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Network analysis of contractors' assessment factors

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Abstract. The effect of assessment management and selecting the appropriate contractor is growing interest in research because of the change in preferences of contractors' behaviour and the growth of competitiveness. The assessment of contractors is a continuous process that demands ongoing monitoring to maintain high quality ranks. In this study, the factors behaviour of contractors' assessment for a construction engineering company and a method of topological analysis are examined to a) aid in the interpretation of existing relationships among all factors and b) find influencing factors of contractors' assessment. The method begins with the network construction of factors considering some criteria or standards. We then propose a method of network analysis and describe the results of studies undertaken to apply the correlation network-based approach and discuss the implications of the methodology. As a result of this study, all influencing factors are involved in a category. The most influential factor is the specialized training of staff that can improve the contractors' productivity and competitiveness.

Keywords: construction engineering company, contractors' assessment factors, topological network analysis.

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1. INTRODUCTION

The industries or companies' management are more challenging and complicated when their management involves multiple tasks with diverse priorities and purposes (Rao & Davim, 2008; Cheng et al.,

2009; Diani & Shiruiyezad, 2012; Shen et al., 2006; Zhou et al., 2022). One of the main parts of industry stakeholders is contractors who have an effective role in the complementation of projects in adequate time, cost and quality as the primary concerns of clients (Lee et al., 2014; Wang et al., 2017; Tian, Liu, 2023). The absence of a clear approach and strategy in contractors' assortment with adequate efficiency is a critical problem in project accomplishment in terms of time and foreseen resources. Besides, the verity of competitiveness definitions and indicators encountered client with challenging procedure during contractor assessment (Phua, 2004; Ning, 2018). This assessment procedure runs into more difficulties with clients' priorities and contractors' capabilities. It is necessary to classify the imperative qualitative and quantitative factors for contractors' assessment before decision-making.

Therefore, the assortment of contractors is a vital action in the privatization of public industries or companies that needs to be reconsidered. In this regard, precise assessment management is indispensable, which will lead to the company's success. In fact, a main part of assessment management refers to selecting the appropriate contractor with adequate capability to reach the project targets. Contractor selection is the procedure of choosing the most suitable contractor to deliver the project specifically to ensure the achievement of the best value for money. Because of the diversity and variety of contractors who are potentially qualified and capable to do the contract and project in a satisfactory way, contractors first should be assessed, levelled and chosen in order to guarantee the project implementation in the best way possible. Since there is an increasing importance and role of contractors in the design and implementation of varied projects, a number of processes are designed and then applied for contractor selection procedures by governments and large employer organizations that is one of the significant decisions to assist organizations (Doloi, 2013).

This study aims to classify and analyze contractors' assessment factors to find significant implications in organizational structure. The objectives of this research are the following:

- Identify and categorize the contractor assessment factors which lead to project goals achievement (Primary consideration)
- Construct a correlation network based on similarity measures among assessment factors (Computational Investigation)
- Analyze the topological properties of inter-connection and the performance of factors (Empirical Investigation)

In the literature, there are many different approaches that have been applied to evaluate factor preferences such as Analytical hierarchy process (AHP) (Saaty, 1980), genetics algorithm, data envelopment analysis (Charnes et al., 1984), and neural networks that consider handling different criteria for project assessment (Ebrahimi et al., 2016; Uzik & Runge, 2023; Danko et al., 2022). However, the perfect approach and technique is essential to assess the persuasive factors that influence toward organizational advantageousness and staff's well-being. Besides, there are some certainties about factors that making the other one happen, and the one that are more influential. In fact, not only finding influence factors will help to improve the quality but the causality and the behaviour of each factor and their role-play in the system is more important. To achieve these objectives, this research used the correlation network-based approach where the information in the network is filtered by using Minimum Spanning Tree (MST) that provides the readable and meaningful network topology and Sub-Dominant Ultra-metric (SDU) that gives the hierarchical tree.

The research progresses as follows. In next section, the preliminary consideration includes a literature review regarding to previous researches, network structure, and components of contractors' assessment. Section 3 seeks to describe the network construction and the procedure of network analysis of assessment factors. Finally, the result obtained from topological network analysis is presented and discussed in the fourth section. The conclusion of this study is highlighted in Section 5.

2. LITERATURE REVIEW

2.1. Previous researches

Selecting the actual contractor is one of the crucial steps in planning and decision making for appropriate implementation of a project. Contractors who generally provide services and equipment are considered as indispensable and valuable in the process of projects. Although there are some potentially qualified contractors in any project, selecting a truthful one is a problem. Construction design and management regulations (Blake, 2016) defined the contractor as direct employers who manage and engage construction workers to construction industry. They commonly should have particular knowledge, skills, and experiences which consequence to carry out the works with adequate health and safety knowledge regarding their work' scope. Therefore, it is considerable to comprise the specific criterion and methods for evaluating contractors. The quantitative criterions have the ability to solve through mathematical methods, but these methods are inapplicable for qualitative criterion (Zare Mehrjerdi et al., 2010).

First, Weber et al. in 1991 proposed quantitative methods for contractors' selections and classified into three categories consist of linear regression, mathematical programming and statistical models. After that, many researches have been carried out in selecting the efficient contractors. In Iran, Gharizadeh and Nasrolahi (2008) examined the preference and importance of indicators by AHP method on contractor selection and recognized effective indicators. Zare Mehrjerdi et al. (2010) examined criteria by using multi criteria decision making attributes through Borda and TOPSIS approaches. Naseri and Afsar (2011) identified 25 criteria via questionnaire and entropy method as contractor assessment criterion. They applied Delphi and the balanced scorecard method to evaluate criterion. Bakhshi et al. (2014) examined a Weighted Categories of a new classification criteria in selecting efficient contractors through fuzzy hierarchical analysis. Tavakoli and Kamrani (2011) examined the indexes of contractor selection in power plants in Iran. They prioritized contractors' selection criteria according to AHP method. Ebrahimi et al. (2016) identified effective factors and ranked contractors in assessment by using fuzzy multi-criteria approaches.

In this regard, most researchers used the fuzzy methods in evaluating contractors' assessment factors. Singh and Tiong (2005) presented a decision framework for the case of construction industry in Singapore to identify the importance of criteria of contractor selection. They assessed contractors' performance to help the decision makers (DMs) based on fuzzy set theory. Li et al. (2007) studied contractor prequalification issues and proposed a fuzzy framework based on fuzzy techniques such as fuzzy TOPSIS, fuzzy filtering and fuzzy number theory to rank contractors that helps DMs to judge qualification easily. Plebankiewics in 2009 presented a model based on fuzzy sets theory to a) evaluate criterion and b) take into consideration evaluation of DMs to be used by polish construction owners. Nieto-Morote and Ruz-Vila (2012) proposed a systematic contractor prequalification procedure according to fuzzy set theory due to uncertain or incomplete conditions of construction projects. Joker et al. (2020) identified the risk factors and proposed hybrid approach based on Fuzzy AHP and Fuzzy TOPSIS to prioritize the risk factors and select the contractor company.

Table 1 shows the highlighted previous research regarding to contractors' assessment that entitled prequalification. Prequalification permits the decision makers in company to qualify the actual contractor with the greatest competency and ability for the project.

Table 1

Highlighted previous research regarding to contractors' prequalification

No	Important previous research	Refs
1	Simple contractor pre-qualification models using linguistic variables	Plebankiewicz, 2010
2	Contractor assessment of criteria weights in group decision environment by using fuzzy AHP approach	Plebankiewicz, 2012
3	Pre-qualification of contractors using fuzzy AHP methods in the Egyptian construction market	Jaskowski et al., 2010
4	Pre-qualification of contractors using fuzzy AHP methods in the Egyptian construction market	Hosny et al., 2013
5	Contractor prequalification based on fuzzy MCDM model	Nasab & Ghamsarian, 2015
6	Practical contractor pre-qualification procedure based on type-2 fuzzy set model	Afshar et al., 2017
7	Model of decision-making process in bidding procedures based on fuzzy sets theory	Plebankiewicz, 2014
8	Contractors ranking approach based on multi attribute fuzzy weighted average and multiple decision making	Alhumaidi, 2015
9	Prequalification criteria and factor analysis to contractor performance in contractor selection on project success	Doloi, 2009

Source: own compilation

The review of literature discussed above signified the particular approaches of the MCDM model for contractor assessment' qualification that most of them are fuzzy logic. However, this study considers the novel approach for evaluating the factors' behavior and their roles in the system of contractor assessment. After considering the interconnection of assessment' factors based on correlation network, the network topology approach employed to analyze the performance of them and determine the level of contractors' assessment that finds significant implications in organizational structure and the companies' operating.

2.2. Network structure of factors

Network theory as a part of graph theory has been used for many different complicated systems; examples span from communication systems and internet to social networks and recently the networks that their representations are more abstract such as financial networks and biological networks (Kwapién & Drözdöz, 2012). Specific economic manifestation is typical for networks based on social capital development between partners (Mishchuk et al., 2023), including partnership in supply chain (Setyaningsih & Kelle, 2021). The most fundamental factors that shape the network as complex systems are the inter-relationships between the pair of objects. Formally, it is constructed in terms of the concepts of nodes that is identified by individual elements, and links that present physical associations or interactions of the nodes (Kwapién & Drözdöz, 2012; Barabási, 2009).

Several real complex systems such as biological, social and information systems can be analyzed by conducting form of a network that consist a set of nodes linked by edges in which the nodes denote individuals' objects of study and links represent the connection between nodes (Albert & Barabási, 2002; Boccaletti, 2006; Dorogovtsev & Mendes, 2002; Maloku et al., 2021; Newman, 2003). It used to demonstrate the network representation for problems. Many researchers have emphasized that the network method is a key in understanding the behavior and principles of the complex systems structure (Albert & Barabási, 2002; Boccaletti, 2006; Dorogovtsev & Mendes, 2002; Newman, 2003).

The existence of the correlations among factors allows to outlook the network structure of relationships among all assessment factors. By concerning the network of factors, the nodes are the individual items and the link between two nodes displays a correlation of the two connected items. The items presented as network nodes that are connected with their neighbors through links with proportional

weight to the coupling strength. In this way, topological network illustrates the physical shape of a network. It refers to the interconnection between all nodes and make clear how the data transferred among them. It used to explain the extent to which two or more correlation structure are different from each other. This technique is general in network analysis in which MST is applied to filter the information and provide topological network. It will explain the structure of interrelated items of contractors' assessment factors in this case of study.

2.3. Contractor assessment' factors

Based on the project objectives and client priorities, the contractors' capabilities should be different due to project type. There are many studies that listed practical qualities factors for contractors' assessment (El-Sawalhi et al., 2007; Arsalan et al., 2008). However, this study precisely considered the contractors capability assessment based on qualitative and quantitative factors. The list of contractors' assessment factors classified in Figure 1 through comprehensive literature.

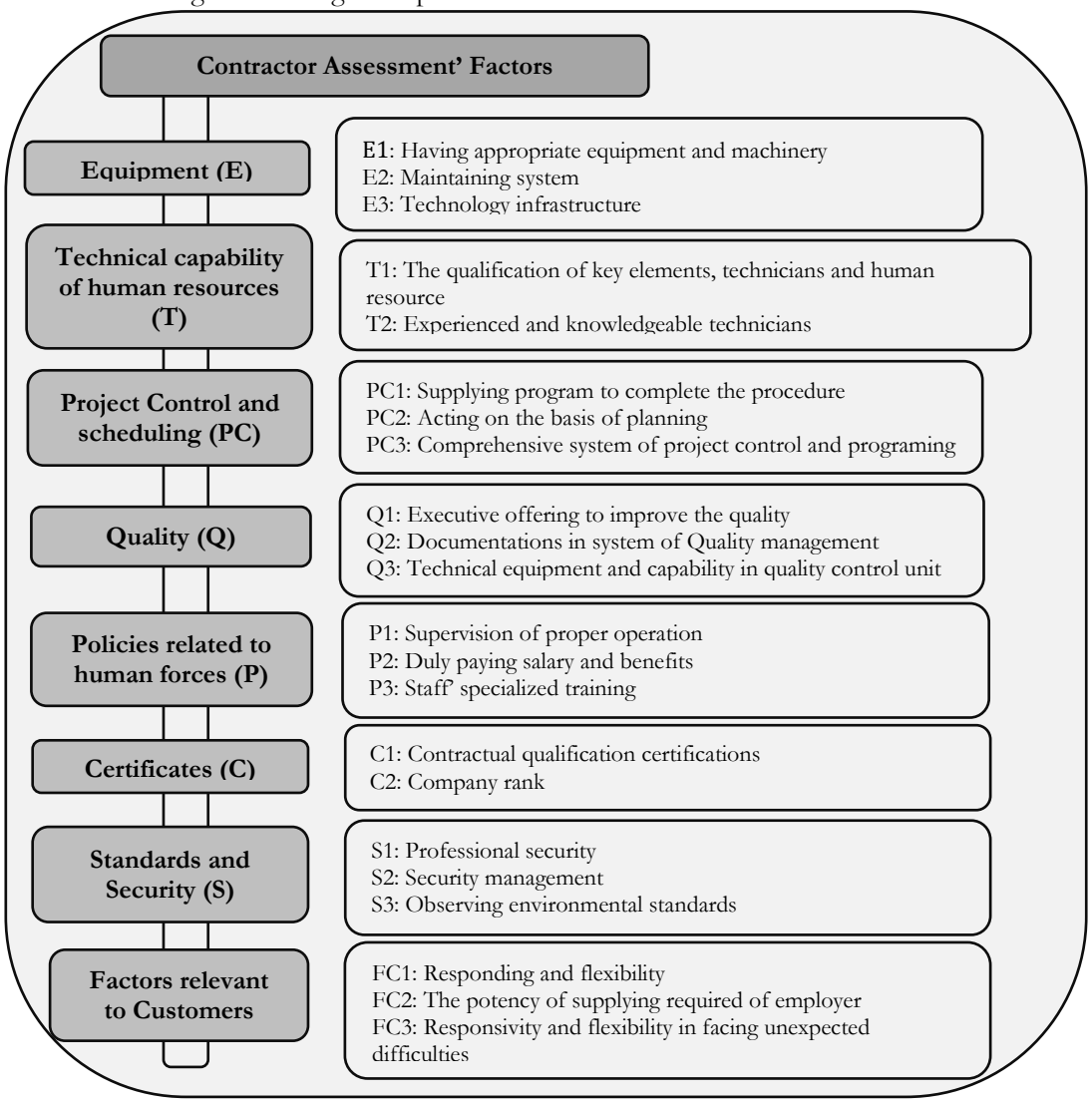

Figure 1. The contractors' assessment factors in construction engineering company

Source: Ebrahimi et al., 2016; Asgharizadeh & Nasrollahi, 2008; Barzinpour & Namazifard, 2011; Dashti et al., 2011; Eshtehardian, 2003; Golbaharzadeh et al., 2013; Heidari & Heidari, 2008; Jaferi & Shiruiyezad, 2012; Kazemi Asiabar, 2011

The factors assessment revealed the eight major factors to contractors' performance, explicitly: Equipment (E), Technical capability of human resources (T), Project Control & scheduling (PC), Quality (Q), Policies related to human forces (P), Certificates (C), Standard and Security (S), and Factors relevant to Customer (FC). The research considered these factors as eight dimensions for contractors' assessment in Iranian construction engineering company by using correlation network based approach as a theoretical basis to analyze factors' behaviors. The next section is research methodology that seeks to describe the network construction and the procedure of network analysis of contractors' assessment factors. The results obtained from topological network analysis are presented and discussed in the fourth section.

3. METHODOLOGY

Recent study focuses on developing a methodological and systematic approach in contractors' assessment to find significant implications in organizational structure in three main parts. The first part concentrated on recognizing the factors of contractors' assessment as primary consideration that done in Section 2.

The second part focused on measurement of similarity and dissimilarity among factors. This part involves design and distribution of the questionnaire, and deliberated Spearman correlation coefficient as a theoretical basis of ordinal data to measure the similarity. The third part focused on network construction and analysis as empirical investigation. The network constructs visual inter-connection structure which is extracted as an influence topological map for all factors.

3.1. Sample size and questionnaire

In the review of the literature, initial standards in selecting contractors were applied by random sampling. This method is required for determination of sample size as signified the population of the questionnaire (Al-Tmeemy et al., 2012) that there is an equal geographic spreading among samples. $\boldsymbol{S}$ is the sample size defined by:

$$S = \frac{z^2\, p(1-p)}{c^2}$$

Where z is z-value of 95% confidence level (the value is 1.96), c is the confidence interval and p is percentage picking a choice. The corrected SS is calculated for fixed a population. The modified S is:

$$SS = \frac{S}{1 + \left(\frac{S-1}{population}\right)}$$

The Modified S (SS) adjusted for the response rate (65% is a typical rate).

According to random sampling technique, approximately 120 questionnaires distributed to staffs in clerical, supervisory and construction stakeholders. All of them have wide work experience within the CI and contract specification. Table 2 shows the majority of respondents go to contractor around 39 percent while remaining percentages distributed approximately equal among the other four different stakeholders. The private sector has higher percent around 47 contributions in this study. Besides, the range of correspondents' years of experience distributed almost identical among the four different ranges.

The questionnaire consists of 24 characteristics (questions) of eight major factors of assessment with sub-factors. The responses regard to their beliefs about contractors' assessment gathered using the Likert scale. The benefit of this format is that the staff could indicate the various degree of their answer to each item (Hayes, 2008). This measurement also called the ordinal scale. It is considered to distinguish whether the measures are relevant. The numeric value applied for making arrangements items being measured

accordingly, from the smallest to the largest. The name "ordinal" means the order of the items based on their relative size of the measures. The questionnaire survey conducted to serve as a secondary resource of data. Data collected from full-time, non-unionized staffs in Iranian construction engineering company of Fars province.

Table 2

Demographic of respondents

Respondents Role in CI					
CI Stakeholders	Client	Designer	Construction Manager	Contractor	Supervisor
Number	19	19	22	39	21
Sector					
Public		Private		Academic	
22		47		31	
Construction Industry Experience of the Respondents					
Years		5 or below	5-10	11-15	Above 16
Percentage		27	31	19	23

Source: own evaluation.

3.2. Main method

The relationship evaluation among factors of contractors' assessment that is favorable for improving the quality as well as assessment management considered as an important topic in this regard. Since the behavior of each factor is influenced by the other factors, the existence of the interaction among all items seems to be complex system. This section deals with the steps in network analysis approach that shortly discusses in order to analyze the relationships and to discover the most effective factors.

The standard practice to measure the similarity as coefficient of correlation among vectors in network analysis is the Pearson's correlations coefficient (Tan et al., 2004). However, in Likert scale, each category represented by a number which is not the real number, they refer to a rank of category. In this case, Spearman's coefficient is appropriate method for ordinal scale to summarize the strength of the association and to assess the independence of random variables. It is a nonparametric statistical method of rank correlation (dependence between the rank variables). Therefore, we applied the Spearman's rank correlation for ordinal data to measure the similarity of variables (Conover, 1971; Hauke & Kossowski, 2011). It computed using the popular formula as defined by:

$$\rho_{ij} = 1 - \frac{\sigma\, T}{n(n^2-1)}$$

Where $T = \sum[R(Y_i) - R(Z_i)]^2$ is the difference between rankings of two variables and n is the number of measures in the correlation (Jerrold, 1972). $R(Y_i)$ and $R(Z_i)$ is the rank of Y_i and Z_i for $i = 1, 2, 3, \ldots, n$, respectively.

The coefficient of nonlinear correlation for i-th and j-th items is quantified by ρ_{ij}. Correlation coefficient ρ_{ij} for all pairs of 24 factors form a symmetric matrix C with size of 24×24 elements. This correlation matrix shows the degree of items which plays an important role as the main source of information. However, the correlation matrix cannot provide an insight into the system's overall behavior which is the purpose of statistical tools. The distance or dissimilarity measure of items provide the appropriate way for constructing a meaningful network of differences among factors and it also fulfils the triangular inequality of a metric (Stanley & Mantegna, 2000) consist of: (i) $d_{ij} = 0 \Leftrightarrow i = j$ (ii) $d_{ij} = d_{ji}$ and (iii) $d_{ij} \leq d_{ik} + d_{kj}$. We initial transform the correlation coefficient ρ_{ij} (similarity measure) into a

dissimilarity measure d_{ij} by using the Euclidean distance: $d_{ij} = \sqrt[2]{2(1-\rho_{ij})}$. d_{ij} for all pairs of items yield a distance matix (D) that can be represented as a weighted, undirected and complete graph with edge distances d_{ij}. Such a complete network in general can presented, but showing all the relationships even for small networks would be an unreadable graph. In this regard, a more significant method is application of a MST graph. MST used to reduce and simplify the complete network of $24 * (24-1)/2 = 276$ connections to a simpler association of just 23 connections for better visualizing insights of the network. In network analysis, MST and SDU are well-known methods as the nearest neighbor single linkage cluster analysis. Kruskal's algorithm will be used to determine MST. In this case, the MST constructs the network topology of 24 factors of contractor' assessment to extract the information in network structure from complex network to a simple map. In the direction of graphical representation to visualize the topological network, Pajek software used as the most suggested software in network analysis (Nooy et al., 2011; Batagelj & Mrvar, 2003; Batagelj & Mrvar, 2001).

The topological properties of MST is analyzed by using centrality measures (Freeman, 2002; Borgatti, 2005). From network analysis viewpoint, the relative significance of each item (or node) contained in MST can be determined based on centrality measures as a result of role played of particular item relevant to the other items. The measure of centrality as a basis concept in network analysis (Espino & Hoyos, 2010; Abbasi & Altmann, 2011; Xu et al., 2009) recommended by many authors such as Borgatti Borgatti (2005, 2006), Park & Yilmaz (2010) and Sieczka & Holyst (2009). Many research issues investigated for interpretation of information and finding the influential items (nodes) in the network. In this study, we conduct analysis based on four measures of centrality consist of degree, eigenvector, closeness and betweenness centrality.

- The degree of connection ($C_A(i)$) refers to the adjacency matrix A_{ij}. A_{ij} is a $n \times n$ symmetric matrix with elements of 0 and 1 and a_{ij} is the (i,j)-th element of the A_{ij} . $a_{ij} = 1$ indicates the connection between a pair of elements in MST.
- Eigenvector centrality introduced by Bonacich in 1972. It used to determine which node connected to most connected nodes. For node i is defined as:

$$C_e(i) = \frac{1}{\lambda_{max}} \sum_{j=1}^{n} (a_{ij} x_j)$$

  $x = (x_1, x_2, \dots, x_n)^t$ is the eigenvector related to the largest eigenvector λ_{max} of A_{ij}(adjacency matrix). It is the weighted average of the values x_j of all nodes linked to node i. The highest value of eigenvector is related to the one node that has highest connections to other high-scoring nodes.
- Betweenness centrality measure for node i describes the frequencies of the node indirectly to connected nodes in the shortest paths. The betweenness centrality is defined as:

$$C_B(i) = \sum_{j,k \in V} \frac{\sigma_{jk}(i)}{\sigma_{jk}}$$

  Where σ_{jk} denotes the number of the shortest paths between node j and node k, and $\sigma_{jk}(i)$ represents the number of the shortest paths containing node i as an intermediately in the geodesics between node j and node k. High score of $C_B(i)$ indicate that a node i located on considerable fractions of shortest paths connecting others or it can reach others on short paths (Batagelj & Mrvar, 2001).
- Closeness centrality describes the efficiency of information propagation from one node to the other (Freeman, 2002). The closeness centrality for node i is the mean geodesic distance in the shortest

path from node i to other reachable nodes in the network. Closeness is relevant to the inverse of the node' distance to every other nodes in the network. It defined as follows:

$$C_C(i) = \frac{(n-1)}{\sum_{j \in V} d_G(i,j)}$$

Where $d_G(i,j)$ signifies the minimum distance between node i and node j.

In next section, we apply centrality measure tools to identify the most important factor and sub-factors (items) in the network that is the way of analyzing system. After that, the results obtained from topological network analysis is discussed.

4. RESULTS AND DISCUSSION

4.1. Results from four centrality measure in network

The MST constructs the topological network of items to extract the information in network structure of contractors' assessment dimensions. In this way, we conduct analysis based on four centrality measures that defined in last section. The dimensions' characteristics classified into eight components (Figure 1). Figure 2 shows the correlation based MST for 24 factors of contractors' assessment. This yields a network that is uncompleted, weighted, and undirected graph. Each item represented by its symbol and colored by its dimension classification.

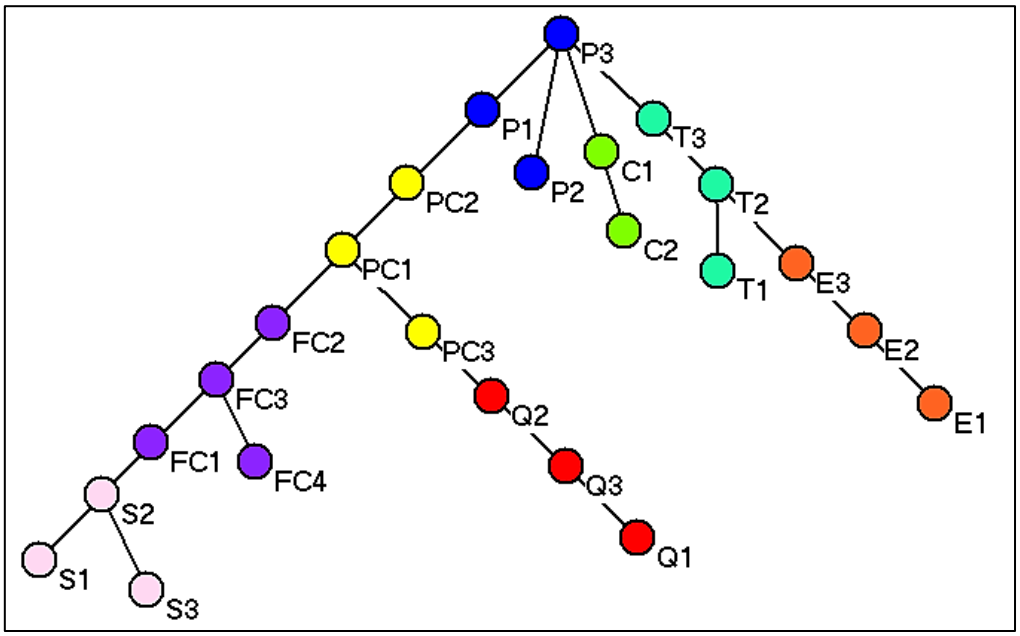

Figure 2. Network topology of 24 items of Contractors' Assessment factors

Source: own evaluation.

For performing the MST to be clear, researchers used the different colors for each dimension. From degree, betweenness, closeness and eigenvector centrality measures, the results discussed below.

The degree of connections (degree centrality) presents the power of influence based on number of connections from each factor to others. Based on the degree of connections as shown in Figure 2, the most important factor is P3 (Staff' specialized training; blue node) which is influential factor with highest linkages

(4) and other three centrality scores. In fact, the training of contractors' personnel can improve the contractors' productivity and competitiveness. This item link to all other items in policies related to human resources (P1: Supervision of proper operation, and P2: Duly paying salary and benefits) and items of technical capability of human resource (T3: Creativities power of employees) and certifications (C1: Contractual qualification certification) factors. Followed by PC1 (Supplying program to complete the procedure; yellow node), FC3 (Responsivity and flexibility in facing unexpected difficulties; purple node), S2 (security management; pink node) and T2 (technicians experience, knowledge and key elements; green node) with 3 linkages. Other factors with two and one links are at the lowest level.

The higher eigenvector centrality measure indicates that a node is central if it connects to most connected node. According to the eigenvector centrality measure, P3 (blue node) also has the highest score (0.523) to others that show this factor is the most significant factor in the following sense. The influences of P3 to the others are connecting to most connected factor. Therefore, P3 plays an important role as a liaison that could affect the information among factors. The other high scoring factors are PC1, PC2 (yellow node) and P1 (blue node) with highest score of betweenness and closeness centrality. In Table 3, the top factors are classified based on four centrality measures.

Table 3

List of four important factors and their centrality scores

Node	Factor	Degree	Eigenvector	Betweenness	Closeness
P3	Staff' specialized training	4	0.523	0.577	0.245
PC1	Supplying program to complete the procedure	3	0.251	0.632	0.261
PC2	Acting on the basis of planning	3	0.258	0.521	0.261
P1	Supervision of proper operation	2	0.341	0.513	0.256

Source: own evaluation.

Surprisingly, all items in a particular factor linked to each other and mostly linked with the items in Policies related to human resources (blue node). For example, Technical capability of human resource (T), Project control and scheduling (PC) and Certifications (C) items are linked directly to Policies related to human resources (P) factor.

4.2. Result from hierarchical structure

Hierarchical tree (HT) presents taxonomical and hierarchical structure of items based on MST to define the connections among items. This method is useful to i) determine the specifically important underlying item within i and j and ii) find the minimal distance between items, which is representative in making a connection between those factors. For this purpose, the single linkage clustering method is used.

The HT of 24 items shown in Figure 3. Each item labeled by its symbol. It shows two items linked when a vertical line drawn between two horizontal lines. The height of the vertical line denotes the distance at which the two items merged. This figure indicates that the all items merged with high distances have weak relationships. This implies that the all items have a high degree of aggregation.

Surprisingly, all items of each factor merged together as mentioned in findings from MST (Section 4-1). It is clear that the items tended to merge to the same factors. This might cause by the same information within them. From that figure, one cluster is clearly presented. However, the position of each item has its own properties and located on will reflects the connections to other items in the network.

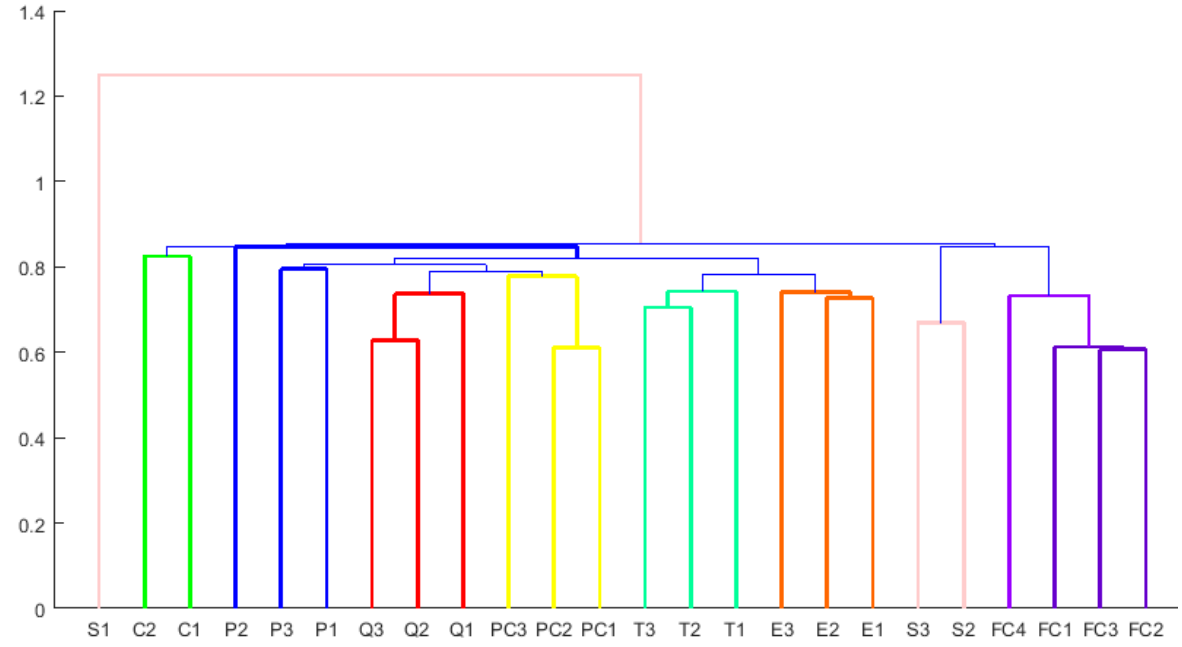

Figure 3. Hierarchical tree of factors based on MST

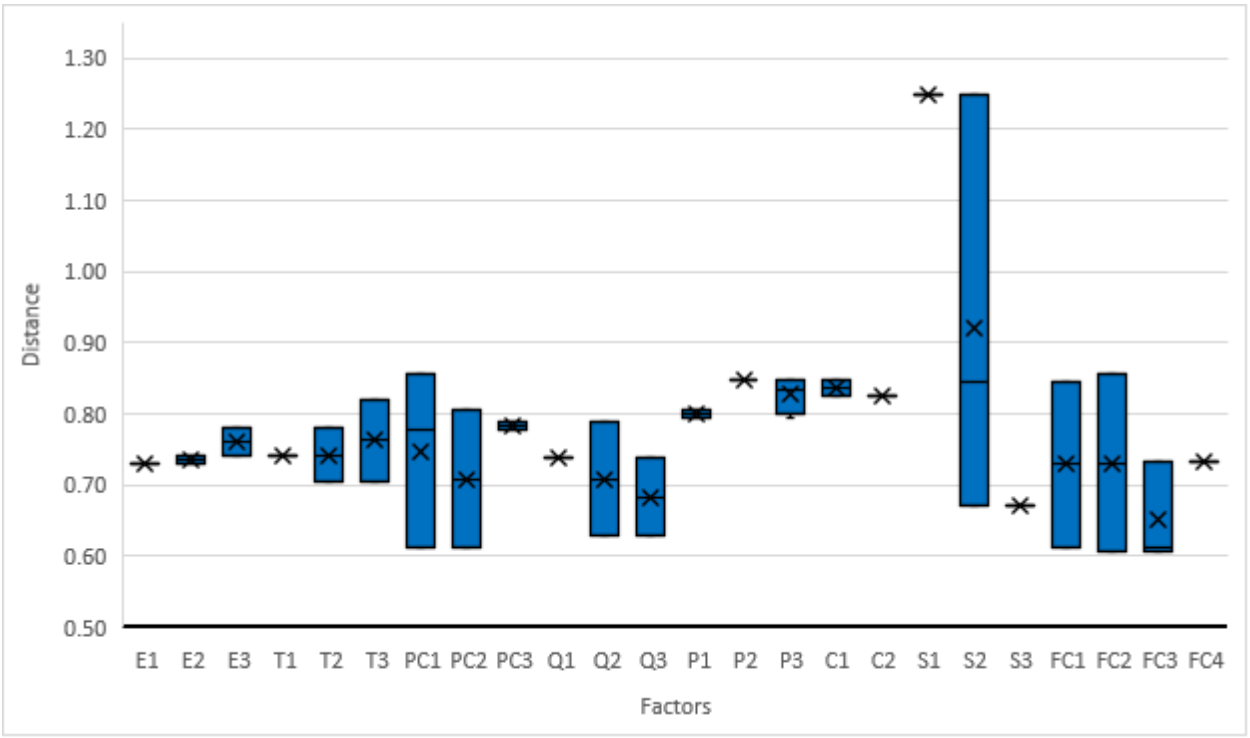

Figure 4. Box plot of factors' distance based on MST

Source: own evaluation.

Figure 4 presents the box plot of distances factors based on MST. It visualizes the range of dissimilarity for particular item to other connected items. The box bounded on the top by the third quartile and on the

bottom by the first quartile. The mean divides the box. The dotted line denotes the Mean of distance. In plot, the items with the star points indicate that they have only one connection ($C_A(i) = 1$) such as E1, T1, Q1, P2, C2, S1, S3, FC4. S1 (Professional security) with maximum distance d=1.25 among star points has weakest relationship in related to other factors. It is also located at the lowest level of centrality in MST and therefore, is the least significant factor.

In figure 4, where the box plot is very short (see E2, PC3, and P1) denotes that particular factor has similar distance in connection to linked items of MST. In addition, if the box plot is comparably tall (see S2) indicates that factor has different distances in related to other connected factors.

5. CONCLUSION

This research considered the factors of contractors' assessment within Iranian construction engineering company. It is important for those organizations to have some information which factors specifically in their organization are the most important ones. Since this case study is small sample, it must remember that the results are not for generalizing and applying all the organizations. As mentioned, the behavior of contractors' assessment factors is relatively complex matter. Even though the factors regarding the organization have important role in it, the organizations are not only ones affecting this. It strongly indicated that the affecting factors and the characteristic of each factor have major impact on contractors' assessment. However, organization and the employee create the premises for these to be good.

The significant contribution of this research is to examine the factors' behaviour in Iranian construction engineering company and find affecting factors associated with eight components of contractors' assessment factor. In order to determine the most influential dimensions, this research considered the similarity measure among factors of contractors' assessment by using Spearman correlation coefficient as a theoretical basis to analyze the ordinal data. After that, the network visually constructs the interaction among factors, which is extracted a topological influence map for major factors by the MST. We discussed the results obtained from topological network analysis by using centrality measures which are useful to know the power of influence of particular factor relevant to other factors.

From the findings, the most influential item in the dimensions of contractors' assessment in Iranian construction engineering company is P3 (Staff' specialized training) with the highest score in those four centrality measures. There are also three items existed with high score in four measure of centrality, namely: PC1(Supplying program to complete the procedure), PC2 (Acting on the basis of planning) and P1 (Supervision of proper operation) that should be paid attention as core factors of high priority to implement in Iranian construction engineering company. The positive effect on the organizational outcomes results when the P3 factor (Staff' specialized training) supported by Iranian construction engineering company.

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