

# PREDICTION RULES OF THE EMPLOYEES' EXPATRIATION WILLINGNESS FOR ENGINEERING CONSULTING COMPANIES

Jieh-Haur Chen and Jia-Zheng Lin

Key words: expatriation willingness, prediction rule, rough set, decision tree.

## ABSTRACT

To assure efficient expatriate assignments, the objective of this study is to establish prediction rules of employees' expatriation willingness using the rough set theory and decision tree. We summarize 22 impact factors from literature regarding expatriation willingness and utilize them to develop a questionnaire. A total of over 400 questionnaires are returned and effective for data analysis, resulting that one factor is removed. The adoption of the rough set theory classifies these factors into three categories. Among them 18 out of 21 factors are set as the inputs for the decision-making model to construct the prediction rules of employees' expatriation willingness. Six rules regarding the refusal of expatriation assignments and three rules regarding the acceptance of expatriation assignments are found. The rules can be valuable to employers in making decisions of international expatriation.

## I. INTRODUCTION

Engineering consulting is a knowledge-intensive industry and engineers are the core of its competitiveness. With the rapid development of the world economy, business operations go beyond the boundaries of countries. The primary activities of many large corporations have branched out into the international marketplace [4]. The Taiwan government has fully supported engineering consulting companies expanding into international markets in recent years, creating a significant demand for expatriate employees. However, the majority of large engineering consulting firms are facing a low willingness from employees to accept international project. Senior executives indicate that numerous companies rely on compulsory assignment to overcome low employees' willingness. This may dampen employees' loyalty and could make the company difficult to retain their talented employees. Besides, it could also cause negative influences to project. Therefore, choosing ap-

propriate candidates is important to international projects.

Related literature indicates that expatriates are a source of company competitiveness in the international market [54, 63]. Employees' expatriation willingness is a decisive factor in the successful management of expatriate assignments [52, 58]. Tung (1981) highlights that employees' expatriation willingness should be considered when dispatching employees overseas. He also believes that devoting resources to those willing to accept overseas transfers will enable the management of expatriation assignments to achieve efficiency with the least effort [57]. Most of studies available regarding employees' expatriation willingness examined a number of related factors [18, 44, 47, 55, 61,], but practitioners need to know the prediction of employee expatriation willingness so as to assure efficient expatriate assignments. The objective of this study is to establish prediction rules of employees' expatriation willingness using the rough set theory and decision tree. The rules can be valuable to employers in choosing appropriate candidates for expatriation which can promote the successful rate of international projects.

## II. LITERATURE REVIEW

### 1. Applications of rough set theory and decision trees

Rough set theory (RST), proposed by Pawlak in the 1980s and resulting from a long-term program of fundamental mathematical research of information systems, can be regarded as a new mathematical approach to vagueness (set) and uncertainty (element) [45]. The approach is based on the assumption that every set will be roughly defined using a lower and an upper approximation. Increasing numbers of researchers have demonstrated an interest in this theory due to its successful application in the fields of data decision, pattern recognition, machine learning, and knowledge discovery [22, 30, 51, 60, 65, 66].

A number of rough set theory (RST) applications are briefly reviewed below. Chang et al. (2007) introduced RST into PMS for maintenance and rehabilitation (M&R) strategy induction [15], while Kim et al. (2009) presented an RST approach to determine the category of crack causes for insufficient and imprecise crack characteristics observed during regular inspections of concrete structures [36]. In recent years, a number of researchers applied RST to explore key factors. For example,

Zhang and Xu (2009) used the RST method to identify the key factors affecting precipitation [67]; Huang et al. (2010) applied RST to define the impact factors that lead to the deterioration of RC bridges.

Decision tree is one of the most popular and widespread classification algorithms in current use in data mining and machine learning, and it provides both classification and predictive functions simultaneously [5, 24, 38]. It exhaustively breaks down cases into a branched, tree-like form until the splitting of the data is statistically meaningful. Unnecessary branches should then be pruned using other test cases to avoid overfitting [25]. In this approach, each node of the tree is a distinguish equation. The equation will focus on a certain variable and determine whether the imported data is greater than, equal to, or less than a certain value. Each node of such can classify the imported data into different category afterwards [16]. The advantages of decision tree approach includes: (1) able to generate understandable rules, (2) perform classification without requiring much computation, (3) able to handle both continuous and categorical variables and (4) provide a clear indication of which attributes are most important for prediction or classification, (5)able to represent decision alternatives, possible outcomes, and chance events schematically. The visual approach is particularly helpful in comprehending sequential decisions and outcome dependencies [23, 20, 62]. Because of its superiority, decision tree learning techniques has been successfully demonstrated in many practical applications [6,13, 14, 17, 21, 26, 35, 40, 56, 64].

Major algorithms of decision tree analysis model include ID3 (Interactive Dichotomiser 3), C4.5, C5.0, classification and regression trees (CRAT), and chi-squared automatic interactive detector (CHAID) models. In the late 1970s, Quinlan (1993) developed a simple decision trees learning algorithm, named ID3. The basic idea of ID3 algorithm is to construct the decision tree by employing a top-down, greedy search through the given sets to test each attribute at every tree node. Based on the theory of information gain, ID3 selects the optimal information gain to as an attribute for branching of decision trees [46]. However, a significant shortcoming of ID3 is its inability to handle noisy data, which will lead to overfitting. The C4.5 algorithm improves ID3 with regard to the splitting rule and the calculation method. It uses information gain-ratio instead as a measurement method to segment attributes. Through the standardized information gain, C4.5 can reduce the influence of shortcoming of ID3. C5.0 algorithm, offers improvements for C4.5, can be most effectively used in processing enormous data set specifically. Besides, C5.0 uses boosting method to increase modeling accuracy, it is also known as Boosting Trees. Therefore, C5.0 is faster and more efficient than C4.5 [16, 20]. Due to the advantages of decision tree, this study uses C5.0 as research method.

## 2. Expatriation willingness

This section provides a discussion of the factors noted in previous studies that influence employees' expatriation willingness based on: (1) demographic variables, (2) family in-

fluence, (3) company expatriation policy, and (4) expatriate location. Selmer (2001) highlights that demographic characteristics are vital indicators to predict potential expatriates, indicating who will accept expatriation [49]. From the traditional social viewpoint, men are usually the breadwinners, and women are the caregivers at home [3, 53]. A study by Fan (2000) found that in Singapore 98 % of the employees willing to be expatriated were male [28]. Regarding age, most research supports that age and employees' EW are negative correlated [39]. A study by Noe et al. (1988) showed that employees aged between 31 and 44 and between 45 and 65 will not have as high expectations of promotion as those aged between 25 and 30. As employee age increases, their EW decreases [43].

Regarding education, Brett and Stroh (1995) proposed that well-educated employees have broader perspectives and higher adaptability; their EW is typically higher than that of less-educated employees [11]. Conversely, individuals with previous expatriation experience adapt to unfamiliar environments more easily than those without related experience do, which might be the reason employees with expatriation experience are more willing to accept international assignments [8]. In addition, any overseas experience (school, work) positively influences employees' acceptance of international expatriation [9, 48]. The available studies that discuss demographic characteristics are summarized and presented in Table 1.

**Table 1. Demographic characteristics.**

Demographic variables	Literature Source	Demographic variables	Literature Source
Gender	Stroh et al.(2000); Fan(2000); Wan et al.(2002)	Marital status	Borstorff et al.(1997)
Age	Landau et al.(1992); Brett et al.(1993);	Overseas living experience	Ronen ( 1989); Borstorff et al.(1997)
Education	Brett & Stroh(1995); Adler(1986)	Overseas expatriation experience	Shamir et al.(1990) ; Black & Mendenhall (1990);

Family systems theory highlights that individual behavior is frequently affected by family members [42]. A study by Brett and Stroh (1995) showed that married people are more willing to transfer their employment if supported by their spouses. However, employees are unwilling to transfer their employment if they have responsibilities toward children [11]. Brett and Reilly (1988) noted this is because overseas expatriates may not be able to offer a good education and care to their children, and because overseas expatriation can affect their children's schooling and social network. Additionally, this situation might increase the cost of accepting overseas employment and, therefore, lowers employees' EW [10].

A company's expatriation policy cannot only increase employees' expatriation willingness, but can also improve the success of expatriation [27]. Adler (1991) highlights that if companies could have expatriates' careers mapped in detail, their willingness to relocate internationally would be promoted [2]. In addition, providing overseas expatriation training can be crucial [7, 29]. Haines and Saba. (1999) mentioned that finan-

cial incentives provided by the company could motivate employees' expatriation willingness and promote successful international management [32]. In addition to career, training, and financial support, a repatriation program will also influence employees' expatriation willingness. Harvey (1989) suggests that companies' repatriation arrangements can not only lower the employee's stress but also improve expatriation stability [33].

Fan (2000) found that location and environmental factors could influence employees' expatriation willingness [28]. Adler (1991) highlighted that if the expatriate countries had a certain economic development level and similar cultural background as the employee's home country, employees will have greater willingness to accept overseas assignments [2]. A study by Wan et al. (2002) also showed that employees tended to work in countries with a similar cultural background as their home country [59]. The influencing factors mentioned above are summarized and presented in Table 2.

**Table 2. Impact factors.**

Category	Impact factor	Literature Source
Family influence	Spousal support	Richardson(2006); Konopaske et al.(2005); Borstorff et al.(1997); Harvey & Buckley(1998); Brett & Stroh(1995)
	Attitude toward child care	Richardson(2006); Landau et al.(1992)
Company expatriation policy	Repatriation support	Harvey(1989); Adler(1986); Aryee et al.(1996)
	Career planning	Adler(1986); Landau et al.(1992)
	Provide training	Black & Gregerson(1991); Feldman & Thomas(1992); Aryee et al.(1996)
	Financial compensation	Noe,et al.(1988); Aryee et al.(1996); Haines & Saba (1999)
Expatriate location	Cultural difference	Adler(1991); Aryee et al.(1996); Mendenhall et al.(1987)
	Economic development	Adler(1991)

### III. DATA COLLECTION AND ANALYSIS

#### 1. Pilot survey

Based on the factors summarized in tables 1 and 2, a pilot survey was conducted to obtain expertise through interviews, targeting high-ranking managers (at least senior division managers) of the top five engineering consulting companies in Taiwan. Each company recommended two senior managers for interview. Five division heads and their five vice presidents and five senior managers were interviewed. The suggestions included the details that provide how to define categories for the demographic variables and impact factors. For example, they suggested three categories of " $\leq 35$ ", "36-50", and " $\geq 51$ " for the Age variable due to regular marriage age and average age of managers in the industry. Considering the project life cycle in average of foreign projects, Variable "overseas living experience" was based on a 5-year period. Similar to how demo-

graphic variables are divided, expertise recommends those three categories in Table 2 being reorganized to personal safety, health care, family, project, expatriation policy, economy, and culture. The first three was derived from "Family influence", the next two came from "Company expatriation policy", and the rest was related to "Expatriation location" in Table 2. The impact factors listed in Table 2 were correspondingly modified and classified based on expertise. For example, for the categories of personal safety, health care, and family, the experts suggested 10 impact factors replacing the original two listed in Table 2. The training program for expatriation was removed. Two categories related to personal safety and healthcare and two factors related to loneliness and expatriation duration were added. The other factors remained the same or similar to the original sources. The restructured factors are listed in Table 3.

Engineering consulting companies in Taiwan entered the international construction market relatively late; markets in Southeastern and Western Asia are their primary targets. The culture, religion, and lifestyle of these areas vary considerably from that of Taiwan. For example, some social behaviors and values that are normal in Taiwan could be considered insulting in these countries. The unforeseen impact of such cultural differences could be harmful to the personal safety of the employees. Some experts suggest that in the category of personal safety, factors of protection, discrimination, and social security should be included. The healthcare category comprises the health of the expatriates' children and spouse. If the projects for which the expatriates are responsible are located near a desert or swamp, the environment could be considered hostile. The availability of adequate healthcare programs plays an important role in expatriation willingness. The factors included in the healthcare category are environmental health, medical standards, and convenience. The scale of a project might result in a single employee engaging in few or even no social activities for a long duration of time, leading to loneliness. Thus, the number of expatriates in a project is positively related to employees' expatriation willingness. In contrast, the duration of expatriation is negatively related to employees' expatriation willingness. These two factors are classified into the project category. Table 3 shows the restructured categories and the corresponding impact factors.

#### 2. Questionnaire design and survey

The questionnaire was developed based on the 22 factors listed in Table 3, using the widely accepted five-point Likert scale method. The five impact levels were defined as "extremely high impact," "high impact," "medium impact," "low impact," and "little or no impact." Combining five demographic variables, this study finalized 22 factors and then randomly distributed 1000 questionnaires to employees of the top five engineering consulting companies. Within a month, 486 questionnaires were returned. Of those questionnaires, 73 out of 486 were invalid, resulting in an acceptance rate of 41.3%. To ensure that the reliability of the returned questionnaires met the threshold at Cronbach's  $\alpha = 0.8$  [19, 31], 413 valid questionnaires were measured. As shown in Table 3, each

**Table 3. Questionnaire design.**

Demographic variables					
Gender	1). Male	2). Female			
Age	1). $\leq 35$	2). 36-50	3). $\geq 51$		
Education	1). below High school	2). University	3). Master	4). Doctor	
Marital status	1). Single	2). Married	3). Others		
Oversea living experience	1). No experience	2). 1-5 years	3). 6-10 years	4). 10-15 years	
	5). 15-20 years	6). $\geq 20$ years			
Category	No.	Impact factor	Category	No.	Impact factor
Personal safety	1	Protests, and riots	Culture	12	Customs and habits
	2	Racism		13	Religious belief
	3	Social security		14	Marital status
Health care	4	Hygiene	Family	15	Child care
	5	Medical standard		16	Family care
	6	Convenience of health care		17	Family support
Project	7	Expatriation period	Expatriation policy	18	Salary and benefit content
	8	Possible loneliness		19	Allowance and subsidies
Economy	9	Economical development	20	Repatriation plan	
	10	Price index	21	Possible promotion	
	11	National income			

Cronbach's  $\alpha$  value is greater than the threshold, indicating the need for further analysis.

Before using RST to determine and classify the impact factors, feature deduction was performed. Nine tests were suggested: missing value, mean, standard deviation, skewness, t-testing, correlation coefficients, factor loading, measures of sampling adequacy (MSA), and Cronbach's  $\alpha$ . Table 3 shows the test results. The thresholds were set according to previous studies [19]. According to Chen and Hsu, if more than three test results for any factor exceed the thresholds, the factor should be removed. Factor No. 2, war, was therefore deleted.

### 3. Basic information analysis

Basic information of the 413 respondents is summarized and presented in Table 4. Regarding gender, there were fewer female students in civil engineering related departments. This study only comprises 57 females, which accounts for 13.8 %. Regarding education level, people whose highest level of education was senior high school or those who had a doctorate degree were fewer because the industry is knowledge-intensive, and since Taiwan developed into a highly-educated society, most companies only recruit employees with a bachelor's or master's degree. Most job openings are affected by the educational crowding effect. High school graduate job openings are easily filled by university graduates. Since doctoral recruitment costs are higher, the accounted percentage of doctorate graduates is also low. The sample distribution is consistent with actual conditions. Regarding previous overseas experience, only 15 people had more than six years experience living overseas, therefore, these people were categorized into one group. Please refer to Table 5 for more details.

## IV. EXPLORING THE KEY INFLUENCES OF EXPATRIATION WILLINGNESS

To promote the efficiency of the decision tree approach, this study applies the RST approach to identify the key influences

of expatriate willingness. Table 6 displays the important classification of these factors. The importance of the factors is defined based on how frequently a factor appears in all set-theoretic intersections, resulting in three categories of impact level being established. Any factor with a frequency  $\geq 90$  % (9 or above of 10 occurrence times) is regarded as a core impact factor. Factor No. 1, 5, 9, 14, 16, and 21 belong to this category. Meanwhile, the other category of insignificant impact factors is similarly determined and set for anything with a frequency  $\leq 10$  %. Six factors are identified and they are No. 8, 10, 10, 12, 17, and 20. The remaining factors form a medium category containing factors with a frequency  $\geq 20$  % or a frequency  $\leq 80$  %.

The impact factors for employees' expatriation willingness are classified into three categories that contain 6 to 9 factors each. The core impact category provides an important insight into how employers should allocate labor overseas. For employees, personal safety, health, sentiments, beliefs, and future career are the top priorities. Expatriate assignments should satisfy employee priorities as much as possible to enhance the efficiency of project performance. In contrast, employees are relatively less concerned about the economic status of the destination country. Subsidies and the duration of expatriation also have minimal effect on expatriate willingness. This finding should alleviate misgivings or difficulty allocating labor to less developed regions. Family care is classified as having an insignificant impact. Most expatriates are not accompanied by their family members, with the exception of their children. The other factors belong to the medium impact category, most with frequencies of 50 % or above. The impact of a possible promotion almost reaches the core impact level. This factor is strongly correlated to the expatriates' future career, ranking at the top of the medium impact class. These findings could be considered criteria that may be of benefit to employers allocating expatriate labor.

**Table 4. Test results.**

No.	Factor	Missing value	Mean	Standard deviation	Skewness	T-test	Correlation coefficient	Factor loading	MSA	Cronbach's $\alpha$
1	Protest	0.00	4.356	0.786	-1.112	0.000	0.375	0.405	0.82	0.890
2	War	0.00	4.736	0.536	-2.408	0.000	0.272	0.302	0.78	0.891
3	Discrimination	0.00	4.269	0.723	-0.611	0.000	0.379	0.424	0.87	0.889
4	Social security	0.00	4.286	0.654	-0.529	0.000	0.522	0.563	0.90	0.887
5	Environmental health	0.00	3.889	0.765	-0.169	0.000	0.581	0.657	0.89	0.885
6	Medical standards	0.00	3.862	0.768	-0.017	0.000	0.625	0.710	0.85	0.884
7	Convenience	0.00	3.792	0.757	-0.004	0.000	0.613	0.701	0.89	0.885
8	Expatriation duration	0.00	2.976	0.769	0.041	0.000	0.489	0.460	0.92	0.887
9	Personal loneliness	0.00	3.947	0.808	-0.375	0.000	0.482	0.502	0.83	0.887
10	Economic development	0.00	3.567	0.937	-0.301	0.000	0.512	0.572	0.94	0.887
11	Price index	0.00	3.031	0.822	0.126	0.000	0.456	0.481	0.83	0.888
12	GDP	0.00	2.772	0.813	-0.077	0.000	0.448	0.495	0.83	0.888
13	Customs and habits	0.00	2.838	0.822	0.071	0.000	0.578	0.637	0.88	0.885
14	Religion	0.00	2.726	0.881	0.157	0.000	0.475	0.520	0.95	0.887
15	Marital status	0.00	3.857	0.964	-0.725	0.000	0.593	0.640	0.88	0.884
16	Child care	0.00	4.094	0.908	-0.873	0.000	0.548	0.587	0.83	0.886
17	Family care	0.00	4.189	0.832	-0.899	0.000	0.510	0.558	0.86	0.887
18	Family support	0.00	4.213	0.784	-0.850	0.000	0.461	0.503	0.89	0.888
19	Salary and welfare	0.00	4.291	0.790	-0.981	0.000	0.225	0.117	0.70	0.893
20	Subsidies	0.00	4.291	0.796	-1.033	0.000	0.244	0.134	0.70	0.892
21	Repatriation plan	0.00	4.148	0.830	-0.793	0.000	0.318	0.218	0.87	0.891
22	Possible promotion	0.00	3.801	0.908	-0.516	0.000	0.186	0.102	0.79	0.895
	<b>Threshold</b>	0.00	2.3~4.4	>0.75	-0.7~0.7	<0.05	>0.3	>0.3	>0.7	>0.8

**Table 5. Basic information analysis.**

Demographic variables	Type	Sample	Percentage	Positive EW	Negative EW
Gender	Male	356	86.2%	82	274
	Female	57	13.8%	16	41
Age	≤ 35	118	28.6%	46	72
	36-50	206	49.9%	31	175
	≥ 51	89	21.5%	21	68
Education	below High school	32	7.7%	14	18
	University	130	31.5%	38	92
	Master	243	58.8%	42	201
	Doctor	8	1.9%	4	4
Marital Status	Single	113	27.4%	51	62
	Married	298	72.2%	47	251
	Others	2	0.5%	-	2
Overseas living experience	No experience	297	71.9%	54	243
	1-5 years	101	24.5%	43	67
	6-10 years	14	3.4%	9	5
	10-15 years	0	-	-	-
	15-20 years	0	-	-	-
	≥ 20 years	1	0.24%	1	-

## V. CLASSIFICATION RULES FOR EXPATRIATION WILLINGNESS

Using RST, the significance of factors is measured by the occurrence of attributes in all reducts, where the higher the occurrence, the greater the significance. However, the occurrence rates ranging between 20 % and 80 % are in the medium impact category. The significance is quite different, because those with occurrence rates of 80 % are considered important impact factors, while those with the frequency rate of 20 % are considered unimportant impact factors. In this study, the factors with a  $\geq 50$  % occurrence rate are considered dependent variables with significant impact (Huang et al., 2010), and are,

therefore, used to predict employees' expatriation willingness and as decision tree variables. These factors are No. 1, 3, 4, 5, 6, 9, 13, 14, 15, 16, 18, 21, and 22, totally 13 variables. In addition, Selmer (2001) indicated that demographic characteristics were important indicators of successful expatriation. In this study, five demographic variables (gender, age, marital status, education, and overseas experience) were examined to identify employees' expatriation willingness. There are 18 classified variables in total. The employees' willingness to be dispatched overseas is considered a decisive factor. The C5.0 decision-making algorithm was adopted to construct the prediction rules of employees' expatriation willingness in engineering consulting firms.

**Table 6. Impact factors for EW.**

No.	Factor	Frequency	occurrence	Core Impact factor	Medium Impact factor	Insignificant Impact factor
1	Protest	9	90%	✓		
3	Discrimination	5	50%		✓	
4	Social security	5	50%		✓	
5	Environmental health	10	100%	✓		
6	Medical standard	7	70%		✓	
7	Convenience	4	40%		✓	
8	Expatriation duration	1	10%			✓
9	Personal loneliness	10	100%	✓		
10	Economical development	0	0%			✓
11	Price index	0	0%			✓
12	GDP	0	0%			✓
13	Customs and habits	6	60%		✓	
14	Religion	10	100%	✓		
15	Marital status	7	70%		✓	
16	Child care	10	100%	✓		
17	Family care	1	10%			✓
18	Family support	5	50%		✓	
19	Salary and welfare	2	20%		✓	
20	Subsidies	0	0%			✓
21	Repatriation plan	10	100%	✓		
22	Possible promotion	8	80%		✓	

Results of the C5.0 decision analysis show that there are six rules regarding assignment rejection, the details are shown in Table 7. The first rule suggests that when employees are indifferent toward career advancements related to expatriate dispatchment, they tend to refuse assignments. The rule accuracy reaches as high as 96 %, indicating that the less the employees care about their career development, the lower the probability of them accepting assignments. In other words, those with a lower positive work attitude are not suitable for expatriation, even if they have adequate professional competence and satisfy the assignment requirements. The second and third rules proposed that married employees prioritizing child rearing, and married employees aged between 36 and 50 tend to reject assignments. The accuracy of these two rules is 90 % and 88 %. Rule 4 shows that married employees aged below 50 are reluctant to accept assignments even though they do not have child-rearing responsibilities. The accuracy rate of this rule is 75 %. Rule 5 suggests unmarried employees with a master's degree and without overseas experience tend to be concerned about the loneliness that may arise when living overseas, 71 % of such employees indicated their reluctance to accept expatriation assignments. Rule 6 proposes unmarried employees with a bachelor's degree, concerned about loneliness when living overseas; 70 % indicated they would not accept overseas dispatchment.

As for the willingness to accept assignments, only three rules emerged from the analysis due to the small sample size. Rule 7 indicates that unmarried employees and those who care less about loneliness are more willing to accept expatriate assignments. This rule reaches an accuracy rate of 82 %. In addition, unmarried employees with a master's degree, but with a low resistance to loneliness and without overseas experience, show

**Table 7. Rules for EW.**

Negative EW	Accuracy	Rule Description
Rule 1	0.96	If No.22 ≤ 2, then 1
Rule 2	0.9	If Marital status = 2 & No.16 > 3, then 1
Rule 3	0.88	If Marital status = 2 & Age = 2, then 1
Rule 4	0.75	If Marital status = 2 & No.16 ≤ 3 & Age < 3, then 1
Rule 5	0.71	If Marital status = 1 & No.9 ≥ 3 & Education = 3 & Oversea Experience = 1, then 1
Rule 6	0.7	If Marital status = 1 & No.9 ≥ 3 & Education = 2, then 1
Positive EW	Accuracy	Rule Description
Rule 7	0.82	If Marital status = 1 & No.9 ≤ 2, then 2
Rule 8	0.78	If Marital status = 1 & No.9 ≥ 3 & Education = 3 & Oversea Experience = 1 & No.22 > 3 & No.1 ≤ 3 & No.3 ≤ 3, then 2
Rule 9	0.8	If Marital status = 2 & No.16 ≤ 2 & Age 3, then 2

their willingness to accept overseas dispatchment even in regions with possible protest riots and racial exclusion. 78 % of employees in this category showed their willingness to accept overseas dispatchment, if expatriation is considered as elements for future promotion. Finally, Rule 9 indicates that married people above 50 years old with less responsibility of children are willing to accept overseas dispatchment. The accuracy rate reaches 80 %.

## VI. DISCUSSIONS.

Based on an understanding of the aforementioned rules, this study concludes the following five vital points: First, in line with Rule 3, it can be concluded that married employees aged between 36 and 50 generally have children to look after. To this group of employees, the child factor forms a crucial reason for them to reject expatriate assignments. The results show nearly 70 % of married employees do not take assignments on the grounds of their children. In addition, Rule 4 shows that married employees below 50 years old, though without responsibilities of children, are also reluctant to accept overseas assignments. Family systems theory suggests that individual behavior is often subject to the influence of primary members of the family (for example, spouse). This theory enables an understanding of the significant changes that expatriation assignments impose on family life, and the pressure they put on spouses. According to Richardson (2006), when the pressure rebounds, it will affect the expatriates' decision. Richardson also highlighted that spouses and children of the expatriates always have a significant impact, and that the impact is independent. Rules 2 and 3 explain the children's impact, while Rule 4 explains the impact of spouses and other family members (elderly) on the expatriates. However, due to insufficient samples meeting the requirement of Rule 4, compared to rules 2 and 3, the child factor shows a higher impact than those of other family members.

Second, in line with rules 2, 3, and 4, this study concludes that most of the married employees tend to reject expatriate assignments on the grounds of their spouse and children. However, there is an exception. Rule 9 suggests employees aged above 50 show increased expatriation willingness because their children are grown and independent and there is less family pressure. Consequently, the spouse and child factors were eliminated. Another possible reason for the increased expatriation willingness of this group might be because engineering consulting firms in Taiwan take a crucial view of expatriation designation, if employees do not accept the expatriation assignment designated, their career development is likely to be impacted negatively. Thus, some employees tend to compromise and accept an expatriation assignment because they are worried about losing their job after reaching 50 years old.

Third, Rule 7 suggests that employees with a higher resistance to loneliness are more willing to accept expatriation assignments. From this finding, it could be inferred that employees with a more cheerful and optimistic personality, who are sociable and rarely lonely, are more likely to accept expatriation assignments. Therefore, this study recommends companies administer personality tests to determine whether a candidate has the appropriate personality and is suitable for expatriate assignments. During the recruitment process, administering a personality test can replace the oral interview where interviewees are questioned on their expatriation willingness.

Forth, Rules 5 to 8 concerned unmarried employees and their

feeling of loneliness when overseas. Data in this study tend to show three levels of feelings of loneliness. If employees attach significant importance to feelings of loneliness ( $\geq 3$ ), they are more likely to refuse expatriation assignments. When the employees are unmarried and are less concerned with feelings of loneliness ( $\leq 2$ ), they are more willing to accept expatriation assignments. These two findings of Rule 5 have an accuracy rate of 80 % and can be used to explain approximately 94 % of the samples. These findings indicate that feelings of loneliness have a critical influence on employees' expatriation willingness due to characteristics of the engineering consulting industry. Loneliness resistance, as a deciding indicator, is significantly important for expatriation assignments.

Fifth, based on rules 2 to 9, marital status clearly plays a decisive role in influencing employees' expatriate willingness. Statistical analysis shows 84 % of married employees, a classification of marital status, indicate their reluctance in accepting expatriation assignments. In other words, an employee's marital status is an indicator for their decision on whether to accept or reject an expatriation assignment. However, the child-rearing factor is a primary influence.

## VII. CONCLUSION.

Through the rough set approach, this study explored the importance of factors influencing employees' expatriate willingness, and classified them into three categories: core, medium, and insignificant. Each category is comprised of 6 to 9 factors that influence employees' expatriation overseas willingness. Therefore, the contribution of this study is the identification and establishing of the influences on expatriate willingness of employees of engineering consulting firms. The core impact category provides a significant insight into how employers should allocate labor overseas. For employees, personal safety, health, sentiments, beliefs, and future career are the top priorities. In contrast, employees are relatively less concerned about the economic status of the destination country. Subsidies and the duration of expatriation also have less influence on expatriation willingness. The findings from nine rules are valuable for employers in making decisions of international expatriation.

Although the study surveyed top engineering consulting firms, the suggestions could lie in the following limitations. Corporate culture among the world may dramatically influence employees' willingness. A guideline for how to explore employees' expatriation willingness is provided; yet, rule should be different from business to business. Country culture also drives the results different even using the same methodology. Advanced algorithms may yield other beneficial findings. The attempt for utilizing latest methods is always suggested.

## VIII. REFERENCES

1. Adler, N. J., "Do MBA's want international careers?" *International Journal of Intercultural Relations*, Vol. 10, pp. 277-300 (1986).
2. Adler, N.J., *International Dimensions of Organizational Behaviour*, PWS-Kent, Boston (1991).
3. Aryee, S., Chay, W. Y. and Chew, J., "An investigation of the willingness of managerial employees to accept an expatriate assignment," *Journal of*

- Organizational Behavior*, Vol. 17, No. 3, pp. 267-283 (1996).
4. Ashamalla, M.H., "International human resource management practices: The challenge of expatriation," *Competitiveness Review*, Vol. 8, pp. 54-65 (1998).
  5. Bae, J.K. and Kim, J., "Product development with data mining techniques: A case on design of digital camera," *Expert Systems with Applications*, Vol. 38, No. 8, pp. 9274-9280 (2011).
  6. Birant, D., "Comparison of decision tree algorithms for predicting potential air pollutant emissions with data mining models," *Journal of Environmental Informatics*, Vol. 17, No. 1, pp. 46-53 (2011).
  7. Black, J. S. and Gregersen, H.B., "Antecedents to cross-cultural adjustment for expatriate in Pacific rim assignments," *Human Relations*, Vol. 44, No. 5, pp. 497-515 (1991).
  8. Black, J. S. and Mendenhall M. E., "Cross-cultural training effectiveness: a review and theoretical framework for future research," *Academy of Management Review*, Vol. 15, pp. 113-136 (1990).
  9. Borstoff, P. C., Harris, S. G., Field, H. S. and Giles, W. F., "Who'll Go? A Review of Factors Associated with Employee Willingness to Work Oversea," *Human Resource Planning*, Vol. 20, pp. 29-41 (1997).
  10. Brett, J. M. and Reilly, A. H., "On the road: Predicting the job transfer decision," *Journal of Applied Psychology*, Vol. 73, pp. 614-620 (1988).
  11. Brett, J. M. and Stroh, L. K., "Willing to relocate internationally," *Human Resource Management*, Vol. 34, No. 3, pp. 405-424 (1995).
  12. Brett, J. M., Stroh, L. K. and Reily, A. H., "Pulling up roots in the 1990s: Who's willing to relocate?" *Journal of Organizational Behavior*, Vol. 14, No. 1, pp. 49-60 (1993).
  13. Bunke, H., Dickinson, P., Irniger, C. and Kraetzl, M., "Recovery of missing information in graph sequences by means of reference pattern matching and decision tree learning," *Pattern Recognition*, Vol. 39, No. 4, pp. 573-586 (2006).
  14. Chandra, B. and Varghese, P.P., "Moving towards efficient decision tree construction," *Information Sciences*, Vol. 179, No. 8, pp. 1059-1069 (2009).
  15. Chang, J.R., Hung, C.T., Tzeng, G.H. and Kang, S.C., "Using rough set theory to induce pavement maintenance and rehabilitation strategy," *Rough Sets and Knowledge Technology*, Springer-Verlag, Berlin, pp.542-549 (2007).
  16. Chang, C.L. and Chen, C.H., "Applying decision tree and neural network to increase quality of dermatologic diagnosis," *Expert Systems with Applications*, Vol. 36, No. 2, pp. 4035-4041(2009).
  17. Chang, P.C., Fan, C.Y. and Lin, J.L., "Trend discovery in financial time series data using a case based fuzzy decision tree," *Expert Systems with Applications*, Vol. 38, No. 5, pp. 6070-6080 (2011).
  18. Chen, G., Kirkman, B.L., Kim, K., Farh, C.I.C. and Tangirala, R., "When Does Cross-Cultural Motivation Enhance Expatriate Effectiveness? A Multilevel Investigation of the Moderating Roles of Subsidiary Support and Cultural Distance," *Academy of Management Journal*, Vol. 53, No. 5, pp. 1110-1130 (2010).
  19. Chen, J.H. and Hsu, S.C., "Quantifying Impact Factors of Corporate Financing: Engineering Consulting Firms," *Journal of Construction Engineering and Management*, Vol. 24, No. 2, pp. 96-104 (2008).
  20. Chen, M.Y., "Predicting corporate financial distress based on integration of decision tree classification and logistic regression," *Expert Systems with Applications*, Vol. 38, No. 9, pp. 11261-11272 (2011).
  21. Chen, R.Y., "A problem-solving approach to product design using decision tree induction based on intuitionistic fuzzy," *European Journal of Operational Research*, Vol. 196, No. 1, pp. 266-272 (2009).
  22. Chen, R.Y., Zhang, Z.W., Wu, D., Zhang, P., Zhang, X.Y., Wang, Y. and Shi, Y., "Prediction of protein interaction hot spots using rough set-based multiple criteria linear programming," *Journal of Theoretical Biology*, Vol. 269, No. 1, pp. 174-180 (2011).
  23. Chen, Y.L., Hsu, C.L. and Chou, S.C., "Constructing a multi-valued and multi-labeled decision tree," *Expert Systems with Applications*, Vol. 25, No. 2, pp. 199-209 (2003).
  24. Chien, C.F., Wang, I. and Chen, L.F., "Using data mining to improve the quality of human resource management of operators in semiconductor manufacturers," *Journal of Quality*, Vol. 12, No. 1, pp. 9-28 (2005).
  25. Choi, M. and Lee, G., "Decision tree for selecting retaining wall systems based on logistic regression analysis," *Automation in Construction*, Vol. 19, No. 7, pp. 917-928 (2010).
  26. Darnell, S.J., Page, D. and Mitchell, J.C., "An automated decision-tree approach to predicting protein interaction hot spots," *Proteins-Structure Function and Bioinformatics*, Vol. 68, No. 4, pp. 813-823 (2007).
  27. Dowling, P.J., Welch, D.E. and Schuler, R. S. *International Human Resource Management, 3rd Ed*, South-Western Collage Publishing, Cincinnati, OH (1999).
  28. Fan, Y.Q., "Expatriate management in China: a survey of Singaporean companies," *Management Development Journal of Singapore*, Vol. 9, pp. 1-8 (2000).
  29. Feldman, D.C. and Thomas, D.C., "Career management issues facing expatriates," *Journal of International Business Studies*, Vol. 23, No. 2, pp. 271-293 (1992).
  30. Geng, Z. and Zhu, Q., "Rough set-based heuristic hybrid recognizer and its application in fault diagnosis," *Expert Systems with Applications*, Vol. 36, No. 2, pp. 2711-2718 (2009).
  31. Hair, J.F., Jr., Anderson, R.E., Tatham, R.L. and Black, W.C. *Multivariate data analysis*, Prentice-Hall, Upper Saddle River, New Jersey (1998).
  32. Haines, V.Y. III and Saba, T., "Understanding reactions to international mobility policies and practices," *Human Resource Planning*, Vol. 22, No. 3, pp. 40-52 (1999).
  33. Harvey, M.G., "Repatriation of corporate executives: an empirical study," *Journal of International Business Studies*, Vol. 20, No. 1, pp. 131-144 (1989).
  34. Harvey, M.G. and Buckley, R. M., "The process for developing an international program for dual-career couples," *Human Resource Management Review*, Vol. 8, No. 1, pp. 457-474(1998).
  35. Huang, S.J., Lin, C.Y. and Chiu, N.H., "Fuzzy decision tree approach for embedding risk assessment information into software cost estimation model," *Journal of Information Science and Engineering*, Vol. 22, No. 2, pp. 297-313 (2006).
  36. Kim, Y.M., Kim C.K. and Lee, J.C., "Rough set algorithm for crack category determination of reinforced concrete structures," *Advances in Engineering Software*, Vol. 40, No. 3, pp. 202-211 (2009).
  37. Konopaske, R., Robie, C. and Ivancevich, J.M., "A preliminary model of spouse influence on managerial global assignment willingness," *International Human Resource of Management*, Vol. 16, No. 3, pp. 405-426 (2005).
  38. Kumar, P.R. and Ravi, V., "Bankruptcy prediction in banks and firms via statistical and intelligent techniques-A review," *European Journal of Operational Research*, Vol. 180, pp. 1-28 (2007).
  39. Landau, J. C., Shamir, B., and Arthur, M. B., "Predictors of willingness to relocate for managerial and professional employees," *Journal of Organizational Behavior*, Vol. 13, No. 7, pp. 667-680 (1992).
  40. Li, X.B., "A scalable decision tree system and its application in pattern recognition and intrusion detection," *Decision Support Systems*, Vol. 41, No. 1, pp. 112-130 (2005).
  41. Mendenhall, M.E., Dunbar, E. and Oddou, G.R., "Expatriate Selection, Training and Career-pathing: A Review and Critique," *Human Resource Management*, Vol. 26, pp. 331-345 (1987).
  42. Minuchin, S., *Families and Family Therapy*. Cambridge, MA: Harvard University Press (1974).
  43. Noe, R.A., Steffy, B. D. and Barber, A. E., "An investigation of the factors influencing employees' willingness to accept mobility opportunities," *Personnel Psychology*, Vol. 41, No. 3, pp. 559-580 (1988).
  44. Okpara, J.O. and Kabongo, J.D., "Cross-cultural training and expatriate adjustment: A study of western expatriates in Nigeria," *Journal of world business*, Vol. 46, No. 1, pp. 22-30 (2011).
  45. Pawlak, Z., "Rough sets," *International Journal of Computer and Information Science*, Vol. 11, No. 5, pp. 341-356 (1982).
  46. Quinlan, J.R. *C45: Programs for machine learning*, Morgan Kaufman, California (1993).
  47. Richardson, J., "Self-directed expatriation: family matters," *Personnel Review*, Vol. 35, No. 4, pp. 469-486 (2006).
  48. Ronen, S., *Training the International Assignees*. In I. L. Goldstein & Associates (Eds.), *Training and Development in Organizations*. San Francisco: Jossey-bass (1989).
  49. Semler, J., "Expatriate selection: back to basics?" *Journal of Human Resource Management*, Vol. 12, pp. 1219-1233 (2001).
  50. Shamir, B., Landau, J. and Arthur, M. B., "Factors related to managers' and professionals' willingness to relocate," *Academy of Management Proceedings*, Vol. 37, pp. 48-52 (1990).
  51. Shyng, J.Y., Shieh, H.M., Tzeng, G.S. and Hsieh, S.H., "Using FSBT technique with rough set theory for personal investment portfolio analysis," *European Journal of Operational Research*, Vol. 201, No. 2, pp. 601-607 (2010).
  52. Stroh, L. K. Dennis, L. E. and Cramer, T. C., "Predictors of expatriate

- adjustment," *International Journal of Organizational Analysis*, Vol.2, pp. 177-194 (1994).
53. Stroh, L. K., Varma, A. and Valy-Durbin, S. T., "Why Are Woman Left at Home: Are They Unwilling to Go on International Assignment?" *Journal of World Business*, Vol. 35, pp. 241-255 (2000).
  54. Takeuchi, R., Tesluk, P. E., Yun, S. and Lepak, D. P., "An integrative view of international experience," *Academy of Management Journal*, Vol. 48, No. 1, pp. 85-100 (2005).
  55. Tharenou, P., "Women's Self-Initiated Expatriation as a Career Option and Its Ethical Issues," *Journal of business ethics*, Vol. 95, No. 1, pp. 73-88 (2010).
  56. Tooke, T.R., Coops, N.C., Goodwin, N.R. and Voogt, J. A., "Extracting urban vegetation characteristics using spectral mixture analysis and decision tree classifications," *Remote Sensing of Environment*, Vol. 113, No. 2, pp. 398-407 (2009).
  57. Tung, R.L., "Selection and training of personnel for oversea assignments," *Columbia Journal of World Business*, Vol. 1, pp. 68-78 (1981).
  58. Tung, R. L. and Miller, E. L., "Managing in the twenty-first century: the need for global orientation," *Management International Review*, Vol. 30, pp. 5-18 (1990).
  59. Wan, D., Hui, T. K., and Tiang, L., "Factors affecting Singaporeans' acceptance of international postings," *Personnel Review*, Vol. 32, No. 6, pp. 711-732 (2002).
  60. Wang, X., Yang, J., Jensen, R. and Liu, X., "Rough set feature selection and rule induction for prediction of malignancy degree in brain glioma," *Computer Methods and Programs in Biomedicine*, Vol. 83, No. 2, pp. 147-156 (2006).
  61. Wilding, M., "Expatriation, location and creativity," *Westerly*, Vol. 54, No. 1, pp. 7-11 (2009).
  62. Witten, I. H. and Frank, E., *Data mining: Practical machine learning tools and techniques*, Morgan Kaufmann, California (2005).
  63. Yan, A., Zhu, G. and Hall, D. T., "International assignments for career building: a model of agency relationships and psychological contracts," *Academy of Management Review*, Vol. 27, pp. 373-391 (2002).
  64. Yang, B.S., Lim, D.S. and Tan, C.C., "VIBEX: An expert system for vibration fault diagnosis of rotating machinery using decision tree and decision table," *Expert Systems With Applications*, Vol. 28, No. 4, pp. 735-742 (2005).
  65. Yang, H. and Wu, C., "Rough sets to help medical diagnosis – evidence from a Taiwan's clinic," *Expert Systems with Applications*, Vol. 36, No. 5, pp. 9293-9298 (2009).
  66. Zhai, L., Khoo, L. and Zhong, Z., "A rough set based QFD approach to the management of imprecise design information in product development," *Advanced Engineering Informatics*, Vol. 23, No. 2, pp. 222-228 (2009).
  67. Zhang, Z. and Xu, Z., "Rough set method to identify key factors affecting precipitation in Lhasa," *Stochastic Environmental Research and Risk Assessment*, Vol. 23, No. 8, pp. 1181-1186 (2009).