The Application of Social Network Analysis in the Construction Industry of Hong Kong

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Abstract

The Hong Kong construction industry is currently facing ageing problem and labour shortage. There are opportunities for employing ethnic minority construction workers to join this hazardous industry. These ethnic minority workers are prone to accidents due to communication barriers. Safety communication is playing an important role for avoiding the accidents on construction sites. However, the ethnic minority workers are not very fluent in the local language and facing safety communication problems while working with local workers. Social network analysis (SNA), being an effective tool to identify the safety communication flow on the construction site, is used to attain the measures of safety communication like centrality, density and betweenness within the ethnic minorities and local workers, and to generate sociograms that visually represent communication pattern within the effective and ineffective safety networks. The aim of this paper is to present the application of SNA for improving the safety communication of ethnic minorities in the construction industry of Hong Kong. The paper provides the theoretical background of SNA approaches for the data collection and analysis using the software UCINET and NetDraw, to determine the predominant safety communication network structure and pattern of ethnic minorities on site.

Keywords: Construction safety, communication, ethnic minorities, social network analysis, Hong Kong

1. Introduction

Recent statistics show that a total of 451,183 ethnic minority population is living in Hong Kong, accounting for 6.4% of the total population of 7,071,600 in 2011 (Census and Statistics Department 2013, p. 7). According to the 2011 Population Census Thematic Report on Ethnic

Minorities, 7.4% of male ethnic minorities were working in the construction industry of Hong Kong. This report also showed that Nepalese (23.2%) and Pakistanis (18.9%) constituted the highest percentage of male ethnic minority construction workers in Hong Kong (Census and Statistics Department 2013, p. 78). The construction industry involves hazardous activities and it is prone to higher accident rates. According to the Hong Kong Labour Department (2014), the construction sector had caused the highest number of fatalities and higher accident rate among all other industry sectors. In the last ten years, the total number of industrial fatalities in the construction industry were 194. In 2013, 22 fatal accidents were recorded in the construction industry, which is higher than the annual average of 19 fatalities in the past five years. Likewise, ethnic minorities (EM) have higher fatalities rate than their local counterparts. According to local newspaper archives from 2007 to March 2014, at least 27 major industrial accidents (including eight fatal cases) were reported among ethnic minorities in the construction industry of Hong Kong.

The Construction Workers Registration Authority (CWRA) (2014) reported that at the end of June 2014, 331,753 registered workers were working in the construction industry and around 42% of them were aged 50 or above whereas around 7% were below 25 years. Currently ten mega infrastructure projects, announced in 2007-08 policy address of the then Chief Executive with a total value of HK$49.6 billion (US$6.39 billion), are being carried out in Hong Kong and a tight completion schedule of these projects will pose challenges to the occupational safety and health of the construction workers. To meet the increasing demand of skilled labour, the Hong Kong Government has introduced a 'Supplementary Labour Scheme (SLS)' for importing skilled workers in a timely manner, resultantly the percentage of ethnic minorities has also increased. Recently, the Hong Kong Government has taken up a number of measures to assist ethnic minorities to join the construction industry. The ethnic minorities are being motivated to actively participate in various safety training courses in English and their EM native languages, arranged by the Hong Kong Construction Industry Council (CIC) and Occupational Safety and Health Council (OSHC). However, the ethnic minorities have high chance of construction accidents due to various reasons including communication barriers, unsafe working behavior and lack of safety trainings etc. Effective safety communication has been considered an important factor for a successful project delivery (Jefferies and Chen, 1999). Earlier researchers opined that open communication and frequent interactions between the frontline workers and their supervisors, and among the frontline workers are the characteristics that distinguish organizations having low incident rates from those having high incident rates (Smith *et al.* 1978 and Zohar, 1980). Smith *et al.* (1978) noted that immediate verbal feedback from frontline supervisors about safety hazards and safety alerts can also enhance the safety performance of workers. It has been recognized that the successful safety supervisors will openly discuss the safety issues and provide necessary guidelines to frontline workers (Mattila *et al.* 1994; Niskanen, 1994; Simard and Marchand, 1994). Other researchers have also recognized the safety communication as one of the top ten management practices having a significant impact on safety performance of workers (Hofmann and Morgeson, 1999; Sawacha *et al.* 1999; Bentley and Haslam, 2001).

Safety communication can be further categorized as formal and informal communication (Johnson *et al.* 1994). Formal communication can be induction trainings, morning briefings, toolbox talks, safety trainings, written rules and regulations. Informal communication can be informal discussions, posters and pamphlets. An effective safety communication structure for ethnic minorities is very important and it may have a direct positive impact on their health and safety to perform their requisite tasks and improve their overall productivity. SNA is an effective tool to measure safety communication structure among various project participants. SNA has been proposed and successfully used to look at information seeking behavior/relationships between individuals within the groups. Construction safety information is communicated through

different channels including the toolbox talks, morning briefings, safety promotional activities. SNA has also been used to study the means of communicating information between actors (workers). The success of this analysis suggested that it might be possible to use SNA to look at the interaction of ethnic minority workers. The actors are defined as people who consume safety information from and contribute information to other people (actors). The third set of definitions concerning the role that an actor might take – that is as consumer or contributor of information. SNA can provide incoming and outgoing flow of safety information. The definitions of the key concepts are provided in the later section.

2. Aim and Objectives

The aim of this research is to improve the safety communication of ethnic minorities in the construction industry of Hong Kong and the research objectives include; (i) to evaluate the safety communication problems of ethnic minorities; (ii) to evaluate the predominant safety communication structure and safety performance of ethnic minorities; (iii) to identify effective safety communication structure for ethnic minorities; and (iv) to recommend measures to improve safety communication of ethnic minorities. The duration of this study is 15 months started from February 15, 2014 to May 14, 2015. As part of the overall research study, the specific objective of this paper is to identify the organizational social network of safety communication structure of ethnic minorities on Hong Kong construction worksites, along with other key members within the project network. It will also look at how the ethnic workers are communicating with each other and co-ordinate with other local workers to get the work done safely. The paper is structured so as to lead the reader through the background and SNA concepts followed by the research method, data analysis and discussions based on 21 items SNA questionnaire. The last section discusses the conclusions and the future research work.

3. Application of Social Network Analysis in the Construction Industry

The idea of using SNA in other areas such as financial transactions and performance incentives, contractual relationships, a range of communication type and conflict resolution has been proposed by earlier scholars. Most notably SNA has been used in the construction related research by (Pryke, 2004; Chinowsky *et al.* 2008; Fang *et al.* 2010; Pryke, 2012; Alsamadani *et al.* 2013a; 2013b; Lingard *et al.* 2014). This research will be carried out into the use of SNA for looking at the safety communication network between construction workers and how they carry out their job on construction site. As the percentage of non-Chinese speaking (NCS) workers is continuously increasing in the construction industry of Hong Kong, attention must be paid to the impacts of communication barriers on construction sites. The recent shift towards SNA means the construction industry has to understand and respond to safety communication challenges faced by increasing number of migrant and/or ethnic minority workers. Fig. 1 provides some insight into the key members of the social network of a safety communication flow of a construction company. The persons with more links to others are more centrally positioned, hence the links are stronger (i.e., the more often those persons communicate and work together). Similarly, persons with fewer links and/or weaker ties inclined to be positioned more around the fringe of the network (Wambeke *et al.* 2012).
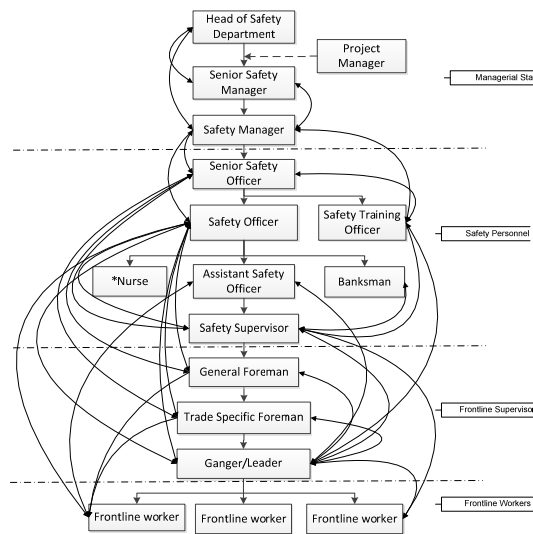
For civil projects, there is a contractual requirement to appoint a registered nurse
Figure 1. Work and safety management structure in the construction projects of Hong Kong.

3. Definitions and Concepts of SNA

The first reason is to test whether it would be possible to know the current communication network structure between actors (local and ethnic minority workers). Three simple relationship components can be identified between the actors in a network. Whether a tie exists between pairs of nodes; the direction of the relationship and how strong the relationship is. These relationships can provide us the information contribution (the sharing of safety information) and information consumption of actors in the network. Table 1 illustrates these relationship components with explanations and Table 2 provides a list of SNA concepts with explanations.

Table 1: Relationship concepts and safety communication (Adapted from Silburn 2006)

SNA concept	Explanations
a) Tie existence	Whether two or more actors or two entities or more entities are connected together by some kind of relationship.
b) Tie direction	In the context of safety information whether one actor provides safety information to another, received safety information from another actor or both.
c) Tie strength	It will provide an insight into how popular/central a person is in a safety communication network. Note that the tie strength may give more information why a node is popular or unpopular in a network.

Table 2: SNA approaches to the analysis of the network data (Adapted from Silburn 2006)

SNA concept	Explanations
a) Centrality (Haythornthornthwaite, 1996; Mead, 2001)	Centrality looks at the connections of each node and will therefore identify the popularity of actors in the network. Centrality not only reveals the prominence of actors in a communication network, but also reflects the effectiveness and efficiency of the flow of information in that network. In conjunction with Cohesion it could be useful in identifying the most popular safety network structure on construction site(s).
b) Degree centrality	Degree centrality shows the frequency of interaction. A high frequency of interaction is represented by a high degree centrality.
c) Cohesion	The cohesion will identify groups of actors with strong ties to each

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	(Haythornthornthwaite, 1996)	other. In this research we will look at the group of specific trade workers and ethnic minority workers groups.
d)	Betweenness centrality (Freeman, 1977; 1979)	Betweenness centrality relates to the frequency with which a given node falls between two other nodes. A high closeness centrality means that communication links are direct and that actors in network are closely connected. An actor with a higher value for betweenness has a better control over the information flowing through them. The actor might typically be performing as a gate keeper type of role i.e. ganger/leader.
e)	Bridge	The concept of bridge will help to identify which tie (relationship) if removed will interrupt the communication network and thus flow of information. A ganger/leader of a group is considered working as a bridge between frontline workers and management for communicating safety instructions.
f)	Density (Haythornthornthwaite, 1996; 2005)	The density will help identify to which actors in the network are connected with each other. It could be noted that the higher the density the greater the degree of connectivity.
g)	Core/periphery structures	This will help to identify key individuals around which other members of the team(s) revolve.

4. Research Methods

The purpose of this research is twofold. The first reason is to test whether it would be possible to know the current communication network structure between actors (local and ethnic minority workers) using SNA. Drawing on the published descriptions of the Alsamadani *et al.* (2013a; 2013b) work and the subsequent application of SNA techniques to the actors' interactions. In particular, it may be possible that SNA techniques could be used to observe safety information seeking (from whom and what information i.e. safety related, is requested) and information sharing (who is safety information given to and how frequent safety information is provided to).

This study is part of the broader research for which a combination of both quantitative SNA data along with qualitative case study analysis and interview data will be used to verify the results. The finalized SNA questionnaire will be distributed through the ethnic minority and industry network of the research team. The questionnaire will comprise two sections. In section A, respondents' background information, construction industry experience, green card trainings etc. will be collected. Section B will solicit about incoming and outgoing safety information including frequency of communication, mode of communication, media of communication and communication language etc. To capture current communication structure of ethnic minorities through the SNA approach, data will be collected on project basis (Loosemore, 1998; Chinowsky *et al.* 2008; Alsamadani *et al.* 2013a; 2013b). For the ethnic minorities who are not fluent in English or Chinese, the SNA questionnaire will be translated into different languages including Nepalese and Urdu. At least 20 project sites with 10 workers per site will be targeted (approximately 200 respondents), as the large dataset facilitates subsequent multivariate statistical analyses.

5. Data Analysis and Discussion

To better achieve the research objectives of a broader Public Policy Research project, descriptive statistics and multivariate statistics will be employed to examine the relationships among demographic variables, communication patterns and safety performance of ethnic minorities. SNA will be employed to find out safety communication structure and pattern for the ethnic minorities. This proposed study will focus on examining communication patterns which require a set of methods and analytical concepts that are distinct from the methods of traditional statistics

and data analysis. SNA is an ideal analytical tool to achieve these objectives. SNA is a recognized method of dealing with relational data (Pryke, 2012; Scott, 2000) and it has been employed in analyzing communication pattern in many earlier studies (Loosemore, 1998; Alsamadani *et al.* 2013a; 2013b). More importantly, SNA has a unique mathematical analytical power and sociometric visualization power to detect the patterns and implications of relationships (Wasserman and Faust, 1994). Measures of SNA such as network density, actor centrality, and betweenness of sociogram will be analyzed as defined in earlier sections. Cohesive subgroups will also be identified. The software UCINET and NetDraw will be used to conduct SNA in the proposed study (Borgatti *et al.* 2002). Because this is an exploratory research so initially 21 pilot test questionnaires were collected from one of the construction site in Hong Kong. Three groups (one Pakistani and two Nepalese groups) were selected working in different trades i.e. general workers (4 persons), scaffolders (9 persons) and steel fixers (7 persons). It is interesting to note that all groups were sharing face-to-face safety information more than once a day basis, a few were communicating once a day. The respondents were communicating through morning briefings, safety trainings, toolbox talks and informal discussions as the most frequently used communication mode, which is also supported by earlier research findings of Alsamadani *et al.* (2013b). Fig. 2 shows the sociogram of a two way communication for a Nepalese group. The sociogram depicts the number and patterns of connections between frontline workers and ganger for providing safety information on a daily basis. Ganger or team leader (J) is working as a bridge between the management and frontline workers which is a traditional and common practice in Hong Kong. Usually the ethnic minorities are working in groups of same nationalities to minimize the communication barriers and better coordination. In response to the question about emergency contact person, i.e. co-workers, native co-workers, ganger and foremen were approached (summary is shown in Table 3).
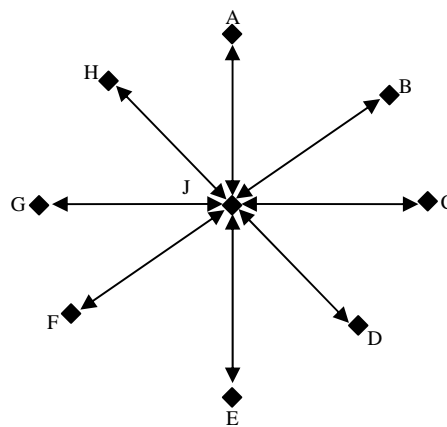
Figure 2. Selected daily safety communication sociogram for a Nepalese group (Adapted from Alsamadani *et al.* 2013a; 2013b)

Notes: The letters (A,B,C….,etc.) represent the actor name in the network. Each actor was represented by a 'node' ◆*Liens with arrows refer to the two way communication link 'relationship'*

Table 3: Overall SNA survey results (Adapted from Alsamadani *et al.* 2013a;b)

Safety communication		Pakistani	Nepalese
1. Frequency of communication	More than once a day	100% (4)	80% (14)
	Once a day	-	20% (3)
2. *Most common mode(s) of communication	Morning briefings	100% (4)	100% (17)
	Toolbox talks	75% (3)	25% (4)
	Safety trainings	25% (1)	35% (6)

		Informal discussions	100% (4)	65% (11)
3.	Most common communication tool(s)	Gestures (Body language)	-	25% (4)
		Face-to-face	100% (4)	75% (13)
4.	*In case of emergency whom do you contact?	Co-workers	-	20% (3)
		Only native co-workers	-	-
		Ganger/leader	-	70% (12)
		Foreman	100% (4)	10% (2)

*Total sample size=21, Pakistani=4, Nepalese=17,*Some of the respondents have chosen more than one option. Number of respondents is in parenthesis.*

6. Conclusion

The current ageing and labour shortage problem has prompted the construction industry of Hong Kong to attract more ethnic minority workers to join this hazardous industry. Hence the ethnic minorities are facing serious communication challenges when working with local workers. The use of social network analysis for the safety communication structure and safety performance of ethnic minorities provide a graphical and visual illustration through sociogram of coordination and cooperation that may be necessary for the complete project team network to work proficiently in a safe working environment. The overall findings of pilot test with 21 ethnic minority workers were echoed with earlier researches that *open and frequent communication* between frontline-workers and supervisors will enhance their safety performance. Morning briefings, safety trainings, toolbox talks, safety promotional activities were also noted on the construction site for improving the safety performance of the workers. Face-to-face was the most frequent communication tool used by ethnic minorities for interaction between the co-workers and front-line supervisors. In case of emergency, Pakistanis and Nepalese workers are frequently contacting foreman and leader of their group. Further research on the application of social network analysis is needed to look at the existing communication network structure and its impact on safety performance of ethnic minorities of Hong Kong.

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