CAREER CHALLENGES MODEL AMONG FEMALE ENGINEERS: PLS-SEM ANALYSIS

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ABSTRACT

Women are likely to leave the job sector as a result of the crisis between their commitments to the career with the household interest. In response to this issue, this study aims to build a career challenge model that caters to the demand among women in this century. Hence, this study has identified the key factors to the challenges faced by female engineers in pursuing their career as an engineer through the Delphi Modified Technique. The result shows this study looking into the relationship between four independent constructs namely, life balance, childcare, leaves and gender discrimination. Meanwhile, the dependent construct of this study is career challenges faced by women. The scope of the study comprises female engineers with families and 211 respondents were selected to answer the questionnaire. The data obtained were analysed using the PLS-SEM 2.0 software via the algorithm, bootstrapping and blindfolding method. The construction process of this model involves two tests including the construction of the measurement model and the structure model. Testing the measurement model involves internal consistency namely (a) convergent validity and (b) discriminant validity in which these two validities have six analyses; (i) external loading, (ii) composite reliability, (iii) average variance extracted (AVE), (iv) Fornell-Larcker, (v) cross loading, and (vi) Heterotrait-Monotrait Ratio (HTMT). Meanwhile, the structural model testing involves the analysis of (i) Multicollinearity (Inner VIF), (ii) Path Coefficient, (iii) R square (R²), (iv) size effect (f²), and (v) Predictive Relevance (Q²). The findings indicate that gender discrimination and life balance have significant relationships in influencing career challenges. Hence, this model is expected to contribute to the literature of Human Resource Management.

Keywords: Career challenges, life balance, female engineers, PLS-SEM

INTRODUCTION

The role of women in the career sector provides the economy with a fresh air especially for low-income families who live in rural areas as it can help to improve the economic standard of the families and the local communities. However, it is inevitable for women to deal with challenges and obstacles as part of their strive to master their career. This might be stressful to their mental immunity particularly to married women1,2. In this regard, women tend to leave the job sector upon experiencing a crisis of personal commitment in the household. Furthermore, 2016 recorded a decrease in the number of women aged 25 years to 64 years who are involved in the employment sector3. This suggests that female engineers are more likely to quit their work after marriage as the responsibility of managing the family is to be prioritized especially after having children4. Therefore, it is not surprising that women participation in engineering is low as compared to the number of female student enrolments in engineering institutions. Hence, a career model for women of this century needs to be built5,6.

LITERATURE REVIEW

Career pattern as an engineer plays an important role in attracting longitudinal participation among women. Hence, this study has identified the key factors to the challenges faced by female engineers in pursuing their career as an engineer through the Delphi Modified Technique. The first challenge is the conflict of balancing their lives which happens when fair responsibility is difficult to be implemented due to the demand in both their professional and personal lives. The concept of work-life balance describes the ideal condition of splitting one’s time, energy and commitment between career and other important aspects of their personal life, including families7. Work-life balance is also an important issue in the engineering industry from the perspectives of both organizational effectiveness as well as career health8. The main factors that lead to limited work-life balance are lengthy working time and tight schedule which subsequently limit the engineers’ personal time9. Moreover, construction engineering workers have limited leniency in managing their working hours as well as frequent work trips as compared to those in other industries10. Thus, work patterns with limited flexible working hours and intense job responsibilities will affect the balance of their lives.

The second challenge is the child care issue where the comfort and safety of the child is a priority. The recent increase in the number of child abuse cases is worrying among parents for them to place their child under the care of outsiders. Childcare is a complex issue as it involves the security and suitability of a nursing home as well as the lack of experience among...
of income. In conclusion, gender discrimination poses a challenge for women to increase employers' confidence in their ability to carry out major tasks for the sake of having equality in their wages and pay rates. Therefore, this model is necessary to guide attention-related parties in order to help female engineers continue working.

**METHODOLOGY**

This study was conducted on 211 female engineers in Malaysia who have their own families. The demographic information for the 211 respondents is shown in Table 1. The questionnaire was developed and adapted from previous studies and was verified by seven experts in the field of engineering and career.

**Table 1 : Respondent Demographic Information**

| Demographic Information | Number of Respondents (n) | Percent (%) |
|-------------------------|---------------------------|-------------|
| Status: Married         | 211                       | 100         |
| Position: Civil Engineering | 211                     | 100         |
| Age (year)              |                           |             |
| <30                     | 61                        | 28.9        |
| 30-34                   | 76                        | 36.3        |
| 35-39                   | 60                        | 28.4        |
| 40-44                   | 14                        | 6.5         |
| >44                     | 0                         | 0.0         |
| Number of Children under 6 year (person) |            |             |
| 0                      | 18                        | 8.5         |
| 1                      | 59                        | 27.9        |
| 2                      | 72                        | 34.3        |
| 3                      | 62                        | 29.4        |
| >3                     | 0                         | 0.0         |
| Work Experience (year)  |                           |             |
| <6                     | 69                        | 32.8        |
| 6-10                   | 78                        | 36.8        |
| 11-15                  | 56                        | 26.4        |
| >15                    | 8                         | 4.0         |

The data obtained were analysed using the PLS-SEM 2.0 software via the algorithm, bootstrapping and blindfolding method. Structural equation modeling (SEM) - partial least squares (PLS) (PLS-SEM). Testing the Confirmatory Factor Analysis (CFA) measurement or testing model is the first step in the data analysis procedure that uses the PLS-Path Modeling approach. The measurement model is conducted to determine how far the items measure what should be measured, its accuracy in representing a construct and fulfilling the standards of validity and reliability. Testing the measurement model is a procedure that should be conducted in most studies. It involves internal consistencies of (a) convergent validity and (b) discriminant validity. The aspect of convergent validity can be seen at the values of (i) outer loading, (ii) composite reliability, and (iii) average variance extracted (AVE). While discriminant validity can be seen in (i) Fornell-Larcker, (ii) cross loading, and (iii) Heterotrait-
Monotrait Ratio (HTMT)\textsuperscript{31}. The researcher uses the algorithm method in the PLS-SEM software. The next step is to evaluate the structure model. Assessment of the structural model should be based on several analyses and this process directly tests the hypotheses of the study. Structural model testing involves the analysis of (i) internal VIF or Multicollinearity (Inner VIF), (ii) structural model coefficient (T), (iii) determination coefficient (R square, R\textsuperscript{2}), (iv) size effect (f\textsuperscript{2}), and (v) predictive relevance (Q\textsuperscript{2})\textsuperscript{30}. For this value analysis, the researcher uses bootstrapping and blindfolding methods in the PLS-SEM software.

RESULTS

Testing of measurement model. Measuring Convergent Validity. The aspect of convergence validity can be seen at the value of (i) outer loading, (ii) composite reliability, and (iii) average variance extracted (AVE). External load or outer loading is the standard load that connects the factor to the indicator variable. Since the data is automatically standardized in the SmartPLS, the load value varies between 0.00 and 1.00. The loading should be significant as larger loads indicate a more robust and reliable measurement model.

The load is also regarded as a form of item reliability coefficient for a reflective model where a closer value of 1.0 is more reliable than the latent variable. Therefore, the load value should be >0.70\textsuperscript{29}. However, any load values within the range of 0.50 to 0.70 should be considered if the value of AVE is >0.50\textsuperscript{30,32}.

Composite reliability is an alternative to Cronbach’s alpha as a convergent validity test in a reflective model. Past studies use composite reliability in PLS research as a measure of reliability because Cronbach’s alpha further underestimates the reliability of the scale and the reliability of the composites can lead to higher estimates of real reliability. The composite reliability may be equal to or >0.60\textsuperscript{29,30}, equal to or >0.70 for a model aimed at authentication\textsuperscript{31}.

Furthermore, the AVE can also be used as a test of convergent and differentiated legitimacy. It reflects the average community for every latent factor in a reflective model. In a reproductive model, the AVE should be >0.50\textsuperscript{30,31} and greater than the cross load. This means that the factor should explain at least half of the variation of each indicator. AVE that is <0.50 means that the error variance is beyond the variation described. The reliability of the indicator can be interpreted as the square measure of measurement, in which 0.708 = 0.50\textsuperscript{30}.

Once the items are eliminated, Table 3 shows that all external loading values, composite reliability and AVE for each construct have fulfilled the required conditions of the load value >0.50, composite reliability >0.70 and AVE >0.50.

Table 2 shows the items in the constructs that need to be eliminated, including three items in the life balance construct (B2, B8, and B10), one item in the leave construct (L19) and two items in the gender discrimination construct (G25 and G26). Such elimination of items is necessary for the convergence validity requirements to be fulfilled.

Table 2: Outer Loading Value, Composite Reliability (CR) and AVE

| Construct      | Item | Outer Loading | CR >0.70 | AVE >0.50 |
|----------------|------|---------------|----------|-----------|
| Life Balance   | B1   | 0.698         | 0.865    | 0.388     |
|                | B2   | 0.032         |          |           |
|                | B3   | 0.761         |          |           |
|                | B4   | 0.720         |          |           |
|                | B5   | 0.684         |          |           |
|                | B6   | 0.763         |          |           |
|                | B7   | 0.656         |          |           |
|                | B8   | 0.209         |          |           |
|                | B9   | 0.701         |          |           |
|                | B10  | 0.222         |          |           |
|                | B11  | 0.745         |          |           |
|                | B12  | 0.669         |          |           |
| Childcare      | C13  | 0.730         | 0.883    | 0.562     |
|                | C14  | 0.859         |          |           |
|                | C15  | 0.553         |          |           |
|                | C16  | 0.764         |          |           |
|                | C17  | 0.699         |          |           |
|                | C18  | 0.849         |          |           |
| Leave          | L19  | 0.360         | 0.807    | 0.474     |
|                | L20  | 0.786         |          |           |
|                | L21  | 0.810         |          |           |
|                | L22  | 0.521         |          |           |
|                | L23  | 0.834         |          |           |
| Gender         | G24  | 0.601         | 0.811    | 0.445     |
| Discrimination | G25  | 0.417         |          |           |
|                | G26  | 0.269         |          |           |
|                | G27  | 0.864         |          |           |
|                | G28  | 0.792         |          |           |
|                | G29  | 0.831         |          |           |

Once the items are eliminated, Table 3 shows that all external loading values, composite reliability and AVE for each construct have fulfilled the required conditions of the load value >0.50, composite reliability >0.70 and AVE >0.50.

Table 3 also shows that the loading value is less than 0.70. However, all AVE values above 0.50 are still acceptable\textsuperscript{30,31}. Therefore, the findings show that the instrument has fulfilled the criteria of convergent validity.
Table 3: Outer Loading Value, Composite Reliability and AVE

| Construct     | Item | Outer loading | CR >0.70 | AVE >0.50 |
|---------------|------|---------------|----------|-----------|
| Life Balance  | B1   | 0.704         | 0.904    | 0.511     |
|               | B3   | 0.764         |          |           |
|               | B4   | 0.722         |          |           |
|               | B5   | 0.683         |          |           |
|               | B6   | 0.765         |          |           |
|               | B7   | 0.659         |          |           |
|               | B9   | 0.705         |          |           |
|               | B11  | 0.746         |          |           |
|               | B12  | 0.676         |          |           |
| Childcare     | C13  | 0.732         | 0.885    | 0.565     |
|               | C14  | 0.858         |          |           |
|               | C15  | 0.564         |          |           |
|               | C16  | 0.769         |          |           |
|               | C17  | 0.703         |          |           |
|               | C18  | 0.846         |          |           |
| Leave         | L20  | 0.803         | 0.884    | 0.583     |
|               | L21  | 0.836         |          |           |
|               | L22  | 0.532         |          |           |
|               | L23  | 0.839         |          |           |
| Gender        | G24  | 0.559         | 0.874    | 0.642     |
| Discrimination| G27  | 0.910         |          |           |
|               | G28  | 0.809         |          |           |
|               | G29  | 0.879         |          |           |

Measuring Discriminant Validity Numbers. Discriminant validity is based on the (i) Fornell-Larcker, (ii) cross loading, and (iii) Heterotrait-Monotrait (HTMT) ratio. By referring to the Fornell-Larcker criteria, AVE values may also be used to prove discriminant validity. The criterion of the Fornell-Larcker posits for each variable is that the primary value of AVE should be higher than its correlation with other variables. This means that for each variable, the variance shared with the indicator block is greater than the variance divided by the other variables. In the output of SmartPLS in the Fornell-Larcker criterion table, the main value of AVE appears inside diagonal cells and the correlation appears below it. Therefore, in absolute terms, if the top number (which is the prime value of the AVE) in any factor column is higher than the number (correlation) below, then there is a discriminant validity. Table 4 shows that all the major AVE values for each construct are higher than the constructs below. This value proves that Fornell Larcker’s criteria are met.

Table 4 - Fornell Lacker (AVE > R)

| Construct     | Life Balance | Childcare | Leave | Gender | Disc. |
|---------------|--------------|-----------|-------|--------|-------|
| Life Balance  | 0.715        |           |       |        |       |
| Childcare     | 0.064        | 0.752     |       |        |       |
| Leave         | 0.314        | 0.052     | 0.801 |        |       |
| Gender        | 0.072        | -0.062    | 0.108 | 0.763  |       |

Cross loading or crosslinking is a good loading indicator for the intended factors and other factors that are not intended to be clearly measured. The determinant for loading factor is >0.70 but it can still be between 0.50 and 0.70. While the determinant for cross loading should be <0.30 or <0.40.

Cross loading is also declared as an alternative to AVE. Hence, if the cross loading value is not eligible, it is still acceptable if the AVE value meets the requirements. Table 5 shows that all cross loading values are <0.40 which reach the criteria of cross loading.

Table 5: Cross Loading

| Item     | Life Balance | Childcare | Gender | Leave |
|----------|--------------|-----------|--------|-------|
| B1       | 0.704        | 0.006     | 0.220  | -0.001|
| B3       | 0.764        | 0.003     | 0.195  | 0.166 |
| B4       | 0.722        | 0.071     | 0.207  | 0.006 |
| B5       | 0.683        | -0.036    | 0.219  | 0.136 |
| B6       | 0.765        | 0.006     | 0.247  | 0.044 |
| B7       | 0.659        | 0.075     | 0.107  | 0.014 |
| B9       | 0.705        | 0.107     | 0.315  | 0.038 |
| B11      | 0.746        | 0.043     | 0.190  | 0.047 |
| B12      | 0.676        | 0.145     | 0.307  | 0.002 |
| C13      | 0.035        | 0.732     | 0.047  | 0.029 |
| C14      | 0.095        | 0.858     | 0.035  | -0.080|
| C15      | -0.074       | 0.564     | 0.045  | 0.035 |
| C16      | 0.004        | 0.769     | 0.005  | -0.116|
| C17      | -0.002       | 0.703     | 0.068  | 0.013 |
| C18      | 0.054        | 0.846     | 0.047  | -0.081|
| G24      | 0.266        | -0.034    | 0.559  | 0.036 |
| G27      | 0.263        | 0.071     | 0.910  | 0.099 |
| G28      | 0.254        | 0.040     | 0.809  | 0.120 |
| G29      | 0.223        | 0.079     | 0.879  | 0.084 |
| L20      | 0.066        | -0.060    | 0.166  | 0.803 |
| L21      | 0.077        | 0.007     | 0.004  | 0.836 |
| L22      | 0.061        | -0.074    | 0.047  | 0.532 |
| L23      | -0.001       | -0.076    | 0.091  | 0.839 |

HTMT ratio is the geometric mean value for the Heterotrait-Monotrait correlation (correlation indicator across different phenomena) divided by the average correlation of Heterotrait-Monotrait (correlation indicator in the same construction). Average geometric mean use is required because there are two montrait-heteromethod (set correlation in construction) due to the existence of two constructs. In the appropriate model, the Heterotrait correlation should be smaller than the Monotrait correlation where the HTMT ratio should be <1.00. If the value of HTMT is less than 0.90, the validity of discrimination has existed between the constructs of the built-in reflective model. The value of Heterotrait-Monotrait (HTMT) ratio should be <0.90. Hence, the Heterotrait-Monotrait (HTMT) ratio in this study has been achieved with all values being <1.00 as illustrated in Table 6.
Testing of structural models in PLS-SEM. As explained, the evaluation of the structural model should be based on several analyses and this process directly tests the hypotheses of the study. Structural model testing involves the analysis of (i) internal VIF or Multicollinearity (Inner VIF), (ii) structural model coefficient (β), (iii) determination coefficient (R square, $R^2$), (iv) size effect ($f^2$), and (v) predictive relevance, $Q^2$ [30].

Multicollinearity (Inner VIF). Multicollinearity test is conducted to determine whether the independent variables are redundant to one another [31]. Collinearity is said to exist in the case of VIF <5.00 30. The results of multicollinearity analysis in this study are presented in Table 7 which shows that all VIF test values are <5.00. Therefore, each variable has met the appropriate VIF criteria.

Table 7: Inner VIF

| Construct          | Life Balance | Childcare | Leave | Gender |
|--------------------|--------------|-----------|-------|--------|
| Life Balance       | 0.106        |           |       |        |
| Childcare          | 0.377        | 0.096     |       |        |
| Leave              | 0.117        | 0.122     | 0.147 |        |
| Gender Discrimination | 0.059 | 0.047 | 0.053 | 0.084 |

R square ($R^2$). The contribution value of all variables can be seen through the R square ($R^2$) values. The value of $R^2 > 0.67$ is strong, $R^2 > 0.33$ is moderate and $R^2 > 0.19$ is weak30. The result shows that the model of this study has a strong predictive power value of $R^2 = 0.994$ where the value of free extract contribution is high as illustrated in Table 9. This means that the $R^2$ value suggests that 99.4% variants can be explained by the independent constructs towards the dependent construct of the research.

Table 8: Path Coefficient

| Hypothesis | Mean/ Beta | Standard Deviation | | | P Values <0.05 |
|------------|------------|--------------------|---|---|
| Ho1        | 0.810      | 0.053              | 15.969 | 0.000 |
| Ho2        | 0.138      | 0.081              | 1.691 | 0.492 |
| Ho3        | 0.279      | 0.047              | 6.243 | 0.000 |
| Ho4        | 0.104      | 0.059              | 1.730 | 0.084 |

The effect size ($f^2$) is determined by the value of R Square ($R^2$). The purpose of evaluating the effect size ($f^2$) is to see the dependency impact of a variable towards the other variables30,31. When an independent variable is removed from the path of the model, it will alter the value of the determinant coefficient ($R^2$) and defines whether the formation of exogenous latent has a significant effect on the value of the latent endogenous construct. The calculation of the size effects towards the variables is based on the following formula:

$$f^2 = \frac{(R^2 \text{ included} - R^2 \text{ excluded})}{(1 - R^2 \text{ included})}$$ (1)

The effect sizes can also be evaluated in three sizes, where $0.00 \leq f^2 < 0.15$ is small, $0.15 \leq f^2 < 0.35$ is moderate and $f^2 \geq 0.35$ is large. Therefore, the analysis result in Table 10 shows that life balance and gender discrimination have a strong impact, with the value of $f^2 \geq 0.35$. Meanwhile, child care and leave have a moderate effect of $f^2 = 0.333$ and $f^2 = 0.167$ (0.15 $\leq f^2 < 0.35$).
Predictive relevance \((Q^2)\). This study uses the blindfolding method to obtain the predictive relevance \((Q^2)\) value. The measured \(Q^2\) value must be greater than zero for specific endogenous latent construction\(^9\). Therefore, the blindfolding analysis result in Table 11 shows that \(Q^2 = 0.161\) and this value meets the \(Q^2\) criteria of \(Q^2 > 0\) \(^{29,30}\). Such value proves that the built model has a predictive relevance. Figure 1 shows the structural model of the career challenges model that has been developed.

**Table 10: Size Effects \((f^2)\)**

| Factor (exogenous) | Endogenous | \(R^2\) included | \(R^2\) excluded | \(f^2\) |
|-------------------|------------|------------------|------------------|--------|
| Life Balance      | Career Challenges | 0.994 | 0.982 | 2.000 |
| Childcare         | Career Challenges | 0.994 | 0.992 | 0.333 |
| Gender Discrimination | Career Challenges | 0.994 | 0.970 | 4.000 |
| Leave             | Career Challenges | 0.994 | 0.993 | 0.167 |

**Table 11 - Predictive Relevance \((Q^2)\)**

| Dependent Variable | SSO | SSE | \(Q^2 = (1 - \text{SSE}/\text{SSO})\) |
|--------------------|-----|-----|----------------------------------|
| Career Challenges  | 5,829.00 | 4,887.64 | 0.161 |

**Figure 1: Career Challenges Model**

**DISCUSSION**

The development of the career challenges model for female engineers who are married and have their own families indicates that this model has a predictive viability. This study finds that life balance and gender discrimination have significant relationships in influencing career challenges. This supported previous studies\(^{33,34}\) which report that life balance affects career challenges among women. Other studies\(^{35,36}\) also explain that discrimination against women affects their career challenges.

**CONCLUSION**

One of the main goals of the Human Resource Management (HRM) is to improve organizational performance. Along with the need to build a new career model\(^5,6\), this model is hoped to contribute to the literature in HRM. Apart from adding to the pool of knowledge, this model demonstrates that career challenges for female engineers can be conceptualized according to four important factors: childcare, leave, gender discrimination and life-balance conflict.

To expand this model, further research is proposed to explore new factors that contribute to the challenge of life balance among women in various fields so that a perfect life-balance model can be developed specifically for women.

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