

IDENTIFICATION OF FACTORS INFLUENCING COMMUNICATION BETWEEN PARTICIPANTS IN CONSTRUCTION PROJECTS

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Abstract: Effective communication among construction participants is important. The diversity in the composition of construction teams increases the communication complexity. Thirty-four factors affecting communication effectiveness between construction participants were identified from literature review. The major factors were identified and validated by conducting a questionnaire survey in Hong Kong. It was found that the top ranked factors affecting communication between construction participants include: the complexity of the project, the communication schedule and construction timescale, the number of participating companies, contribution of project manager, good spirit and trust between the parties etc. Through factor analysis, these factors were clustered into eight groups which build up a conceptual model for improved communication between construction participants.

Keywords: Communication; Construction; Factor; Factor analysis

1 Introduction

Construction projects have become technically complex with more design and construction activities. The multidisciplinary nature of construction projects requires management and execution by highly skilled, task organized project teams, usually by multiple organisations (Thomas et al., 1998). These teams are made up of many different companies and people with competing needs and interests (Blyth, 2001). Typically they include architects, engineers, consultants, contractors, sub-contractors, manufacturers, and government agencies.

The multi-organisational construction process depends heavily on the exchange of large amounts of complex data and information (Dawood et al., 2002). This information must be identified and disseminated among team members (Thomas et al., 1998). Project participants both want and need full, proper and timely information about all project related aspects so that they can make proper decisions for contributing to the successful implementation of construction projects.

To ensure information to smoothly flow and a construction project to function, it has to have a communication system that links the project participants. If there is effective communication between project participants, accurate technical information will be quickly communicated, as well as consensus decision will be easily achieved. It will improve team work, reduce conflicts and reworks, and then contribute to the project success.

2 Construction Communication

Proper and effective communication among project participants is known to have a critical influence on the performance of construction projects. Numerous studies have highlighted the importance of effective communications to project success. However, the communication is complicated by a number of factors.

Construction projects involve multiple project team members. Typically project team members are temporary; their knowledge and skills are specialized and fragmented; they have different organisational cultures; the organisations and the people are often involved in the project at different times (Blyth, 2001). The professions have also developed their own conventions and working habits independently (Watkinson, 1992). These diverse backgrounds and dynamic composition of these teams hinder the development of critical communications for these technically complex projects (Thomas et al., 1999). Usually there is lack of trust and relationships become adversarial. Construction projects have the bad reputation of fragmented, separation of design and construction activities, lack of coordination and the construction industry has become more

litigious (Emmitt & Gorse, 2003).

Except for the increasing number of specialist professionals, widely applied Information Technologies (IT) in today's construction projects contribute to the great challenge to the communication between participants in construction projects as well. Today, IT is developing along four main lines including standardisation, visualisation, communication, and integration (Mead, 1999). New and emerging Information and Communications Technologies (ICT) have changed and deepened the complexity of communication activities in construction industry, such as internet, multimedia, virtual reality, and broadband communication networks, etc. (Anumba and Evbuomwan 1999; Shen, 1992). ICT uses provide opportunities to solve coordination problems associated with construction fragmentation (Latham 1994, in Walker and Peansupap, 2004). These technologies may result in more efficient information transfer. However, it also brings some new problems such as information overload etc. How effective communication is under these technologies environment also need examining.

Therefore, these factors make project communication between project participants in construction project further complex which should be explored in both academic and practical areas.

3 Studies On Communication Factors

It is clear that good communications are fundamental to the construction process; however as Emmitt and Gorse (2003) said research on communication in the construction industry is scarce. They point out that “clearly construction communication research is in its infancy and we must seek to learn from those social scientists and industrialists from other sectors, who have recognised the importance of communication for some time”. But, this area attracts more interests in academic area recently. There are some research studies exploring the communication issues, examining communication variables, observing communication and interaction process etc. In looking at factors influencing construction projects communication, the writer has examined the work of other researchers on exploring factors influencing communication effectiveness.

Guevara & Boyer (1981) examined communication problems within a construction company and their influencing factors which are some interpersonal communication characteristics. They only identified the factors of the individual and the communication process characteristics. Lack of information about organisational and project characteristics restricted this study's conclusion. Xie (2002) examined communication problems in construction design in UK. She also identified the factors that caused these communication problems, and suggested consequent management strategies by conducting interviews in some case studies. However the communication factors were only identified through a limited number of interviews.

Little progress has been achieved in improving project team communications, especially during the construction phase (Thomas et al., 1999; Wong, et al., 2000). There is a lack of research that observes interaction of the construction manager and other key professionals at the construction stage. Research into the communication during the construction process tends to be focused on one particular event or one aspect of communication. Some of the variables relating to communication in construction have been studied at one point in time or another (Guevara, 1979; Emmitt and Gorse, 2003). Guevara's (1979) comprehensive study of communication in construction organisations found that all of the communication factors are related to each other. There has been few study on the relationship of these variables, therefore there is a need to review these variables and to find out how they are related. Effective communication between construction project participants is essential to the successful implementing of construction projects. However only Thomas et al. (1998, 1999) and Xie (2002)'s studies focus on the inter-organisational communication on projects.

Therefore, this study pays special attention to inter-organisational communication at the construction stage in construction projects. Communication among client, design team, main-contractor, and key sub-contractors at the construction stage in the building projects will be studied. Efforts have been put to explore all potential factors influencing project team communication including project and organization characteristics etc. Aiming to improve the communication effectiveness, the postal questionnaire survey is carried out to identify the major communication factors and to explore the relationship among the complex communication factors.

The survey will provide important insights into the communication between the construction project

participants and will help us to capture the most important aspects of communication and then further explore for improved communication effectiveness.

4 Methodology

4.1 Issues Identification

The factors influencing communication between project participants are the fundamental reasons that cause the inter-organisational communication problems between the construction participants and are crucial to the communication effectiveness in the project context.

After reviewing the previous studies, there are little studies focusing on identifying communication factors. To explore this research topic, interviews with project managers were arranged to identify the current practical communication issues and set up the focus area of the research. These interviews confirm there is a need to explore the communication between construction project participants.

The potential factors leading to the effectiveness of the project extracted from the literature were therefore confirmed by the questionnaire survey. The major factors were identified and the relationship among the factors were clarified.

4.2 Questionnaire survey

Before sending out large quantities of questionnaire, pilot questionnaire test was conducted to inquiry the meaning of the content and terminology of the questionnaire.

The research aims to improve communication effectiveness between the project participants at the construction stage of the project. The main participants in construction stage will be the target populations that are clients, main-contractors, design consultants and material suppliers and professional subcontractors. The context of the research indicates the population (Fellows and Liu, 2003). We will conduct the questionnaire survey mainly in Hong Kong. Therefore, the list of involved companies in building & construction related associations in Hong Kong have been used to initially set up the population.

This questionnaire seeks representatives from the every participant organisation during the construction phase of projects to provide opinions on communication issues. Communication problems, if they exist on the project, should be apparent and will be exacerbated at the first-supervisor level if information is incorrect or does not flow smoothly”(Thomas,1998). So, the project managers and the other first-line managers in each organisations are requested to complete the questionnaire.

The questionnaire comprises three sections: section I is designed to obtain general information about the participants and their companies; section II to investigate the effective communication factors; then, section III to in query other communication issues in the construction stage of a project.

A list of factors derived from the literature, interviews with three project managers and researchers’ observation as potentially influencing inter-organisational communication was identified for the respondents to provide opinion on the extent of influence of each factor to the effective communication on a five-point Likert-type scale.

4.3 Description of the questionnaire survey

There are 34 factors listed in the questionnaire which, together with a covering letter was addressed to the managing director of the firm. The letter indicated the objectives of the research and requested that the questionnaire be completed by a project manager in the firm.

In a postal survey the 689 questionnaires have been issued to industry representatives of Architects, Quantity Surveyors, Main contractors, Sub-contractors and Suppliers in the Hong Kong construction industry. The 100 follow-up questionnaires were sent to the top 100 contractors and architect. Nearly 100 questionnaires have been withdrawn due to different reasons..

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97 questionnaires were returned. The response rate is around 15%. 4 questionnaires were returned but not fill in and 3 of questionnaire weren't complete. That is totally 90 questionnaires which could be used in statistical analysis. Among the respondents, 33% need the report of outcome of questionnaire, which show their interests in the communication topic in construction industry.

We incorporated all respondents into four groups: Clients, Contractors, Consultants and Sub-contractors. Among the respondents, 50.0% of respondents were contractors, 27.8% were consultants, 15.6% were clients, and 6% were sub-contractors. Contractors and consultants predominate in the respondent firms.

Table 1 Mean percentage of the firms' workload

Workload	Building Work	Civil Engineering Work	Others	Total
Percent %	64.18	24.32	11.50	100

Table 1 depicts the workload of the firms involved in the survey. The major workload of the firms is building work. The implication is that the communication practice as presented in this postal survey could be regarded as relevant to building work.

Table 2 Designation of the respondents

Position	Overall percent %	Cumulative Percent%	Overall	Not indicate
Director	24.4	24.4	22	1
Senior manager	16.7	41.1	15	1
Project manager	28.9	70.0	26	1
Manager	21.1	91.1	19	3
Others	8.9	100.0	8	1
Total	100.0		90	7

Table 2 and 3 show the designation and the construction experience of the respondents, respectively. The respondents are mainly over the project manager level, with the more than 10 years construction experience. Therefore, the results of this survey can be believed.

Table 3 Construction experience of the respondents

Years	Percent %	Cumulative Percent	Overall	Not indicate
Over 30y	5.6	5.6	22	0
21-30y	25.6	31.2	40	1
11-20y	44.4	75.6	23	4
1-10y	24.4	100	5	2
Total	100.0		90	7

5 Data Analysis and Results

Two separate statistical analyses were undertaken using the Statistical Package for Social Sciences (SPSS). The first analysis ranked the factors based on mean value of response, compared the mean for the groups and provide an analysis of variance (ANOVA), which tests the null hypothesis that the mean of the dependent variable (individual factor) is equal in all the groups.

The second analysis was intended to explore and detect underlying relationships among the communication effective factors using factor analysis. Factor analysis is a statistical technique used to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables (Norusis, 1992). The principle component analysis for factor extraction is used in the analysis, the distinctive characteristic being its data-reducing capacity.

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5.1 Analysis and ranking of communication factors

As part of the analysis, the Cronbach alpha reliability (the scale of coefficient) is produced, which measures the internal consistency among the factors. Cronbach alpha reliability measure or tests the reliability of the five-point Likert-type scale used for the study (Norusis, 1992). The Cronbach's coefficient alpha is 0.933 (F statistic = 8.602, p = 0.000), which was greater than 0.5, indicating that the 5-point Likert scale used for measuring factors influencing communication in construction is reliable at the 5% significant level.

The first analysis ranking the factors based on mean value and standard deviation of all the sample results, shown in Table 4, indicated that the main factors (value of mean > 3.60) influencing communication in construction

Table 4 Factors influencing communication in construction ranking by mean value

	Factors	Min.	Max.	C•V %	S. D.	Mean	Rank
F3	The complexity of the project	1	5	21.39	.894	4.18	1
F27	The timing of the communication i.e. when the information is distributed relating to the construct process	1	5	23.01	.918	3.99	2
F6	The timescale for completion of the project	1	5	27.47	1.096	3.99	3
F10	The number of companies involved in the project	1	5	25.43	.974	3.83	4
F33	The contribution of the project manager	1	5	24.54	.930	3.79	5
F32	The good spirit and trust between the parties	1	5	25.63	.969	3.78	6
F21	A formal and visible communication system	1	5	24.19	.900	3.72	7
F2	The size of the construction project	1	5	27.04	1.006	3.72	8
F24	The quality of the information content	1	5	24.78	.917	3.70	9
F20	The medium used to convey the information, i.e. written documents by post, by telephone, by meeting, by bulletin, by email or by intranet etc.	1	5	29.05	1.069	3.68	10
F25	Clear classification of the information	1	5	24.60	.893	3.63	11
F5	Specific constraints on the project	1	5	26.38	.955	3.62	12
F8	The Project organisational structure	1	5	22.24	.803	3.61	13
F30	The information needs of the participants related to the different project activities and different project stages.	1	5	24.82	.896	3.61	14
F31	The project group culture	1	5	27.56	.992	3.60	15
	Valid N	90					

“The complexity of the project (ranking 1st)”, “the size of the construction project (ranking 8th)”, “the number of companies involved in the project (ranking 4th)”, were identified as the important project communication factor. Today, increasing technological complexity is shifting project control toward specialised subcontractors (Kubal, 1995). As noted by Baldwin et al (1998): more complex buildings have necessitated design input from an increasing range of specialist sub-contractors. This increasing number of specialist sub-contractors requires effective management of the interfaces between these organisations (Potter, 1995). It presents the project communication a great challenge.

The other important factors identified for project communication are “the timing of the communication, i.e. when the information is distributed relating to the construct process (ranking 2nd)” and “the timescale for completion of the project (ranking 3rd)”. They are all related to the communication time. Project Management Institute (2000) claims there should be a communication schedule which show when each type of communication will be produced. Other communication should be scheduled to meet the demands of the project participants.

“A formal and visible communication system (ranking 7th)” and “the project organisational structure (ranking 13th)” relating to communication channels were also identified. Guevara and Boyer (1981) argued the importance of a visible communication system through which project information would flow. This ability to process information depends largely on the structural characteristics of an organization (Mead 1999). Eisenberg (1985 in Mead 1999) noted that communication problems are often the result of unstructured organisational systems.

Same as the previous studies, “the contribution of the project manager (ranking 5th)” was identified the important communication factor by the survey. Project manager play an important role in the

communication and co-ordination activities during the project development. The other human issue identified is “the good spirit and trust between the parties (ranking 6th)”. Xie (2002) claims human issues, such as trust, respect, good working relationships and appreciation, can lower the communication barrier and build a good environment for communication.

“The quality of the information content (ranking 9th)”; “clear classification of the information (ranking 11th)”, and “the medium used to convey the information (ranking 10th)” were also confirmed as the important communication factors. It is easily understood because these factors are the fundamental communication process elements.

Some factors as “the computer hardware used by the project team”; “the number of professional staff employed specifically for information management purposes”; “the information security methods adopted on the project”; “the type of construction project”; and “the project location” were regarded as the unimportant factors.

5.2 Comparison of Different Groups

An analysis of variance (ANOVA) confirmed there is no statistically significant difference in the opinion of different groups classified by the respondent experience in construction industry, organisation type. This suggests that construction firms generally have similar opinions on the communication factors.

Independent samples two-tailed T-Test was used to test for the difference between the two independent groups with different working experience over 10 years and less than 10 years. The factor of “the format of the information i.e. written document, drawing photograph, or different type of soft document etc.” was ranked 20th overall, but this is a major factor for respondents having less than 10 years experience with a rank of 6th. The format is the specific characteristic of the document especially the technical information which the junior and new staff may usually deal with many kinds of the technical information. With the exception of the variable “the format of the information” that is significant at 5% level, there is no statistically significant difference of the other variables according to the opinion of different experienced respondents. That is the experience of the people who have completed the questionnaire document is satisfactory to make the responses worthwhile.

To compare the dependences of the different organisation type of contractors, consultants, clients and sub-contractors, an analysis of variance (ANOVA) was conducted, which tests the null hypothesis that the mean of the dependent variable (individual factor) is equal in all the groups. With the exception of “a formal and visible communication system”, “the person is responsible for producing and sending the information to the project participants”, “the relationship between the participant organisations prior to the commencement of the project”, and “the information load” variables, that are significant at 5% level, there is no statistically significant difference in the opinion of the different firms of the other variables. This suggests that the different construction participants generally have similar opinions regarding the factors influencing communication in construction.

The factor of “a formal and visible communication system” was ranked 20th and 29th by contractors and sub-contractors respectively, but this is a major factor for consultants and clients with a rank of 2nd and 7th respectively. The consultants and client is the major sender of the information who more emphasize on the how to send information through the communication system. Contractors and sub-contractors are the practicers of the construction who focus more on how to put the blueprint into the real projects. It is not surprising, therefore, the consultants and clients could pay more attention to communication channels and system. Consultants, the producer of the most technical information related to how to realize the project, pay more attention to the factor “the person is responsible for producing and sending the information to the project participants” and “the information load”. The factor of “the relationship between the participant organisations prior to the commencement of the project” was ranked in 17th and 9th position by the contractors and sub-contractors respectively compared with a rank of 22nd and 33rd by consultants and clients respectively. It may be due to the contractors and sub-contractor should coordinate all the groups in construction site and the low status in contract make them pay some attention to the long-term good relationship.

Overall, the analysis suggests that construction companies focus more attention on communication time,

communication channels and system and human perspective of communication. Comparatively, consultants and client more focus on the communication system and message; and contractors and subcontractors more focus on the human perspective.

5.3 Factor Analysis of Communication Factors

To explore and capture any multivariate relationship existing between the communication factors, the factor analysis technique was used to investigate the cluster of the relationship. This technique is appropriate (Hair et al., 1995) because of little a priori knowledge about the number of different cluster relationships to expect, and as the members of these different tendencies were unknown. The 34 factors were subjected to factor analysis, with principal component analysis and varimax rotation.

Based on the correlation matrix various tests are required for the appropriateness of the factor analysis for the factor extraction, including the Kaiser-Meyer-Olkin (KMO) measure of sampling accuracy, anti-image correlation, measure of sampling activities (MSA). The value of the MSA must be reasonably high for a good factor analysis. In this case, the value of the MSA was 0.648-0.905, suggesting no need to eliminate any variable from the analysis. Practically, the most important is the value of KMO, if the value of KMO > 0.6, the factor analysis is suitable, otherwise can compound or deleted some factors. The value of the KMO statistic is 0.812, which according to Kaiser (1974) is satisfactory for factor analysis. In essence, these tests show that factor analysis is appropriate for the factor extraction.

Since the purpose of factor analysis is to group variables into factors determined by factor loading, meaningful interpretation of the factors generated is important. Rotation techniques, such as the varimax method, transform the factor matrix produced from an unrotated principal component matrix into one that is easier to interpret. Then varimax orthogonal rotation of principal component analysis was used to easily interpret these factors.

Factor loading gives the correlation between variables and factors. Whilst factor loading of 0.30 is often used as a cut-off for significance, Nunnally (1978) suggests that it is doubtful that loadings smaller than 0.40 should be taken seriously. In this study, the criterion of the factor loading of 0.40 was used as a cut-off for significance.

The factors and associated variables which are shown in Appendix are readily interpretable according to the associated initial variables. The concept model for improved communication was therefore put forward as Figure 1.

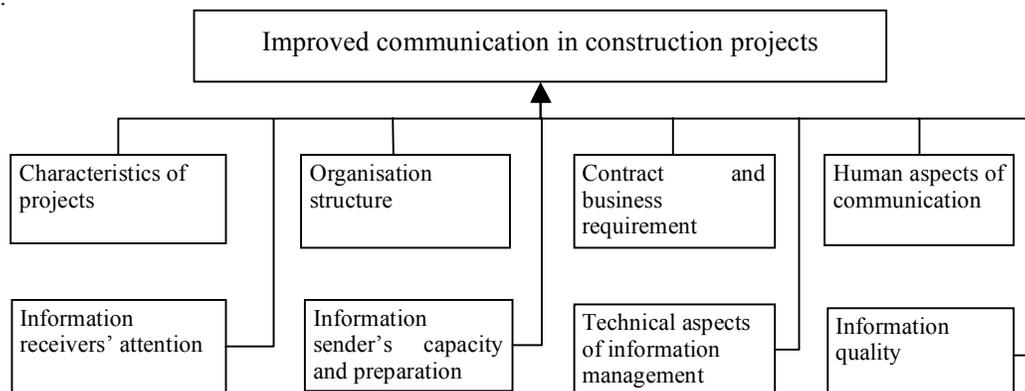


Figure 1 A concept model for communication improvement on construction projects

6 Conclusion

Some persons in the high position in the company have filled the questionnaire. Some respondents filled the questionnaire in earnest that could be seen from the open-ended section of the questionnaire. It shows that the construction industry have some interests in this topic.

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Project complexity, the number of involved companies; communication time schedule; project managers' capacity and the organization relationship; and communication process elements such as information quality and media choice are the important factors influencing project team communication effectiveness.

From the ranking of the factors influencing communication in construction, it shows that the focus of the issue related to communication is the business and management aspect not the IT aspect as well. It can't be drawn a conclusion. But it could be seen from the questionnaire that communication issues are related to the exchange of the information and the mutual interaction of communication but the communication problems mainly come from the conflicts of profits, distrust between the participants and no transparent communication line, not mainly come from the technical aspects.

Basically, there is no statistically significant difference in the opinion of different groups classified by the respondent experience in construction industry, organisation type. Construction companies focus more attention on communication time, communication channels and human perspective of communication. Comparatively, consultants and client more focus on the communication system and message; and contractors and subcontractors more focus on the human perspective.

The factors are further grouped into eight factors by factor analysis: technical aspect of information management; characteristics of projects; human aspects of communication; information receivers' attention; information sender's capacity; organisation structure; contract and business requirement; information quality. Then the further improved strategies could be explored based on these eight aspects of communication factors.

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Appendix: Factor analysis grouping using varimax orthogonal rotation

Factor1: Technical aspect of info. mgt.	Factor2: Characteristics of projects	Factor3: human aspects of communication	Factor4: Information requirement analysis	Factor5: Communication system	Factor6: Organisation structure	Factor7: Contract and business requirement	Factor8: Information quality
V16.The computer hardware used by the project team	V2.The size of the construction project	V32.The good spirit and trust between the parties	V29.The information load	V19.The Person is responsible for producing and sending the information to the project participants	V8.The Project organisational structure	V11.The alignment of the objectives of the participant organisations	V4.The quality of the information content
V18.The number of professional staff employed specifically for information management purposes	V5.Specific constraints on the project	V33.The contribution of the project manager	V30.The information needs of the participants related to the different project activities and different project stages.	V22.The circumstance of project i.e. communication system under the emergency of things e.g. fire condition; crisis circumstance.3	V9.The participants organisational structures	V12.How familiar the participants are with the type of contract	V3.The relationship between the participant organisations prior to the commencement of the project.
V26.The Information Security methods adopted on the project	V3.The complexity of the project	V31.The project group culture	V28.The frequency of information transfer i.e. The number of information transmissions within in a specified period.	V21.A formal and visible communication system			V5.Clear classification of the information
V23.The format of the information i.e. written document, drawing photograph, or different type of soft document etc.	V1.The type of construction project	V27.The timing of the communication i.e. when the information is distributed relating to the construct process					
V15.The financial investment in information management	V6.The timescale for completion of the project						
V17.The computer applications software used by the project team	V34.The business emphasis of the company i.e. the desire to maximize profit						
V14.The Information Management Policy	V4.The type of procurement method used on the project						
V20.The medium used to convey the information, i.e. written documents by post, by telephone, by meeting, by bulletin, by email or by intranet etc.	V0.The number of companies involved in the project						
V7.The Project location							