 3 - (Continue)**

Item		Round 2	Round 3
I obtain satisfaction in my career when I have colleagues who...			
KR17	give cooperation in every meeting.	2.1	-
KR18	stern and serious in conducting their assignments.	0.0	0.0
KR19	highly committed in carrying their responsibilities.	0.0	0.0
KR20	show their understanding among friends.	0.3	0.3
KR21	include others' opinions into consideration upon making work-related decisions.	0.0	0.0
KR22	open to share personal problems.	0.3	0.3

Table 4 shows the list of nine items for the construct of salary before they were distributed to the experts. Following the second and third round, no items were omitted and all nine items were included in the questionnaire. This is because the interquartile range values of all items are within the range of 0 until 1.99. According to Peck and Devore (2007), the interquartile range value between 0 to 1.99 indicates a high level of uniformity and agreement among the experts towards the items.

**Table 4 - Items for 'salary'.**

Item		Round 2	Round 3
I obtain satisfaction in my career when...			
KG34	there is no salary gap between male and female employees who are within the same salary grade in my organisation.	0.0	0.0
KG35	salary is paid according to the quantity of work.	0.0	0.3
KG36	salary is paid based on accurate grade.	0.5	0.0
KG37	employer offers yearly increment.	0.6	0.1
KG38	salary increment is evaluated based on working experience.	0.0	0.1
KG39	salary is paid according to the quality of assignment.	0.0	0.0
KG40	basic salary is paid according to level of education.	0.5	1.3
KG41	receive additional salary for specialised skills acquired.	0.0	0.8
KG42	no salary cut for leaves taken for family emergencies.	0.4	1.4

## 5. Conclusion

In conducting the analysis using the Modified Delphi technique, the researcher has considered all comments and suggestions offered by the experts for the purpose of improvement. Following the process of omitting irrelevant items and re-arranging the accepted items, the sentence structure of each item was revised and proofread for maximum accuracy. The findings show that all 11 items in the 'relationship with colleagues' construct as well as the nine items in the 'salary' construct should be made as to the focus in the aspect of career satisfaction. Therefore, this study has served its prominent role in looking at the necessary items for a female employee, particularly female engineers in Malaysia. For the purpose of achieving the status of a high-income country as well as to sustain highly skilled workers, policymakers in all organisations should consider the needs of their subordinates. Such consideration is necessary for helping female engineers to maintain their service in the industry. This is parallel with the ultimate aim of the Human Resource Management (HRM) that is to increase the performance of the organisations.

Having employees, particularly senior officers, who are productive and consistent is essential for an organisation to encourage and sustain the motivation to work among subordinate female employees. It is in line with the theory and model outlined by Mainiero and Sullivan (2006) that the changing world of work involving women with a lot of commitment to family and career is necessary. Industrial relations department, for example, need to consider the potential of satisfying female workers so that they can continue to work. Furthermore, other stakeholders should invest more effort to improve and revise existing plans for it to be more systematic. Malaysia has the potential of being the global hub for technical industry if the administrators of every organisation in the technical industry are working to attract highly skilled female workers to remain in the industry and share their skills and knowledge with the future generations.

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