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THE INFLUENCE OF COMMUNICATION NETWORK CENTRALITY ON INDIVIDUAL POPULARITY: A CASE STUDY OF A CHINESE CONSTRUCTION PROJECT

Sulafa Badi[1], Minhui Li[1], and Stephen Pryke[1]

[1] *The Bartlett School of Construction & Project Management, University College London, 2nd Floor, 1 – 19 Torrington Place, London, WC1E 7HB*

ABSTRACT

Individual popularity has been found to have a positive impact on leadership behaviour, individual performance, group performance and job satisfaction. However, there remains a limited understanding of the concept of individual popularity and its antecedents in construction projects. In this research study, we propose that the position which an individual occupies in the project social network will influence his/her popularity. Although different types of networks exist in project environments, e.g. informal friendship networks, we focus on project-related information-exchange networks to capture individuals' recurrent patterns of work-related communication. Our goal was to consider individuals' structural positions within the project function-related communication networks, rather than the more casual and less work-significant informal friendship networks. A single case-study approach was adopted, examining a road-construction project in Baoshan City in China. Data collection involved the completion of a questionnaire by project participants, identifying their communication with, and their perception of, the popularity of other project actors. Analysis was based upon actor centrality (Degree, Betweenness, and Closeness) within the communication and popularity networks. The findings supported the proposition and showed that communication network centrality is positively associated with popularity, in that individuals who are more central in the project communication network also assumed central positions in the popularity network. The degree of centrality in the project communication network was found to be particularly salient in predicting popularity, underlying the social dominance of the "prominent disseminators" who control a large amount of information resources.

Keywords: Centrality, individual popularity, social-network analysis (SNA), communication networks, construction project.

1. INTRODUCTION

In tandem with formal relationships, such as those predicated by organisational structures and reporting procedures, informal relationships proliferate in construction projects (Pryke, 2012). In organisational settings, a meta-analysis by Chiaburu and Harrison (2008) has shown that the structure of these informal relationships has a significant effect on an employee's attitudes, behaviour, and job performance, above and beyond the structure of formal relationships. However, there remains a myopic understanding of these relationships and their profound influence in construction projects.

Popularity, i.e. being liked among one's peers, is a concept that is gaining increasing attention in management research as a result of its association with several positive outcomes. Popular individuals have been shown to enjoy higher individual performance (Bass, 1962), group performance (Lodahl and Porter, 1961), and job

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satisfaction (Zelst, 1951; Scott and Judge, 2009) and enjoy a greater amount of social capital (Cillessen and Rose, 2005; Scott and Judge, 2009; Scott, 2013). While popularity has been heavily studied as a salient phenomenon with significant effects among schoolchildren (Rubin et al., 2006; Newcomb et al., 1993) and in the workplace environment (Bass, 1962; Lodahl and Porter, 1961; Zelst, 1951; Scott and Judge, 2009; Scott, 2013; Cullen et al. 2014), it has received little attention within temporary and transient project organisations.

To attend to this void and to stimulate research on popularity in project settings, we propose that the popularity of a team member in a project context is to a large extent determined by the project function-related social network among which he/she is embedded. We particularly focus on the centrality of an individual's position in the project communication network with the aim to explore the relationship between an individual's position within the project communication network and his/her popularity. We propose that project communication network centrality (Degree, Betweenness, and Closeness) will be positively associated with popularity, in that individuals who are more centrally positioned in the project communication network will also be central in the popularity network. The hypothesis is tested by examining the communication networks among 23 project actors involved in a road-construction project in Baoshan City in China. Data pertaining to the frequency and importance of their communication as well as the perceived popularity of other team members was collected using a social-network questionnaire. Analysis was based upon the actor's centrality (Degree, Betweenness, and Closeness) within the communication and popularity networks. The findings supported the proposition and showed that communication network centrality is positively associated with popularity, in that individuals who are more central in the project communication network also assumed central positions in the popularity network. Degree centrality (based upon a simple calculation of the number of links with other actors) in the project communication network was found to be particularly salient in predicting popularity, underlying the social dominance of the "prominent disseminators" (Pryke, 2012) who control a large amount of information resources. The study's findings will help project managers better understand behaviour in project organisations and why some project actors are more popular than others. It will also add to a project manager's repertoire of influence strategies for building a collaborative project environment.

We begin this paper by summarising the important literature on popularity and social networks, leading to the development of the research hypothesis. The following section illustrates the methodology of social-network analysis (SNA), and outlines the case-study methodology, data collection instruments, and the analytical procedures adopted. The results of the study are then presented and discussed. The final section outlines the conclusions and recommendations for future research.

2. THEORETICAL UNDERPINNINGS
2.1. Popularity

According to Merriam-Webster's Dictionary (2003), *popular* is 'frequently encountered or widely accepted', while the Oxford English Dictionary (2005) described *popular* as 'generally accepted, commonly known'. Whereas popularity is prone to social dominance, it is considered that if one is 'friendly' and 'cooperative', one's 'popularity' and 'likeability' are closely linked (Van der Linden et al., 2010). In most cases, popularity is defined as a likeability among peers, and it is a property of an individual embedded in a group (Rubin et al., 2006). A few explanations regarding this definition ought to be noted. To begin with, despite the fact that popularity is the property of an individual, an individual must be part of a group to have it.

Subsequently, regarding the level of investigation, popularity is both an individual and group-focused construct (Rubin et al., 2006). *Popular* and *unpopular* are titles given by team members to a particular individual, reflecting those team members' shared observations. Additionally, when assessing the popularity of a given team member, individuals are less likely to depend on their own feelings towards the team member in question. Rather, individuals assess how others see the focal individual, predominantly reflecting the general opinion of the whole team (Bukowski and Hoza, 1989). Another important distinction that needs to be clarified is the contrast between interpersonal liking and popularity. Although these are clearly related, they are fundamentally different. While interpersonal liking takes place at a dyadic level and its evaluation is self-referenced, being popular occurs at the group level and is otherwise referred to. Popularity reflects how the individual is seen by others (Rubin et al., 2006).

In the workplace, popularity can bring about many positive outcomes for an individual. Workers well-liked by their colleagues and superiors are most likely to receive higher salaries and quicker promotions (Scott and Judge, 2009). This is because the work environment requires interactions among workers. The more popular an individual is, the more help and information he/she will get from co-workers. Therefore, popularity and likeability are positively associated with job satisfaction, individual performance, and group performance (Scott and Judge, 2009). Several studies have examined the relationships between an individual's popularity and his/her performance (Hu et al., 2010; Szabo and Huberman, 2010). For instance, Lehmann and Schulze (2007) studied the influence of the popularity of German soccer players upon their performance and social recognition. They noted that in the season of 1998/9, the top 5% of the soccer players earned about 5.5 times more than other players. These soccer *superstars* used their own individual popularity to attract more attention from audiences. The more popular they were, the more fans they attracted. Some of those fans were family and close friends, but the majority were acquaintances and strangers whose evaluation of players was mainly based on their talent and performance. Therefore, the *superstar* effect, which can also be understood as individual popularity, facilitates the development of social capital (Lucifora and Simmons 2003; Adler, 2006).

2.2. Network Centrality

A social network can be viewed as a set of actors and the relationships between them (Wasserman and Faust, 1994). Network theory attempts to explain the effects that different structural properties may have on the actors. The SNA measure of centrality, or 'prominence', is important to the discussion in this paper. Freeman (1979) distinguishes between three different measures of centrality: Degree, Betweenness, and Closeness. Degree Centrality measures the extent to which an actor receives or transmits information to his/her immediately adjacent neighbours in the network. Freeman (1979) describes an actor of High Degree Centrality as being 'in the thick of things', a focal point of communication, in the mainstream of information flow in the network. In addition, in graph theory, points falling on the only geodesic or all the geodesics linking a given pair of points are said to stand between the end points (Freeman, 1979). Bavelas (1948) and Shaw (1954), amongst others, have suggested that when a person is strategically located on the communication paths linking pairs of others, that person is 'central'. Similarly, Pettigrew (1973) refers to 'gatekeepers': actors who use information as a power resource by controlling information flows between other actors. The third measure of centrality, Closeness, measures the shortest distance score of one point to all others in a network and can be interpreted as representing efficiency (Brass and Burkhardt, 1992), in that an actor with high Closeness Centrality can reach all others in the network with relatively few steps.

Freeman's (1979) interpretation is that Closeness Centrality is an indicator of the extent to which an actor can avoid the control potential of others; an actor with a high measure of Closeness Centrality has the advantage of being less dependent on others for relaying information. Freeman's (1979) original work discussed the appropriateness of the three centrality measures in different contexts: interest in communication activity requires a measure based on Degree; concern with regard to the control of communication advocates a Betweenness measure; and concern with either independence or efficiency necessitates a measure based on Closeness. In the following section, a concise outline of what key authors have proposed about the relationship between centrality and popularity will lead us towards establishing a hypothesis for this paper.

2.3.   Towards a hypothesis: network centrality and popularity

In this research study, we propose that the positions that individuals occupy in the social network will influence their popularity. As the previous section explained, individuals connected to many others are referred to as central. Although different types of networks exist in project organisations, e.g. informal friendship networks, we will focus now on project-related information-exchange networks to capture individuals' recurrent patterns of work-related communication. Our goal is to consider individuals' structural positions within the project's function-related communication network, rather than friendship network.

Why should team members who are centrally located in the project communication network be more popular than those who are less centrally located? Due to the positions they occupy, central individuals should be more frequently contacted by their team members than less central individuals. Frequent communications among team members afford them the opportunity to familiarise themselves with each other's aims, objectives, and work-related progress and requirements. While frequent communication may not necessarily ensure that people will like each other, it reduces inter-group anxiety and promotes avenues for conflict resolution (Pelled, 1996; Stephan and Stephan, 1988). Individuals who communicate more frequently with other group members are often considered as hardworking, diligent, and motivated by their peers (Xia et al., 2007). In addition, after some time, this continual encounter ought to result in greater acceptance. Indeed, several studies have underlined the positive association between simple 'exposure' to a stimuli and its positive evaluation (Bornstein, 1989). Early work by Zajonc (1968) contended that repeated exposure to a stimulus that is not assessed as risky will gradually result in increased familiarity, comfort, and acceptance. Other studies of popularity in school settings have also shown that popular schoolchildren are often those who are central in the social network of their classrooms (Farmer and Rodkin, 1996). Degree Centrality measures the information resources that the given actor accesses from his/her adjacent neighbours in the social network (Wasserman and Faust, 1994). Secondly, Betweenness Centrality analyses the positions of an actor (Cross and Cummings, 2004). Actors in the network with high Betweenness Centrality are the 'valves' of information flows within a project (Cohen and Marriott, 1958; Pryke, 2012). Moreover, an actor who has high Closeness Centrality can interact with others more quickly and conveniently. Thus, we forward the following hypothesis:

> *Hypothesis: project communication network centrality (Degree, Betweenness, and Closeness) will be positively associated with popularity, in that individuals who are more central in the project communication network will also be central in the popularity network.*

The next section will provide further explanation of the methods adopted in order to test the hypothesis above.

3.   RESEARCH METHOD

A case-study approach was best suited for this study, as the aim was to investigate the association between communication network centrality and an individual's popularity in a temporary project environment which necessitates an in-depth analysis of the specific project in its context. The study adopted a single case-study approach examining a road-construction project in Baoshan City in China. The construction sector occupied more than 25% of China's GDP in 2011 and the average revenue of the construction industry reached $1.24 trillion. Generally, construction projects are complex, high-cost undertakings involving numerous groups and individuals (Ofori, 1990). China offers a unique context to the study due to its dominant collectivist society, which strongly values group and interpersonal relationships (Hofstede et al., 1997; Chen, 2000; Farh et al., 2007). The project was selected following set criteria to maximise what could be learned from the study. First, the project should be ongoing during the data collection stage of the research. This was to safeguard against recency biases inherent in self-reporting SNA questionnaires. In addition, a commitment from senior management to the research project was critical to facilitate access to the project as well as project team members' willingness to take part in the study.

SNA evolved from graph theory into the analysis of interpersonal relationships linking individuals, groups, and organisations (Freeman, 1984; Scott, 2000). It helps illustrate the nature of the relationships in social networks by visualising the links of actors (Pryke, 2012). In order to structurise a useful understanding, SNA requires as a starting point of analysis a holistic and rigorous description of relationship patterns (Knoke and Yang, 2008). Due to the wide range, the transitory and infinite nature of social networks, the study boundary was defined in a nominalist approach (Pryke, 2012). The boundaries of the network were established as the management and supervisory team, those actors whose job predominantly entailed the management and supervision of aspects of the project delivery, rather than the use of hand tools. A total of 23 individuals were identified as meeting the criteria above, including one client, one consultant, 16 contractors, and 5 subcontractors.

The "roaster method" of data collection was used, in which a list of the names of all 23 individuals identified above was presented to participants as possible network connections. This strategy has been shown to improve the accuracy and reliability of the data (Marsdden, 1990). Data collection involved face-to-face interviews with the 23 actors involved in the project team in order to complete the social-network questionnaire. The interviews lasted at least 30 minutes with each actor. From the list of names provided, participants were asked the following questions: "From whom do you receive information?", "To whom do you send information?", and "Who do you believe is popular on this project?" Emails, phone calls, letters, or face-to-face conversations are collectively represented as an exchange of information between two actors. Likert scale values were recorded for frequency (1 = every 6 months, 2 = every three months, 3 = once a month, 4 = weekly, 5 = daily, 6 = several times a day) and for importance as perceived by the actor (1 = not important, 2 = important, 3 = very important). The scores were multiplied and used, following Pryke (2012), as a proxy for tie strength. In addition, to support the quantitative data, qualitative follow-up interviews were conducted with key actors, such as the project manager and identified popular actors, to discuss the study's preliminary finding and elicit further insight into the identified popularity of certain individuals.

The three data sets (information-receiving, information-sending, and popularity) were converted into node lists and the node lists imported into the SNA software package, UCINET 6 (Borgatti et al., 2002). Analysis was based upon the point centrality (Degree, Betweenness, and Closeness) within the three social networks examined. The UCINET software also converted the mathematical values of the data into network diagrams (also known as "sociograms") using a facility called Netdraw. Nodes on the network diagrams are identified with an abbreviated role label which relates to the job title of the respondents as outlined in Table 2 above. Trends and themes are initially established through inspection of the network visualisations. Inspection of the data analysis underpinning the visualisations is available to provide evidence in support, avoiding the use of data mining which is frequently used in the analysis of network data.
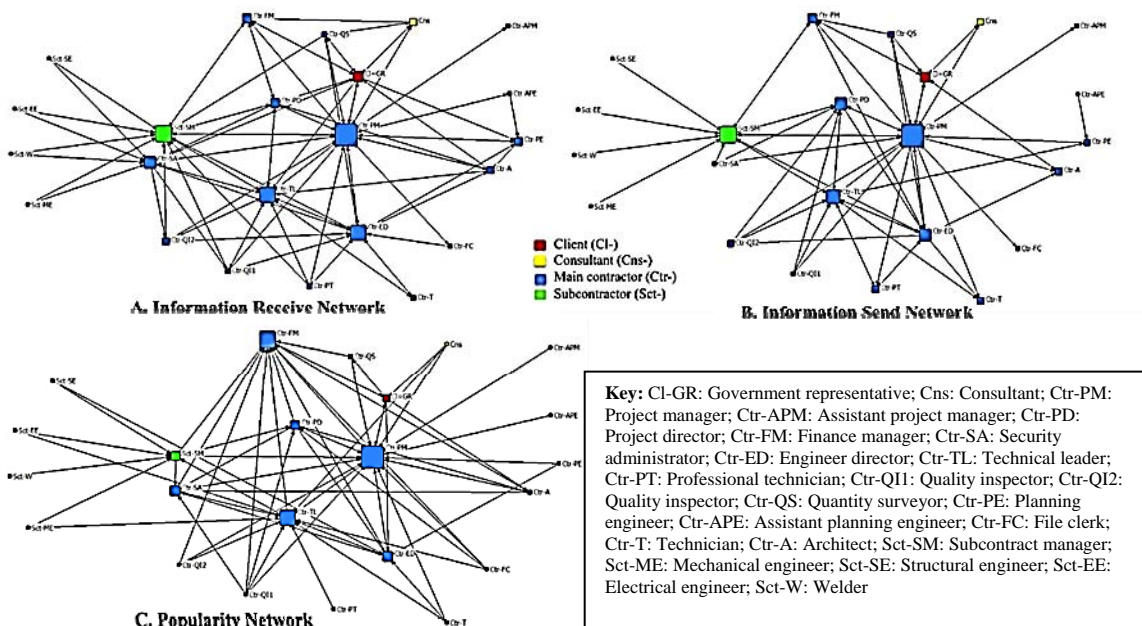
4.   FINDINGS

This section presents the findings of the study presented under three sections according to the SNA analyses conducted: (1) Degree Centrality, (2) Betweenness Centrality, and (3) Closeness Centrality.

4.1.   Degree Centrality

Figure 1 displays Degree Centrality in an information-receiving network, an information-sending network, and a popularity network. The larger the node, the higher its Degree Centrality. Actors with High Degree Centrality are more active and enjoy higher visibility in the network (Freeman, 1979). Examining the information-receiving network in Figure 1, it can be observed that the separated subgroups of subcontractor and main contractor are connected by subcontractor manager (Sct-SM) and security administrator (Ctr-SA). Passing through these two actors are the only paths to exchange information between subcontractors and contractors. Among the group of contractors, the project manager (Ctr-PM) has the highest level of Degree Centrality. This means that the project manager displays a high "receptivity", thus having access to abundant resources. Other key actors, such as Ctr-ED, Ctr-TL, and Ctr-PD, also have relatively High Degree Centrality. Moreover, the client—the government representative—directly receives information from contractor leaders, such as the project manager and the technical leader. The consultant only communicates with the client, Ctr-PM, Ctr-QS, and Ctr-FM. In this network, the technicians (Ctr-T, Ctr-PT), assistants (Ctr-APM, Ctr-APE), and consultant (Cns) access a relatively low level of resources.

It can be observed from Figure 1 that the information-sending network is less dense than the information-receiving network. However, the project manager (Ctr-PM) remains with the highest Degree Centrality and controls the richest resources in the information-sending network, displaying high activity and 'expansiveness' in the network and plays the role of a 'prominent disseminator' (Pryke, 2012). Similarly, the subcontractor manager (Sct-SM) also has relatively high Degree Centrality, resulting from information aggregation from other subcontractors. Note that the security administrator (Ctr-SA) assumes a low Degree Centrality in the information-sending network, only sending information to Sct-SM, Ctr-PD, and Ctr-PM. He plays a role as a 'gatekeeper hoarder' (Pryke, 2012) who *receives* a large amount of information but *sends* very little. Therefore, he still holds an abundant information resource regardless of the low Degree Centrality in the information-sending network.

Figure 1: Information Network and Popularity Network -Degree Centrality

Key: Cl-GR: Government representative; Cns: Consultant; Ctr-PM: Project manager; Ctr-APM: Assistant project manager; Ctr-PD: Project director; Ctr-FM: Finance manager; Ctr-SA: Security administrator; Ctr-ED: Engineer director; Ctr-TL: Technical leader; Ctr-PT: Professional technician; Ctr-QI1: Quality inspector; Ctr-QI2: Quality inspector; Ctr-QS: Quantity surveyor; Ctr-PE: Planning engineer; Ctr-APE: Assistant planning engineer; Ctr-FC: File clerk; Ctr-T: Technician; Ctr-A: Architect; Sct-SM: Subcontract manager; Sct-ME: Mechanical engineer; Sct-SE: Structural engineer; Sct-EE: Electrical engineer; Sct-W: Welder

Inspecting the popularity network in Figure 1, it can be observed that the actors located in leadership positions enjoy high levels of popularity. There is no doubt that Ctr-PM is the most popular in this project, resulting from his advantages on the information exchange networks. But it is surprising that Ctr-FM, who does not occupy a significant position in the network, shows his remarkable popularity. After follow-up interviews, it was found that Ctr-FM had a wider and stronger social capital beyond this project. Zhenguo Sun (Ctr-FM) was one of the relatives of the chairman in this company. Ctr-FM also kept a good relationship with the local government. Therefore, other actors valued the rich social resources behind Zhenguo (Ctr-FM). Additionally, his position as the finance manager has afforded him with high status and power. In such situation, actors evaluate him as popular in a wider context beyond his communication network centrality; in this case his position in the formal organisational hierarchy.
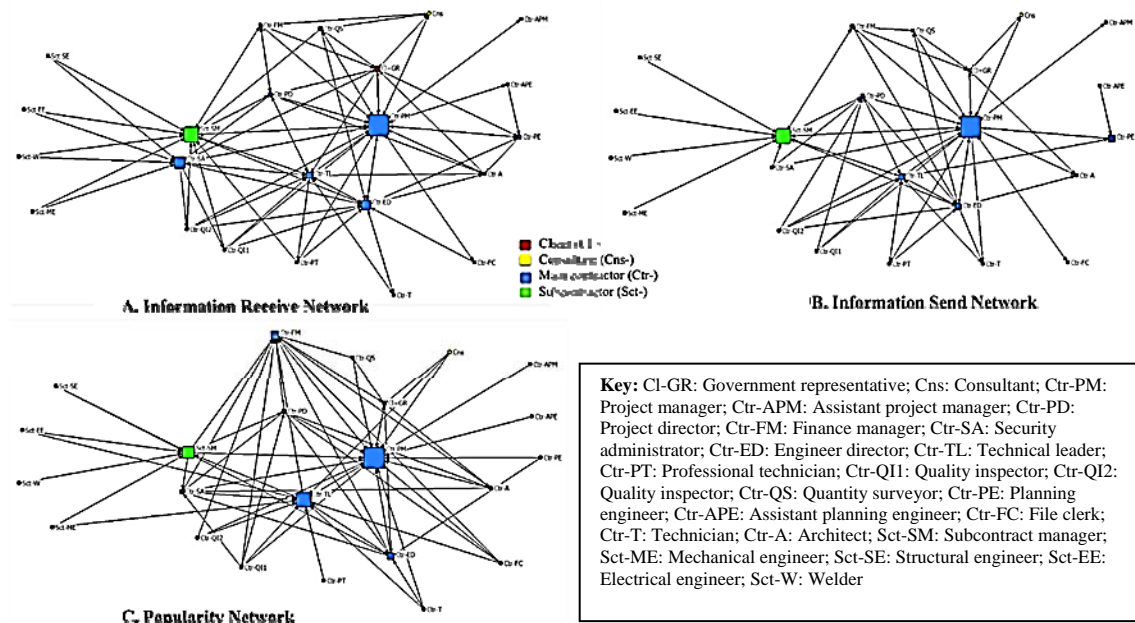
Following a comparison between the information-receiving network, the information-sending network, and the popularity network, it can be observed that the network of popularity exhibits a close similarity to the network of information exchange, especially the information-receiving network. The central actors, such as Ctr-PM, Sct-SM, and Ctr-TL, who keep their High Degree Centrality in both information-receiving and information-sending networks, have a high level of popularity as well. But the Degree Centrality of most other actors, especially Ctr-SA and Ctr-ED, is decreasing in the popularity network. This is because their Degree Centrality has decreased in the information-sending network. Therefore, it can be concluded that the Degree Centrality of the information-exchange network is positively correlated with that of the popularity network. The dominant disseminators in both networks keep their High Degree Centrality, but other actors have lower Degree Centrality in the popularity network. This result accords with the proposition made that with the more resources held by an actor, the more popular he/she is. This also can explain why Ctr-FM stands out in the popularity network.

4.2. Betweenness Centrality

Figure 2 illustrates Betweenness Centrality in an information-receiving network, an information-sending network, and a popularity network. The larger the node, the

higher its Betweenness Centrality. Betweenness Centrality shows the importance of an actor who is located on the shortest path between other actors and it is an indicator of 'power', 'control potential', 'brokerage', and 'coordination activity' (Pryke, 2012; Hossain, 2009). Inspecting the information-receiving network in Figure 2, it can be seen that Ctr-PM has the highest Betweenness Centrality. His position is the most important information flow hub of the whole network. Therefore, he controls the information flow among client, consultant, contractors, and subcontractors. Ctr-TL and Ctr-ED also have relatively high Betweenness to connect subcontractor manager with other contractors. On the other hand, actors have High Degree Centrality, such as Ctr-PD and Ctr-A, but have low Betweenness Centrality because they rarely locate at the shortest paths between two nodes.

Figure 2: Popularity Network and Information Network—Betweenness Centrality

A. Information Receive Network

B. Information Send Network

C. Popularity Network

Key: Cl-GR: Government representative; Cns: Consultant; Ctr-PM: Project manager; Ctr-APM: Assistant project manager; Ctr-PD: Project director; Ctr-FM: Finance manager; Ctr-SA: Security administrator; Ctr-ED: Engineer director; Ctr-TL: Technical leader; Ctr-PT: Professional technician; Ctr-QI1: Quality inspector; Ctr-QI2: Quality inspector; Ctr-QS: Quantity surveyor; Ctr-PE: Planning engineer; Ctr-APE: Assistant planning engineer; Ctr-FC: File clerk; Ctr-T: Technician; Ctr-A: Architect; Sct-SM: Subcontract manager; Sct-ME: Mechanical engineer; Sct-SE: Structural engineer; Sct-EE: Electrical engineer; Sct-W: Welder

Examining the difference between Betweenness Centrality in the information-sending network and the information-receiving network, the most significant change could be observed on Ctr-SA, who assumed an important Betweenness position in the information-receiving network, although not in the information-sending network. Ctr-SA is responsible for monitoring safety issues on-site in the construction project. Therefore, subcontractors need to receive safety requirements from Ctr-SA. But subcontractors send information through Sct-SM instead of Ctr-SA to contractors. Any other actors who attempt to send information to subcontractors must go through Sct-SM. Therefore, Sct-SM has high Betweenness Centrality among subcontractors and contractors. Similarly, Ctr-PM still keeps his unrivalled central position in both information-receiving and information-sending networks. With high Betweenness among many actors, he decides and controls the flow of information among network actors.
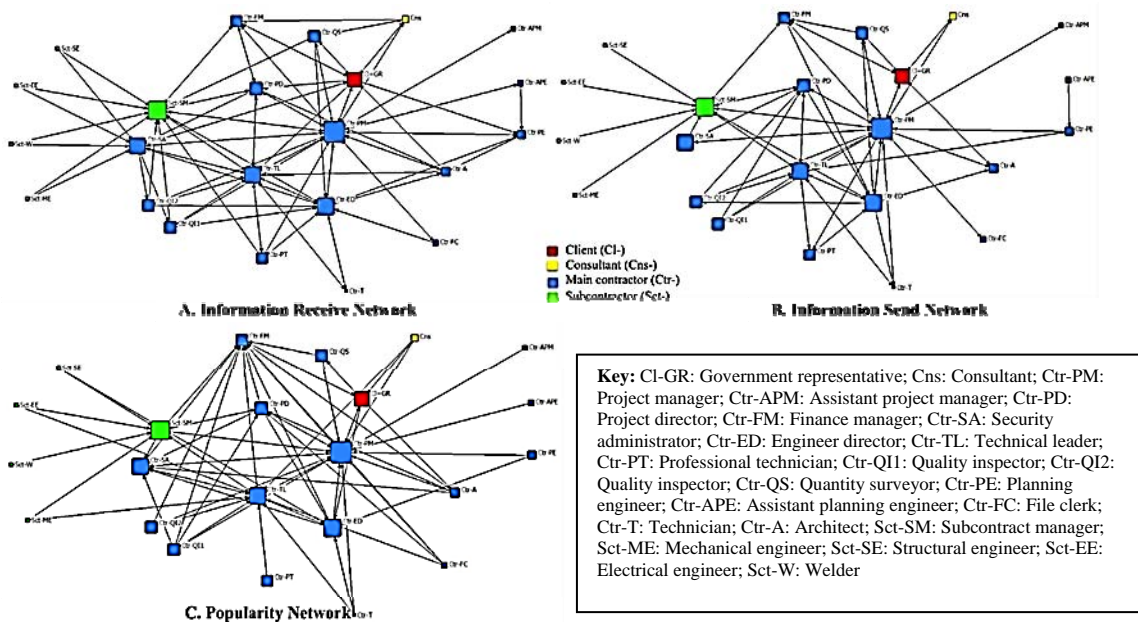
Following a comparison between the information-receiving network, the information-sending network, and the popularity network, it can be observed that the Betweenness Centrality network of popularity is similar to the information-sending network, except for Ctr-TL. Ctr-TL has low Betweenness Centrality in both the information-receiving network and the information-sending network, but has high popularity. An explanation for this is that although Ctr-TL does not occupy an important position in the network,

he does control, however, abundant information resources (High Degree Centrality). Ctr-PM, who has the highest Betweenness Centrality, still is the most popular. However, the actors at the margin of the information-exchange network indeed have a low level of popularity. We can thus argue that Betweenness Centrality, to some extent influences popularity, but not as evidently as Degree Centrality.

4.3. Closeness Centrality

Figure 3 presents Closeness Centrality in an information-receiving network, an information-sending network, and a popularity network; the larger the node, the higher its Closeness Centrality. Actors with high Closeness enjoy efficient and rapid access to information resources (Freeman, 1979). Examining the information-receiving network in Figure 3, it can be observed that more than half of the actors have relatively high Closeness Centrality. Thus, the information exchange in this network is effective as network paths are effective - high Closeness Centrality indicates the shorter distance between a specific actor and others. For instance, Ctr-PM has the highest Closeness Centrality, which means his being "in the thick of things" having the shortest distance and quickest speed to receive information from other key actors. Furthermore, Sct-SM has the shortest distance to approach other subcontractors and directly connects with important contractors such as Ctr-PM and Ctr-ED. Ctr-TL and Ctr-ED also have high Closeness Centrality. In contrast, other subcontractors have relatively low Closeness Centrality. They must go through Sct-SM or Ctr-SA to receive information from others. This adds the distance between subcontractors and contractors. It is worth noting that the high-status actors with leadership roles (Ctr-PM, Ctr-TL, and Sct-SM) are well positioned to readily receive information and to more quickly benefit from their high Closeness Centrality.

Figure 3: Popularity Network and Information Network—Closeness Centrality

A. Information Receive Network

B. Information Send Network

C. Popularity Network

Key: Cl-GR: Government representative; Cns: Consultant; Ctr-PM: Project manager; Ctr-APM: Assistant project manager; Ctr-PD: Project director; Ctr-FM: Finance manager; Ctr-SA: Security administrator; Ctr-ED: Engineer director; Ctr-TL: Technical leader; Ctr-PT: Professional technician; Ctr-QI1: Quality inspector; Ctr-QI2: Quality inspector; Ctr-QS: Quantity surveyor; Ctr-PE: Planning engineer; Ctr-APE: Assistant planning engineer; Ctr-FC: File clerk; Ctr-T: Technician; Ctr-A: Architect; Sct-SM: Subcontract manager; Sct-ME: Mechanical engineer; Sct-SE: Structural engineer; Sct-EE: Electrical engineer; Sct-W: Welder

Comparing between the information-receiving network and the information-sending network, it can be observed that the Closeness Centrality of key actors in the information-sending network almost remains the same as the information-receiving network. The figure further suggests that the higher the leadership position, the higher the Closeness in the information network. In other words, the higher the status that an actor enjoys in the project, the easier it is to access important information quickly. Ctr-PM, as the principal in the project, receives information from client, consultant,

contractors, and subcontractors with ease. However, actors occupying roles of less leadership status, such as Ctr-T and Sct-SE, have longer paths to follow to obtain information from other subgroups. On the one hand, it is not necessary for those specialists to communicate with all network actors as they may need to spend more time focused on their professional work. On the other hand, their relatively weak positions in the network indicate the small amount of information they will have access to.

Following a comparison between the information-receiving network, the information-sending network, and the popularity network, it can be observed that, on average, the result of Closeness Centrality of information networks conforms to the popularity network. The shorter the path to access information, the more popular the actor. That is why Ctr-PM, who has the highest Closeness Centrality, was the most popular person in the project, and similarly for Ctr-ED, Ctr-TL, Sct-SM and Ctr-SA. To the contrary, actors who had relatively low Closeness Centrality were generally less popular. It makes sense that the speed to which an actor reaches important information is a unique resource based on power. Leaders find it easier to receive or send information to others without passing through intermediaries. The more quickly the actor reaches a wide range of information, the more popular he/she is perceived. Therefore, Closeness Centrality is found to have a positive correlation with popularity.

5.   CONCLUSION

This study examined an important yet understudied aspect of the construction project social environment: communication centrality as an antecedent of the individual's popularity and it contributes to theoretical development of the concept by establishing "how" and "why" some project actors are more popular than others. Adopting a social-network perspective, SNA was used to analyse the networks of information exchange and popularity, based on collected data from 23 project actors on a live road-construction project in Baoshan City, China. The information-exchange and popularity networks were examined based on the SNA measures of Degree, Betweenness, and Closeness Centrality. Following a comparison between the networks of information exchange with the networks for popularity, a number of important conclusions could be drawn:

- Degree Centrality of an information-exchange network was found to have a high positive correlation with the popularity network, especially the information-receiving network. The prominent disseminators, those enjoying high Degree Centrality with many direct connections to other actors and access to more information resources—in our case the project manager, the technical leader, and the subcontractor leader—were found to enjoy high popularity.

- Betweenness Centrality of the information-sending network is correlated with that of the popularity network. Generally, actors who have high Betweenness occupy control positions in the network, thereby increasing their popularity. However, a project actor could become highly popular if he/she controls abundant information resources (high Degree Centrality) regardless of his/her Betweenness Centrality and, possibly, beyond the boundary of the network studied, such as having a job role with high status within the formal organisational hierarchy. This indicates that network centrality is not the only construct at play in determining popularity, and other concepts, e.g. status (Chen et al., 2003), relative power (Brass et al., 1998), and prestige (Belliveau et al., 1996) may have a significant impact in determining popularity, particularly in a high power-distance society, such as that of China (Hofstede et al., 1997).

- Closeness Centrality has also been found to have a positive correlation with popularity; with actors who are closer to others in the network being found to be more popular.

Overall, network "activity", represented by Degree Centrality, was found to be the most influential factor in predicting individual popularity. Such well-connected actors enjoy high visibility and access to a large amount of information resources, thus seen to be popular by their colleagues. Understanding why some project actors are more popular than others will help project managers better understand behaviour in project organisations and specifically behaviours that facilitate or inhibit effective information exchange. Some further work also needs to be done on personality characteristics in the context of organisational networks. In this way project managers may become more effectively equipped to build a collaborative project environment.

The study has yielded a number of interesting questions in need of further investigation. Particularly, the association between the concepts of centrality, popularity and coordination of information flows in project organisations. For example, what is the relationship between an individual's leadership qualities, such as their emotional intelligence and their popularity? We might ask whether the relationship between increased network centrality and popularity progressive or rather curvilinear, in that a tipping point may be reached at which network centrality negatively affects popularity. In addition, further research may examine the association between occupying such central and popular network positions on a team member's psychological wellbeing, experiences, and other intrinsic and extrinsic work outcomes (Anderson, 2008). Indeed, role ambiguity and role overload have been found to negatively affect individuals assuming more central positions in communication networks (Cullen et al., 2014; 2015). A longitudinal study that would explore popularity over time and its evolution during the lifespan of the project and perhaps between different projects would also be an interesting area of future research.

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