

Structural Analysis on Team Internal Soft Factors to Project Success

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Abstract—Project has witnessed a high rate of failure. The project management is concerned with disciplines that better manage the project inherent strengths and weaknesses. In contrast to the hard factors, soft factors are very often ignored during project management. Such factors, involved with the internal services within the team, are concerned with working with people, ensuring customer satisfaction and creating a conducive environment for the project team to deliver high quality products which meeting stakeholder expectations. This research aims to investigate the intertwined effects of project team internal soft factors. Combining the exploratory factor analysis and fuzzy decision making trial and evaluation laboratory (DEMATEL) technique, an empirical case is demonstrated to show the effectiveness of the proposed method. The exploratory factor analysis is applied for extracting the dimension and criteria structure. The fuzzy DEMATEL technique is then used to analyze the intertwined effect. The proposed method has proven to be an effective one for analyzing the complex interrelation of human psychological concerns.

Keywords—*exploratory factor analysis, decision making trial and evaluation laboratory (DEMATEL), fuzzy logic, project management, internal service.*

I. INTRODUCTION

Project management is important in order to control projects throughout the entire project life cycle and to eventually lead to project success and better project performance. It can also have “strategic value when a clear connection is made between how efficiently and effectively a project is done and how the project’s products and services provide business value” [23] (p.19). In order to properly manage a project, it is necessary to understand the controllable factors and its intertwined effects that impact the project team’s performance.

There has been a significant amount of research done on project success factors within the Western cultural settings (e.g. [1],[6],[37],[38]). However, most of these researches focused on the team hard factors and rarely discuss how soft factors internally in the project team may influence the overall project success. Hard factors relate to technical abilities in implementing the project, while soft factors relate to teamwork and interpersonal skills. Soft factors are often neglected in previous studies; however, it plays significant in project success.

As culture impacts the values and norms [15][20], the culture setting must be taken into consideration when investigating impact factors in non-Western settings. No research has been found that investigate the impact of soft factors have within a Chinese cultural setting on project performance. In addition, the research of soft skills on project management has rarely seen in the literatures. Understand the intertwined effects of soft factors on project success is critical to managers who conduct projects. These criteria that affecting that project success are numerous and influence one another.

The purpose of this paper is to first indentify the hierarchy structure of soft skills that influence on project success and then analyze the intertwined effects between the criteria. Exploratory factor analysis is applied to generate the independent factors/criteria. Then, the DEMATEL (Decision Making Trial and Evaluation Laboratory) technique [10][11] is adopted. In recent years, a number of scholars have proposed Multiple Criteria Decision-Making (MCDM) theories to strengthen the comprehensiveness and reasonableness of the decision-making process [28][46][50], and DEMATEL technique is commonly used to illustrate the interrelations among criteria.

The remainder of this paper is organized as follows. The research background and literature reviews on factors that impact project performance are presented in Section 2. In Section 3, a brief introduction of exploratory factor analysis and the fuzzy DEMATEL technique is given. An empirical study in the case of soft factors on project success is presented in Section 4, while a hierarchy structure with dimension and criteria is proposed and its intertwined effects is analyzed by fuzzy DEMATEL. In Section 5, the analysis result is discussed and the implication is drawn. Finally, the concluding remarks are presented in Section 6.

II. FACTORS IMPACT PROJECT PERFORMANCE

Project performance metrics can be viewed as the key attributes and objectives which must be met or reached to consider a project successful [27]. Most researchers agree that time, cost, and quality should be used as performance metrics and the key determinants of project success [1][6][7][27][37][47]. However, many agree that success criteria should not be limited to the iron triangle of time, cost, and quality [1][27][29][47].

A team's project performance is influenced by factors both external and internal to the team, while culture and soft factors are highly impacted.

A. Cultural Context

Culture, both national and corporate [16], can be defined as "the collective programming of the mind which distinguishes the members of one group or society from those of another" (p. 82). Within each nation, there can be dominant groups and non-dominant groups. All the groups will have their own and sometimes similar group-ideologies, beliefs, and values, but the national culture will resemble the largest or more influential dominant group's. Therefore, it is vital to understand the dominant group's underlying views if one is to gain a general understanding of the views of the people within that culture [44]. As previous studies have taken place in Western cultural settings, their findings are not adequate when applying in the Chinese cultural context, which is highly influenced by the teachings of Confucius. "Confucian social theory is concerned with the question of how to establish a harmonious secular order in the man-centered world" [25](p.65). The term *guanxi* (role-relationship) is deeply embedded in Confucian social theory and uses the term *architect* to refer to Confucian individuals who build their *guanxi* throughout their life, creating their own social networks outside their family structure [19][25].

In Taiwan, Hofstede's [15] study has found that in supporting the Confucianism regarding unequal relationships, it was found to rank on the higher end of power distance, meaning hierarchal structures are common. For the Confucianism regarding the importance of upholding 'he', or harmony, Hofstede [15] showed that the Taiwanese culture leans toward collectivism rather than individualism, meaning that individuals are focused on the group's interest rather than their individual self. This is further supported by the findings of Gao [12], who conducted a study on understanding Chinese speaking practices, and found that in the Chinese culture the self involves and is made up of multiple relationships. For Hofstede's [15] last two dimensions (*i.e.* uncertainty avoidance and masculinity), Taiwanese would prefer to avoid uncertainty and show characteristics of both masculinity and femininity as the masculinity score is modest. Further studies have confirmed that both the Confucian values and cultural dimensions are reflected in the work values that Taiwanese employees hold [16][17].

B. Soft Factors

A team's project performance will depend heavily on how well the team works together. The factors that impact these dynamics are the relationships between the team members, and the perceived quality of the 'internal services' between the team members as work flows between them. The scope of the internal-team factors for this study is limited to interactions and relationships between project group members.

In terms of work-flow, McGrath's [32] paper on the theory of group's assumes groups to be "complex, intact social systems...that engage in purposeful activity at three partially nested levels: projects, tasks, and steps" (p. 151). It is thus clear that work may flow from one team member to the next at the

level of steps and tasks. This work-flow is an internal service between the team members, and the interaction related to the work being passed on to the next step is the service encounter. The service encounter can be viewed as the "dyadic interaction between an internal customer and an internal service provider" [13](p.35).

The perceived quality of the service encounter is evaluated by an internal customer after the service encounter takes place, whereby an internal customer evaluates the individual internal service quality attributes to gain an overall perception of the quality of the service encounter [13]. Improving and managing this perceived quality is important for organizations since researchers have found linkages between high levels of internal service quality (ISQ) and higher productivity, improved relationships between departments and groups, lower employee turnover, increased external customer satisfaction, and increased profits [13][35] [36][39][41].

While previous studies have mostly applied western internal service quality attributes to the Taiwanese setting (e.g. [8][9][28][30]), as an organization's culture – which is based largely on national culture – has a direct impact on the internal service providers and internal customers' values, norms, behavior, or even way of thinking [4][20][42], using Western attributes in an Eastern cultural setting could produce inadequate results as cultural differences create unique work places with different views, values, practices, etc. [16]. To overcome this limitation, Stanworth et al. [43] developed the internal service quality attribute that is Taiwanese context based, which 29 service quality attributes were derived.

As stated, Confucianism is shown to have an undisputable impact on the national and organizational culture of Taiwan, where it is important to maintain harmony within relationships [16]. Furthermore, studies related to group project performance within the Chinese context have shown that focusing on creating friendly relationships within organizations and groups can positively impact project performance by increasing their odds of success [22][24], while Bromiley and Cummings [2] found that a harmonious relationship based on trust can lead to lower costs and shorter durations when conducting business. Thus, as relationships play a major role within Taiwan due to the Confucian influence. Furthermore, Katz [24] found that high levels of internal communication between all project members will lead to higher project performance.

Based on the above literature reviews, this research adopts Stanworth et al.'s [43] internal service quality structure and slightly modified as follows: two items are removed when changing the negative attributes to a positive (Incomplete Professional Knowledge and Quarrel), as they are in fact a polar opposites of positives already present (Detailed Professional Knowledge and Consensus), and one item is expanded into two separate items (Work Loading to Work Loading and Accessible) to better capture the complexity of the attribute. This leaves a total of 26 attributes. In addition, Pinto and Prescott's [37] two trouble-shooting attributes (trouble-shooting and handle deviations), and Jin and Ling's [22] seven relationship attributes were added to our list. Thus, the final scale to be investigated in this study is made up of 35 team internal soft factors includes friendly (*chin-chieh*), polite (*ke-*

chi), patience, positive/proactive (jiji), responsible, trouble-shooting, handle deviations, please supervisor, competent, effective, detailed and professional knowledge, consensus, shows empathy, shared objective, considerate, reliable, internal efficiency, external efficiency, harmony, personnel connection, emotionally stable, internal communication, litigation, risk exposure, change orders and claims, mutual understanding, client satisfaction, learning culture, help each other, cooperation, coordination, work loading, accessible, bureaucracy, exchange thoughts.

III. BUILDING A STRUCTURAL MODEL

In reality, it is difficult to quantify a precise value in human psychological feeling. However, the complex phenomenon can be divided into many criteria to more easily judge differences or measure scores of the divided criteria. The exploratory factor analysis method is commonly used to gather criteria into groups. These criteria may have interdependent relationships; therefore, the DEMATEL technique is used to construct the interrelations between criteria.

A. Finding Independent Factors for Building a Hierarchical System

Based on the suitable measuring method, the criteria can be categorized into distinct aspects. When the evaluated criteria are too large to determine the dependent or independent relation with others, using factor analysis can verify independent factors.

Exploratory factor analysis is a dimension reduction method of multivariate statistics, which explores the latent variables from manifest variables. It is used to uncover the underlying structure of a relatively large set of variables. The main procedure of exploratory factor analysis can be described in the following steps:

Step 1: Find the correlation matrix (R) or variance-covariance matrix for the objects to be assessed.

Step 2: Find the eigenvalues ($\lambda_k, k=1, 2, \dots, m$) and eigenvectors ($\beta_k = [\beta_{1k}, \dots, \beta_{ik}, \dots, \beta_{pk}]$) for assessing the factor loading ($a_{ik} = \sqrt{\lambda_k} \beta_{ik}$) and the number of factors (m).

Step 3: Consider the eigenvalue ordering ($\lambda_1 > \dots > \lambda_k > \dots > \lambda_m; \lambda_m > 1$) to decide the number of common factors, and pick the number of common factors to be extracted by a predetermined criterion.

Step 4: To facilitate the interpretation of factors, choose a rotation methods. In this study, the promax rotation method is applied which allows the factors to be correlated.

Step 5: Name the factor referring to the combination of manifest variables.

When a large set of variables are factored, the method first extracts the combinations of variables, explaining the greatest amount of variance, and then proceeds to combinations that account for progressively smaller amounts of variance. Two kinds of criteria are used for selecting the number of factors: latent root criterion and percentage of variance criterion. The

former criterion is that any individual factor should account for the variance ($\text{Var}(Y_k) = \lambda_k$) of at least a single variable if it is to be retained for interpretation. In this criterion only the factors having eigenvalues greater than 1 (i.e. $\lambda_k \geq 1, k=1, 2, \dots, m$) are considered significant. The latter criterion is based on achieving a specified cumulative percentage of total variance extracted by successive factors. Its purpose is to ensure the extracted factors can explain at least a specified amount of variance. Practically, to be satisfactory the total amount of variance explained by factors should be at least 95% in the natural sciences, and 60% in the social sciences. However, no absolute threshold has been adopted for all applications [14].

B. Fuzzy DEMATEL Technique for Building Structural Model

DEMATEL [10][11] is a comprehensive method for building and analyzing a structural model involved of causal relationships between complex factors. It was developed in the belief that the proper use of scientific research methods could facilitate comprehension of the specific problematique, the cluster of intertwined problems, and contribute to recognition of practical solutions by a hierarchical structure. The methodology, according to the characteristics of objective affairs, can verify the interdependence among the variables/attributes/criteria and confine the relation that reflects the characteristics with an essential system and evolution trend [5][18]. The method is a practical and useful tool, especially for visualizing the structure of complex causal relationships with matrices or digraphs. The matrices or digraphs show a contextual relation between the elements of the system, in which a numeral represents the strength of influence of each element. Thus, the DEMATEL technique is able to convert the relationship between the causes and effects of criteria into an intelligible structural model of systems [48].

Fuzzy set theory can be efficiently dealt with the vagueness of human thought and expression in making decisions. To tackle the ambiguities involved in the process of decision-making, the linguistic terms can be more effective in estimation.

A fuzzy set $\tilde{A}$ is a subset of a universe of discourse X , which is a set of ordered pairs and is characterized by a membership function $\mu_{\tilde{A}}(x)$ representing a mapping $\mu_{\tilde{A}}(x): X \rightarrow [0,1]$. The function value of $\mu_{\tilde{A}}(x)$ for the fuzzy set $\tilde{A}$ is called the membership value of x in $\tilde{A}$, which represents the degree of truth that x is an element of the fuzzy set $\tilde{A}$. It is assumed that $\mu_{\tilde{A}}(x): X \in [0,1]$, where $\mu_{\tilde{A}}(x)=1$ reveals that x completely belongs to $\tilde{A}$, while $\mu_{\tilde{A}}(x)=0$ indicates that x does not belong to the fuzzy set $\tilde{A}$.

$$\tilde{A} = \{ \langle x, \mu_{\tilde{A}}(x) \rangle \} \quad x \in X \quad (1)$$

where $\mu_{\tilde{A}}(x)$ is the membership function and $X = \{x\}$ represents a collection of elements x .

A triangular fuzzy number $\tilde{N}$ can be defined as a triplet (l, m, u) , and the membership function $\mu_{\tilde{N}}(x)$ is defined as:

$$\mu_{\tilde{N}}(x) = \begin{cases} 0, & x < l \\ (x-l)/(m-l), & l \leq x \leq m \\ (r-x)/(u-m), & m \leq x \leq u \\ 0, & x > u \end{cases} \quad (2)$$

where l, m , and r are real numbers and $l < m < u$.

To deal with the problems of group decision-making in a fuzzy environment, an effective fuzzy aggregation method is required. The human judgments with fuzzy linguistic variables are fuzzy numbers, which a defuzzification method is required to transform the crisp elements into scores. Proposed by Opricovic & Tzeng [33], the CFCS (Converting Fuzzy data into Crisp Scores) defuzzification method is based on the procedure of determining the low and up scores by fuzzy min and fuzzy max, and the total score is determined as a weighted average according to the membership functions. This would provide a more appropriate crisp value comparing with other methods.

Let $\tilde{z}_{ij}^k = (l_{ij}^k, m_{ij}^k, u_{ij}^k)$ indicates the fuzzy assessment of evaluator k ($k=1,2,\dots,p$) about the degree to which the criterion i affects the criterion j , the CFCS algorithm can be described in following five steps:

(1) Normalization:

$$xl_{ij}^k = (l_{ij}^k - \min l_{ij}^k) / \Delta_{\min}^{\max} \quad (3)$$

$$xm_{ij}^k = (m_{ij}^k - \min l_{ij}^k) / \Delta_{\min}^{\max} \quad (4)$$

$$xr_{ij}^k = (r_{ij}^k - \min l_{ij}^k) / \Delta_{\min}^{\max} \quad (5)$$

where $\Delta_{\min}^{\max} = \max r_{ij}^k - \min l_{ij}^k$.

(2) Compute left (ls) and right (rs) normalized value:

$$xls_{ij}^k = xm_{ij}^k / (1 + xm_{ij}^k - xl_{ij}^k) \quad (6)$$

$$xrs_{ij}^k = xr_{ij}^k / (1 + xr_{ij}^k - xm_{ij}^k) \quad (7)$$

(3) Compute total normalized crisp value:

$$x_{ij}^k = [xls_{ij}^k (1 - xls_{ij}^k) + xrs_{ij}^k xrs_{ij}^k] / [1 - xls_{ij}^k + xrs_{ij}^k] \quad (8)$$

(4) Compute crisp values:

$$z_{ij}^k = \min l_{ij}^k + x_{ij}^k \Delta_{\min}^{\max} \quad (9)$$

To further the practicality of the conventional DEMATEL technique for group decision-making in a fuzzy environment, the process is illustrated as follows:

Step 1: Design the fuzzy linguistic scale. To deal with the ambiguities of human assessments, the linguistic variable “influence” is used with five linguistic terms as {No, Very

low, Low, High, Very high} that are expressed in positive triangular fuzzy numbers (l_{ij}, m_{ij}, u_{ij}) .

Step 2: Calculate the fuzzy direct-influence matrix by scores (depending on the views of the experts by linguistic scales of natural language) and evaluate the relationship among elements based on Table 2, we can obtain the fuzzy direct-influence matrix $\tilde{D}$ by Eq. (15).

$$\tilde{D} = [\tilde{d}_{ij}]_{n \times n}, \text{ where } \tilde{d}_{ij} = (d_{ij}^l, d_{ij}^m, d_{ij}^u) \quad (10)$$

Step 3: Normalize the fuzzy direct-influence matrix: Based on the fuzzy direct-influence matrix $\tilde{D}$, the normalized fuzzy direct-relation matrix $\tilde{N}$ is acquired by using Eq. (16).

$$\tilde{N} = \tilde{D} / u \quad (11)$$

where

$$u = \max_{i,j} \left\{ \max_i \sum_{j=1}^n d_{ij}, \max_j \sum_{i=1}^n d_{ij} \right\}, i, j \in \{1, 2, \dots, n\},$$

$$\tilde{N} = [\tilde{e}_{ij}]_{n \times n}, \tilde{e}_{ij} = (e_{ij}^l, e_{ij}^m, e_{ij}^u).$$

Step 4: Attain the fuzzy total-influence matrix: once the normalized fuzzy direct-influence matrix $\tilde{N} = (N^l, N^m, N^u)$ obtained, where

$N^l = [e_{ij}^l]_{n \times n}$, $N^m = [e_{ij}^m]_{n \times n}$, and $N^u = [e_{ij}^u]_{n \times n}$; the fuzzy total-influence matrix $\tilde{T}$ is arrived at through Eq. (12), in which the I is denoted as the identity matrix.

$$\tilde{T} = [\tilde{t}_{ij}]_{n \times n}, \text{ where } \tilde{t}_{ij} = (t_{ij}^l, t_{ij}^m, t_{ij}^u) \quad (12)$$

where, $T^l = [t_{ij}^l]_{n \times n} = N^l (I - N^l)^{-1}$, $T^m = [t_{ij}^m]_{n \times n} = N^m (I - N^m)^{-1}$ and $T^u = [t_{ij}^u]_{n \times n} = N^u (I - N^u)^{-1}$ respectively; the elements of triangular fuzzy numbers in fuzzy total-influence matrix $\tilde{T}$ are divided into T^l , T^m and T^u , and $T^l = [t_{ij}^l]_{n \times n} < T^m = [t_{ij}^m]_{n \times n} < T^u = [t_{ij}^u]_{n \times n}$, when $e_{ij}^l < e_{ij}^m < e_{ij}^u$ for any $i, j \in \{1, 2, \dots, n\}$.

Step 5: Defuzzy into the crisp values. Using the CFCS method showing in Eqs. (3)-(9), the total fuzzy influence matrix $\tilde{T} = [\tilde{t}_{ij}]_{n \times n}$ are defuzzified as crisp values into the total-influence matrix $T = [t_{ij}]_{n \times n}$.

Step 6: Analyze the results: in the stage, the sum of rows (given influence) and the sum of columns (received influence) are separately expressed as influential vector $d = (d_1, \dots, d_i, \dots, d_n)'$ by factor j ($j = 1, 2, \dots, n$) and influential vector $r = (r_1, \dots, r_j, \dots, r_n)'$ by factor i ($i = 1, 2, \dots, n$) using Eqs. (13)-(15). Then, when $i, j \in \{1, 2, \dots, n\}$ and $i = j$ the horizontal axis vector $(d+r)$ is made by adding vector d to vector r , which exhibits total important influence of each criterion. Similarly,

the vertical axis vector ($d-r$) is made by deducting vector d from vector r , which may separate criteria into a cause group and an affected group. In general, when the value of d_i-r_i is higher, the criterion is belonging to the cause group. On the contrary, if the value of d_i-r_i is lower, the criterion is belonging to the affected group. Therefore, the causal-and-effect graph can be achieved by plotting the data set of $\{(d_i+r_i, d_i-r_i) \mid i = 1, 2, \dots, n\}$, providing valuable approaching for making decisions.

$$T = [t_{ij}]_{n \times n}, \quad i, j \in \{1, 2, \dots, n\}, \quad (13)$$

$$d = \left[\sum_{j=1}^n t_{ij} \right]_{n \times 1} = [t_i]_{n \times 1} = [d_i]_{n \times 1}, \quad (14)$$

$$r = \left[\sum_{i=1}^n t_{ij} \right]_{n \times 1}' = [t_j]_{n \times 1} = [r_j]_{n \times 1}, \quad (15)$$

where vector $d = (d_1, \dots, d_b, \dots, d_n)$ and vector $r = (r_1, \dots, r_j, \dots, r_n)$ express the sum of rows and the sum of columns based on total-influence matrix $T = [t_{ij}]_{n \times n}$, separately.

IV. EMPIRICAL STUDY: CASE OF PROJECT SUCCESS

The empirical experiment was focused on Taiwanese firms that consist of project group. The study includes two parts, the exploratory factor analysis and fuzzy DEMATEL analysis, as detail described below.

A. The Exploratory Factor Analysis to Obtain Independent Criteria Groups

The questionnaire was sent to several Taiwanese companies that have project groups consisting of Taiwanese working professionals, and was explained that through the study, they can receive a clearer understanding of which factors are perceived to lead to greater project performance, which ultimately leads to increasing the probability of project success. A total of 224 questionnaires were collected for this study, while 16 questionnaires were not fully completed, this makes 208 useable feedbacks.

For the soft factor items, a clear structure emerged on the third iteration using a kappa rotation of 7. The Kaiser-Meyer-Olkin (KMO) test and the Bartlett's test are both acceptable on each iteration, with the lowest KMO being 0.949 and highest Bartlett's being 0.000. The Cronbach's Alpha and Pearson's Correlation were also both acceptable on each iteration with the lowest alpha being 0.851 and the lowest correlation being 0.618. After iterations one and two, the original 35 item list was reduced to a final 26 items that categorized into eight dimensions. Eigenvalues are all greater than 1 and all items' item-to-total correlations are above the cutoff value 0.5. The exploratory factor analysis final iteration result is shown in Table I.

B. The Fuzzy DEMATEL Method to Find the Interrelation between Criteria

According to the factor analysis results, 50 project managers and senior team members were invited to score the influence level of criteria based on the fuzzy DEMATEL method.

TABLE I. DIMENSION AND CRITERIA EXTRACTED

Extracted Dimensions	Items / Criteria	Factor Loading	Eigenvalues (Rotated)	Item-to-Total Correlation
Synergy (D_1)	Work Loading (C_{11})	1.22	14.27	0.79
	Accessible (C_{12})	0.95		0.84
	Reliable (C_{13})	0.90		0.79
	Considerate (C_{14})	0.87		0.83
	Coordination (C_{15})	0.83		0.87
	Help each other (C_{16})	0.81		0.84
	Cooperation (C_{17})	0.74		0.86
	Consensus (C_{18})	0.68		0.83
	Shared objective (C_{19})	0.63		0.75
Competence (D_2)	Trouble-shooting (C_{21})	0.95	12.08	0.80
	Handle deviations (C_{22})	0.93		0.86
	Positive/proactive (jiji) (C_{23})	0.86		0.85
	Responsible (C_{24})	0.80		0.81
Attitude (D_3)	Polite (ke-chi) (C_{31})	1.08	9.93	0.77
	Friendly (chin-chieh) (C_{32})	0.86		0.79
	Patience (C_{33})	0.69		0.70
Relationship (D_4)	Learning culture (C_{41})	1.04	11.62	0.69
	Client satisfaction (C_{42})	0.81		0.79
	Bureaucracy (C_{43})	0.59		0.68
Consideration (D_5)	Shows empathy (C_{51})	0.85	10.43	0.75
	Competent (C_{52})	0.84		0.73
	Effective (C_{53})	0.53		0.69
Risk Exposure (D_6)	Risk exposure (C_{61})	0.86	4.92	N/A
	Change orders and claims (C_{62})	0.80		N/A
Litigation (D_7)	Litigation (C_{71})	0.91	3.71	N/A
Personnel Connection (D_8)	Personnel connection (C_{81})	0.84	2.49	N/A

TABLE II. THE DEFUZZIED TOTAL-INFLUENCE MATRIX $T (\times 10^{-4})$

	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{21}	C_{22}	C_{23}	C_{24}	C_{31}	C_{32}	C_{33}	C_{41}	C_{42}	C_{43}	C_{51}	C_{52}	C_{53}	C_{61}	C_{62}	C_{71}	C_{81}
C_{11}	367	875	360	755	800	930	856	671	459	635	790	314	464	608	605	802	488	838	539	647	468	880	702	587	628	530
C_{12}	344	211	324	453	467	680	495	623	444	242	258	211	215	201	225	198	686	885	53	205	188	282	92	73	89	863
C_{13}	517	346	80	182	256	250	235	206	208	230	285	247	673	377	421	343	273	882	45	248	517	290	65	57	69	723
C_{14}	259	754	204	187	383	818	696	635	344	209	318	163	165	300	445	330	312	817	39	691	178	263	75	48	55	846
C_{15}	582	370	181	352	265	801	693	728	700	685	729	290	247	341	280	618	400	982	58	370	556	737	78	78	97	570
C_{16}	608	766	304	716	374	275	811	404	320	290	282	256	229	258	392	266	485	602	56	273	213	347	109	79	96	845
C_{17}	275	264	129	182	276	677	183	717	734	222	209	114	212	159	146	125	588	564	44	107	155	650	76	64	185	626
C_{18}	198	163	101	177	240	224	258	120	620	173	208	59	103	98	71	76	478	609	37	86	103	588	51	45	42	228
C_{19}	163	326	130	117	282	340	358	500	134	197	247	71	165	71	66	80	282	671	35	60	99	626	39	42	37	193
C_{21}	469	170	125	142	530	290	244	193	181	128	339	147	167	142	132	644	206	714	53	145	652	397	76	264	106	237
C_{22}	228	207	104	240	554	228	278	255	360	478	133	207	140	224	181	310	240	708	32	130	606	312	54	60	196	256
C_{23}	534	224	125	150	192	313	257	202	179	127	179	63	355	152	148	125	497	661	51	105	496	448	102	67	186	450
C_{24}	398	145	110	111	138	158	147	133	123	93	108	191	45	93	91	76	253	383	38	73	139	135	54	47	72	200
C_{31}	302	691	151	224	662	324	267	272	241	147	249	144	125	109	446	225	549	837	39	137	127	227	64	54	54	800
C_{32}	300	757	221	242	287	319	310	273	262	164	193	159	174	321	108	195	347	815	35	258	173	258	59	49	47	838
C_{33}	260	302	141	145	354	183	162	153	142	103	397	87	120	124	115	73	363	579	38	130	140	306	46	40	45	553
C_{41}	192	193	94	104	262	368	415	395	451	134	198	61	83	81	76	70	125	516	195	63	90	348	278	289	212	206
C_{42}	464	184	79	118	441	278	433	239	554	194	223	122	114	147	163	149	481	232	44	118	174	276	63	56	60	579
C_{43}	645	69	28	57	120	79	138	138	81	113	119	26	43	45	43	64	178	84	64	47	43	84	404	714	734	49
C_{51}	246	582	148	715	251	706	369	289	237	144	197	155	140	296	336	216	414	633	34	112	138	237	63	48	50	761
C_{52}	418	128	66	86	153	257	225	136	157	447	411	113	138	74	74	103	340	648	38	74	93	402	55	54	58	204
C_{53}	198	131	199	96	187	125	178	184	163	117	302	259	113	66	64	119	356	542	27	70	247	96	47	36	44	139
C_{61}	443	62	31	55	76	64	79	68	56	88	78	25	37	39	35	53	182	63	435	44	38	63	128	680	698	38
C_{62}	702	105	48	114	385	157	351	338	305	458	458	49	71	71	67	160	287	188	129	87	108	184	701	137	688	102
C_{71}	95	12	6	12	30	16	28	27	23	44	34	5	8	8	8	15	31	18	182	10	11	17	698	624	95	10
C_{81}	380	735	322	368	803	529	484	701	443	347	434	234	216	544	469	214	480	891	45	306	233	371	73	64	68	315

Followed by the above mentioned steps, the initial fuzzy direct-influence matrix $\tilde{D}$ was produced. The normalized fuzzy direct-influence matrix $\tilde{N}$ is then retrieved based on Eq. (11). Subsequently, the fuzzy total-influence matrix $\tilde{T}$ was calculated. Next, the CFCS method listed on Eq. (3)-(9) was used to aggregate the fuzzy data. Table II shows the defuzzied total-influence matrix T . The degree of influence in dimension level and criteria level are presented in Table III and IV, respectively. Based on the above analysis, the dimension and criteria impact relation maps can be generated in Fig. 1 and Fig. 2, respectively.

V. DISCUSSION AND IMPLICATION

The proposed hybrid method has proven to be an effective model for evaluating the complex psychological intertwined effects. Based on our empirical experiments, factor analysis was used to classify each element/criteria into eight different independent factors/dimensions. Those criteria under the same dimension had some interrelations with each other. The direct/indirect influential relationship of criteria was figured using the fuzzy DEMATEL method.

A clear structure of the Team-Internal impact factors for project performance within the Taiwanese cultural context was created through exploratory factor analysis (see Table I). By combining Stanworth et al.'s [43] 26 attributes from ISQ, Pinto and Prescott's [37] two trouble-shooting attributes, Jin and Ling's [22] seven relationship attributes, thus the final scale investigated in this study was made up of 35 attributes. The exploratory factor analysis was then conducted and extracted a final structure of eight dimensions and 26 criteria: Synergy (9 criteria), Competence (4 criteria), Attitude (3 criteria), Relationship (3 criteria), Consideration (3 criteria), Risk Exposure (2 criteria), Litigation (1 criterion), and Personnel Connection (1 criterion).

According to the fuzzy DEMATEL analysis, the factors which show greater values of $(d_i - r_i)$ are intensely affecting others, the factors show lesser values of $(d_i - r_i)$ are intensely

TABLE III. THE INFLUENCE OF CONCERN FACTORS IN DIMENSION LEVEL

	d_i	r_i	d_i+r_i	d_i-r_i
D_1	0.2676	0.2185	0.4861	0.0492
D_2	0.1748	0.1462	0.3210	0.0287
D_3	0.2083	0.1409	0.3493	0.0674
D_4	0.1723	0.2468	0.4191	-0.0746
D_5	0.1576	0.1567	0.3143	0.0009
D_6	0.1895	0.1765	0.3660	0.0131
D_7	0.0917	0.1575	0.2492	-0.0659
D_8	0.2473	0.2660	0.5133	-0.0187

TABLE IV. THE INFLUENCE OF CONCERN FACTORS IN CRITERIA LEVEL

	d_i	r_i	d_i+r_i	d_i-r_i
C_{11}	1.6598	0.9587	2.6185	0.7011
C_{12}	0.9005	0.8771	1.7776	0.0234
C_{13}	0.8021	0.3812	1.1833	0.4210
C_{14}	0.9532	0.6098	1.5630	0.3434
C_{15}	1.1789	0.8766	2.0555	0.3024
C_{16}	0.9657	0.9388	1.9045	0.0269
C_{17}	0.7684	0.8949	1.6633	-0.1266
C_{18}	0.5156	0.8601	1.3757	-0.3446
C_{19}	0.5330	0.7920	1.3250	-0.2589
C_{21}	0.6893	0.6211	1.3105	0.0682
C_{22}	0.6722	0.7378	1.4100	-0.0656
C_{23}	0.6389	0.3773	1.0162	0.2616
C_{24}	0.3556	0.4563	0.8118	-0.1007
C_{31}	0.7468	0.4947	1.2415	0.2521
C_{32}	0.7163	0.5205	1.2368	0.1957
C_{33}	0.5101	0.5650	1.0751	-0.0548
C_{41}	0.5497	0.9320	1.4817	-0.3824
C_{42}	0.5986	1.5364	2.1350	-0.9378
C_{43}	0.4211	0.2386	0.6597	0.1824
C_{51}	0.7515	0.4594	1.2109	0.2921
C_{52}	0.4952	0.5986	1.0938	-0.1034
C_{53}	0.4106	0.8824	1.2930	-0.4718
C_{61}	0.3657	0.4253	0.7910	-0.0596
C_{62}	0.6449	0.4351	1.0801	0.2098
C_{71}	0.2067	0.4713	0.6781	-0.2646
C_{81}	1.0068	1.1162	2.1230	-0.1093

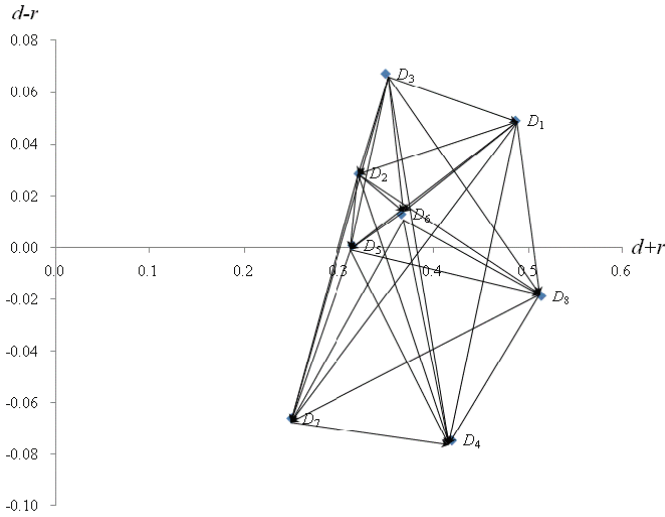


Figure 1. Dimensional impact relation map

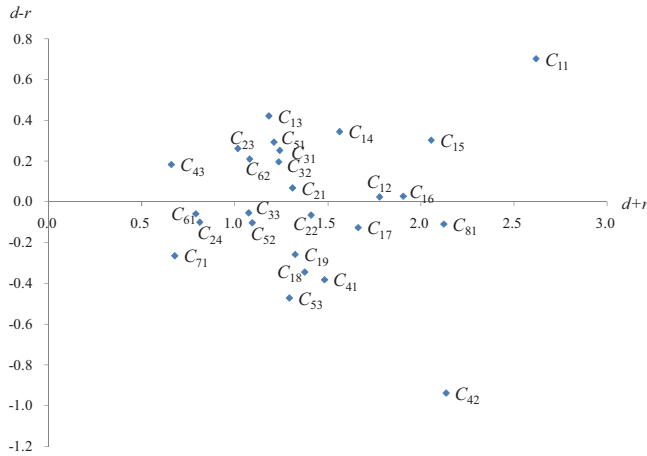


Figure 2. Criteria impact relation map

affected by the others. Figure 1 and 2 show a clear picture of intertwined effect in between dimensions and criteria.

Based on Figure 1, the attitude (D_3) plays a significant role that highly influences other soft factors towards the project success. On the other hand, the relationship (D_4) is impacted by all dimensions. The personal connection (D_8) presents a high relationship with other dimensions. From Figure 2 cross-dimensionally, the work loading (C_{11}) is a key factor that greatly impacts all other criteria, while ultimately meets the customer satisfaction (C_{42}). Bureaucracy (C_{43}) and litigation (C_{71}) show less relationship with other factors.

Project leadership requires more than just technical competence and encompasses the ability to manage a team. Stated by Kloppenborg and Petrick [26], skills in managing relationships are critical to achieve stakeholder satisfaction through all stages of the project. Creating the right relationships between team members is one of the biggest challenges that

face project managers [3][45][34]. Whitty [49] mentioned that "projects are simply a synthesis of human sensations and expectations about how multiple resources are to be used" (p.577). Ropponen and Lyytinen [40] stated that personnel management is one of the major risk components in software development project. Above evidences highlight the importance of understanding the interrelation of project team soft factors.

The result of this study gives a clear picture to the project manager on the intertwined effects of team internal soft factors. As work loading plays as a key influencer, when more resources such as people are needed than are available, the tasks need to be rescheduled concurrently or even sequentially to manage the constraint. The project manager should apply resource leveling to resolve the conflicts of schedule instead of overloading the work to a single resource. Attitude is the one that project team should emphasize in order to create a harmony working environment, which can further build the team synergy. From internal service point of view, Jeng [21] stated that rewards and recognition can be the best strategy to enhance the team internal service operation.

VI. CONCLUDING REMARKS

This research proposed a hybrid method combines the factor analysis and fuzzy DEMATEL technique to understand the factors intertwined effect in complex system. Supported by previous qualitative studies, exploratory factor analysis is applied to extract a clear factor structure consist of dimension and criteria. Then, the fuzzy DEMATEL technique is utilized to analyze the intertwined effect between the extracted dimension and criteria. Based on the impact relation map, project manager can gain a clear picture on the impact of soft factors on project performance. A project manager may set the strategies to better manage the working environment and team atmosphere. The result provides directions to enhance the team synergy, increase relationship, and ultimately achieving the project success. This study may also provides the information for a company to further adopt effective training agenda and employee assistance programs (EAPs) that improve the working atmosphere of the project team.

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