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Stakeholders Analysis and Communication for Utility Relocation in Construction Projects

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***Abstract*—Construction projects often involve complex underground utility networks that need to be relocated before the construction commences. It is often difficult to recognize the key stakeholders and manage the expectations, or even prioritize resource allocation among the stakeholders during such project. Therefore, practical investigation and interviews with experts are conducted to define the 25 key stakeholders, who are then evaluated based on their significance using six attributes - power, interest, influence, impact, legitimacy and urgency with two-round Delphi method. The 25 stakeholders are classified into 3 groups - Intensive, Intermediate, and Standard using k-means clustering technique. During the study, common communication issues associated with utility relocation are compiled. Their significance is compared through questionnaires and their relationship to Groups Intensive, Intermediate and Standard are also analyzed. The result can provide practical references for communication and coordination during utility relocation projects.**

***Keywords*—Utility relocation, Communication, Stakeholders, Project management**

I. Introduction

Communication among the different stakeholders in the construction industry is complex and difficult to control, especially when the projects involve utility relocation in urban areas due to the fact that most utilities are underground and each is under a different jurisdiction with different specialization. Hence, it is critical to identify the stakeholders in a utility relocation project and manage their expectations in the early stage.

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Most scholars emphasize the importance of communication in a project, which reflects the principal role of communication in ensuring the effectiveness of construction projects[1][2][3][4]. In addition, Olander and Landin [5] and Aaltonen et al. [6] mentioned that an important issue for a project management team is to identify those stakeholders who can affect the project, and then manage their differing demands through good communication in the early stages of a project. Yang et al. [7] proposed as many as 15 critical success factors (CSFs) for stakeholder management in construction projects. Communication has long been recognized as a crucial element in project management, while stakeholder analysis could be regarded as the hinge in communication. However, though most managers agree on how critical effective communication is to the project success, little progress has been achieved toward improving communication effectiveness [3]. In the field of construction engineering and management (CEM), research studies concerning stakeholder analysis are also sporadic. Therefore, this study focuses on communication management, specifically, the utility relocation projects for the Mass Rapid Transit System in Taipei (MRT) with in-depth exploration on stakeholders, their priority, and the communication issues.

Stakeholders involved in utility relocation for the MRT in Taipei City are identified and analyzed to explore their level of significance. The research process is shown in Fig. 1. Based on the discussion with construction engineers, initial key stakeholders and coordination issues are identified. 6 attributes are also consolidated through literary review to classify the stakeholders and produce the Delphi questionnaire. 2-round Delphi Method is applied to analyze the 6 attributes for each stakeholder. Based on the results of the questionnaire, the stakeholders are classified into 3 groups using k-means clustering technique. Meanwhile, the weights of key communication issues are determined through questionnaires. The issues and the stakeholders are then used to establish the relational matrix. Finally, the recommendations for coordination are proposed.

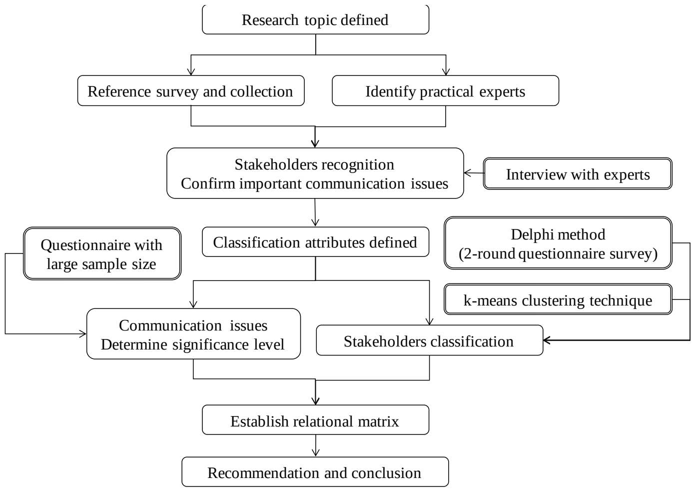

Figure 1. Research process

II. Stakeholders Recognition of Utility Relocation

When the design phase of the MRT project is complete, the conventional MRT utility relocation process began by going through planning, information gathering, inter-departmental meetings, public notices and meetings, construction and acceptance. Fig. 2 illustrates this process. Project teams must pay attention to the needs and expectations of all units during each stage and apply them toward the initial planning stage. The initial planning stage must include drawings with the correct utility type; number required for each type, and address possible conflicts among each type of utility. To reduce uncertainty between the utility location and the MRT structure, utility entities have to understand the scope and detail of the project before the construction begins. These entities can also conduct site inspection to gain an actual understanding of the on-site conditions and communicate with each other at the information gathering stage. Before the public notice is posted, the client, Department of Rapid Transit (Taipei City Government), holds inter-departmental meetings to record the coordination process among each entity. The minutes of the meeting will be the basis of measuring project performance or modifications. The purpose of the public notice and meeting is to present the detailed construction schedule and road safety planning for the local residents, businesses and organizations involved.

The actual relocation may only take a few days, but the first 4 stages may take months due to the number of stakeholders involved and their different agenda, which requires a complex communication process. For example, gas may fall under the responsibilities of different companies. Ultra high-pressure pipes and part of the high-pressure pipes are under the jurisdiction of the Gas Corporation, while the low-pressure pipes, medium-pressure pipes and some of the high-pressure pipes belong to Natural Gas Co. Ltd. The electrical power lines are also the most widely spread and the most complicated utility system. After aggregating and

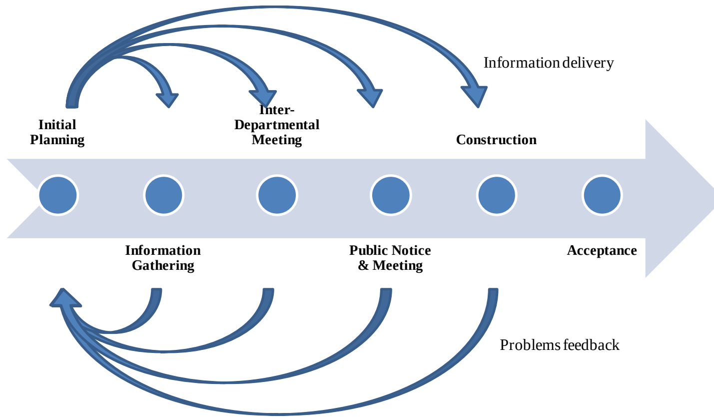

Figure 2. Relocation construction process

TABLE 1. STAKEHOLDERS OF THE UTILITY RELOCATION ROJECTS

Stakeholders
1. Taipower Power Supply Station
2. Taipower District Office
3. Chunghwa Telecom District Office
4. The Parks and Street Lights Office, Taipei City Government
5. Traffic Engineering Office, Taipei City Government
6. Network Transmission Squad of the Signal Group, Army Corps
7. Fixed Line Companies
8. Telecommunication Companies
9. Cable Companies
10. Storm Drainage Section of the Hydraulic Engineering Office, Public Works Department, Taipei City Government
11. Sewage Systems Office, Public Works Department, Taipei City Government
12. Engineering Division, Taipei Water Department
13. Taipei City Fire Department
14. Natural Gas Companies
15. Client (Department of Rapid Transit, TCG)
16. Material Suppliers
17. Utility Contractors
18. Local Traffic Police
19. Local Police
20. Local Borough Office
21. Local Representatives and Council Members
22. Local Community Management Center
23. Local Financial Sector
24. Local Businesses
25. Local Residents

organizing these entities, 25 significant stakeholders are identified and listed in TABLE 1.

In practice, the engineers respond to the needs or expectations of the 25 stakeholders based on the scenario in which the issues occur as well as the resources and limitations within the project. This approach may apply the limited resources toward the initial stage of the project rather than toward the most critical issues or stakeholders, which may severely limit resources available later on when negotiating with key stakeholders. If the stakeholders' level of significance can be classified and the resource allocation can be prioritized based on objective attributes, the use of project resources can be more efficient. Additionally, the engineers evaluate the stakeholder's level of significance directly with subjectivities. When differences in opinions occur, there is a lack of objective means to convince each other. Thus, a systematic and objective approach to classify the stakeholder attributes will be beneficial for building consensus among the engineers. It will also help devise the best possible means for communication and negotiation among the stakeholders from different classification with different levels of significance. The goal of this study is to explore ways of utilizing objective attributes from multiple perspectives and the clustering technique from data mining to classify the stakeholders in utility relocation projects. The following is an overview of literatures addressing stakeholder classification in utility projects.

III. Literature Review

According to "A Guide to the Project Management Body of Knowledge" [8], stakeholders are individuals and organizations that are actively involved in a project or whose interests may be affected as a result of project execution or project completion. Many scholars have discussed stakeholder classification. Olander and Landin [5,9] used the power/interest matrix to identify stakeholders and their influence on the projects. They also presented the stakeholder impact index to analyze the stakeholders. Olander and Landin [10] further analyzed two railway development projects in Sweden and found that in one case, the project manager identified 6 groups of stakeholders in the initial stage of the project, including project owner, authorities and politicians, the public, local trade and industry, employees and suppliers, and the media . Mitchell et al. [11] identified power, legitimacy, and urgency as the three attributes for classifying the stakeholders into 7 groups. McElroy and Mills [12] proposed five different levels of stakeholder positions toward the project - active opposition, passive opposition, not committed, passive support and active support. Newcombe [13] applied the power/predictability matrix and the power/interest matrix to classify the stakeholders and analyze their influences. Bourne [14][15] used the Stakeholder Circle methodology to classify and prioritize stakeholders, develop strategies and monitor effectiveness. Rowlinson and Cheung [16] identified stakeholder classes as upstream stakeholders, downstream stakeholders, external stakeholders, invisible stakeholders, and project stakeholder group. Yuan et al. [17] divided the stakeholders in Public-Private Partnership projects (PPP) into 4 groups based on their roles. In addition, Yang et al. [18] collected and classified the potentially useful approaches in stakeholder management. They are power/interest matrix, stakeholder circle methodology and social network analysis. An array of methods and attributes are used in the above studies to classify the stakeholders and they have achieved different results. However, the classifications are not entirely applicable for utility relocation projects.

IV. Methodology

A. *Delphi Method*

The Delphi concept was developed by the American defense industry [19]. It collects the opinions of the experts in the related field through questionnaire to deal with complex issues. Its characteristics include anonymity, iteration with controlled feedback and statistical response. To keep the experts from influencing each other's opinions, the Delphi utilizes one to several rounds of questionnaires in an anonymous fashion. Generally, the number of rounds varies between 2 and 7 and the number of participants ranges from 3 to 15 [20]. Delphi method is a popular and simplistic way to collect expert opinions and has been applied in CEM in recent years. Hollowell and Gambatese [21] had conducted in-depth research on this subject and proposed a suggested Delphi procedure. Chan et al. [19] also stressed that the success of Delphi lies in the careful selection of the panel members. Based on the above referenced research, the following three criteria were devised in order to identify eligible participants for the current Delphi study:

1. Practitioners with extensive work experience in utility relocation;
2. Experts with sound knowledge and understanding of utility relocation concepts;
3. Experts with current, recent or direct involvement in the management of utility relocation.

According to the above principles, 13 questionnaires (one for each panel member) were distributed. The 13 panel members were managers, official representatives, or senior engineers who have over 10 years of experience in related projects with college degrees or above. In addition, the recipients of the questionnaires are from both public and private sectors, including 7 from electricity, telecommunications and gas sectors, 6 from the MRT construction units, design consulting firms and construction companies. The background of each panel member is provided in TABLE 2.

B. *K-Means Clustering*

Clustering is the art of finding groups in a data set. The relevant algorithms have numerous scientific and practical applications, such as artificial intelligence, pattern recognition, medical research and CEM. In general, clustering analyses can be divided into various categories based upon their principles and algorithms, for example, grid-based methods such as CLIQUE [22], STING [23], MAFIA [24]; partitioning methods such as k-means [25][26]. The traditional clustering methods have various advantages. They are generally simple, requiring little CPU time and easy applying in large database systems. Different algorithms that improve upon the traditional clustering approaches have emerged. However, high-dimensional clustering is used for the 25 stakeholders in this study and does not require complex

TABLE 2. BACKGROUND OF EACH PANEL MEMBER

No.	Entity	Position	Degree	Experience Years
1	Taiwan Water Corporation	Senior Engineer	Bachelor	Above 20
2	District Offices of Water Corporation	Manager	Master	Above 15
3	MRT construction contractors	Person in charge Site Superintendent	Master	Above 10
4	South District Project Office Department of Rapid Transit System	Senior Engineer	Master	Above 20
5	East District Project Office Department of Rapid Transit System	Senior Engineer	Bachelor	Above 20
6	MRT construction contractors	Person in charge	Master	Above 10
7	Railway Reconstruction Bureau	Senior Engineer	Master	Above 20
8	Taipower District Office	Senior Engineer	Bachelor	Above 20
9	Taiwan Fixed Line Company	Manager	Master	Above 15
10	Network Management Department of Telecommunication Companies	Person in charge Lead Engineer	Bachelor	Above 20
11	Gas Company	Manager	Bachelor	Above 20
12	Consultant Companies for MRT	Person in charge	Master	Above 20
13	Taipower District Office	Senior Engineer	Master	Above 15

clustering algorithm. Traditional clustering methods would suffice. k-means clustering is chosen for this study because of its simplicity and speed. This method is often characterized with two disadvantages. First, it can only be applied toward numeric data. However, the data used in this study is numeric in nature and the numeric clustering algorithm is appropriate. Second, the user must specify the initial number of clusters. In this case, the number of clusters has been determined from the questionnaires and k-means clustering is used to create more precise clusters to reach the final results.

k-means clustering aims to classify n observations into k clusters in which each observation belongs to the cluster with the nearest. The definition of "nearest" is determined by the Euclidean distance among the elements. It is an iterative clustering algorithm in which items are moved among sets of clusters until the desired set is reached [27]. The cluster mean Ki = {ti1,ti2,….tim} is defined as

$$m_i = \frac{1}{m}\sum_{j=1}^{m} t_{ij} \quad (1)$$

where t is elements, k is clusters, and m is mean value.

The simple k means from Waikato Environment for Knowledge Analysis (WEKA) are adopted to analyze the stakeholders. WEKA is a machine learning software written in Java and developed by the University of Waikato, New Zealand. It supports several standard data mining tasks such as clustering and classification.

V. Classification of Stakeholders and Coordination Issues

A. *Classification of stakeholders*

The Delphi questionnaire assigns a seven-point Likert scale for the 6 attributes of each of the 25 stakeholders. The 6 attributes, which are obtained from the previously mentioned researches [5][8][11][13], are power, interest, influence, impact, legitimacy and urgency. In order to understand the characteristics of each stakeholder, all 6 attributes are included in the questionnaire. The meaning of each attribute is described as follow[8][10][28].

1. Power: The power of stakeholders may arise from their ability to mobilize social and political forces, as well as from their ability to withdraw resources from the project organization.
2. Legitimacy: Legitimacy can be defined in terms of stakeholders who bear some sort of risk in relation to the organization, be it beneficial or harmful.
3. Urgency: The dynamic character of stakeholder influence is covered by the term 'urgency', which is defined as the degree to which claims (or stakes) call for immediate attention.
4. Interest: Interest refers to the stakeholders' level or concern regarding the project outcomes.
5. Influence: Influence is the stakeholders' active involvement in the project.
6. Impact: Impact means the stakeholders' ability to affect changes to the project's planning or execution.

The analysis of the questionnaire is shown in TABLE 3. A two-step classification is applied toward the 25 stakeholders.

TABLE 3. AVERAGE OF ATTRIBUTES FOR STAKEHOLDERS FROM QUESTIONNAIRES

Stakeholders \ Characters	Power	Interest	Influence	Impact	Legitimacy	Urgency
Taipower Power Supply Station	***4.9231***	***5.5385***	***6.0000***	***6.3077***	***5.6154***	***6.8462***
Taipower District Office	***5.6923***	***5.8462***	***6.0769***	***6.3846***	***5.9231***	***6.7692***
Chunghwa Telecom District Office	***5.2308***	***6.0000***	***6.0000***	***6.0769***	***5.5385***	***6.1538***
Storm Drainage Section of the Hydraulic Engineering Office, Public Works Department, Taipei City Government	***4.8462***	***5.0769***	***5.1538***	***6.0769***	***6.2308***	***5.0000***
Natural Gas Companies	***5.3846***	***6.1538***	***5.8462***	***6.2308***	***5.7692***	***6.8462***
Engineering Division, Taipei Water Department	***5.0000***	***5.3846***	***5.9231***	***6.1538***	***5.8462***	***5.8462***
Client (Department of Rapid Transit Department, TCG)	***5.5385***	***6.0769***	***6.2308***	***5.4615***	***5.5385***	***5.0769***
Sewage Systems Office, Public Works Department, Taipei City Government	4.9231	4.9231	5.0769	5.9231	5.7692	4.7692
The Parks and Street Lights Office, Taipei City Government	4.3846	4.4615	4.6923	4.3846	5.2308	5.0769
Traffic Engineering Office, Taipei City Government	4.3846	4.7692	4.8462	4.6154	5.3846	5.7692
Network Transmission Squad of the Signal Group, Army Corps	3.8462	4.6923	4.3846	4.1538	5.5385	5.3077
Taipei City Fire Department	4.5385	5.0000	4.8462	4.6154	5.3846	5.2308
Fixed Line Companies	4.6154	5.3846	4.4615	5.0000	4.7692	4.7692
Telecommunication Companies	4.3077	5.1538	4.3846	4.7692	4.5385	4.5385
Utility Contractors	4.5385	5.3846	4.6154	4.3077	4.0000	3.9231
Local Representatives and Council Members	4.5385	4.1538	4.0769	3.6923	4.0000	3.0000
Local Businesses	3.6923	5.6154	3.9231	3.5385	3.5385	3.4615
Local Residents	3.8462	5.4615	3.6923	3.3846	3.3846	3.1538
Cable Companies	***4.2308***	***4.8462***	***4.1538***	***4.4615***	***4.3846***	***4.3846***
Material Suppliers	***4.3077***	***4.3846***	***4.0000***	***4.0769***	***3.9231***	***3.6923***
Local Traffic Police	***4.2308***	***4.4615***	***4.6154***	***3.8462***	***4.3077***	***3.3077***
Local Police	***3.6923***	***4.2308***	***4.3846***	***3.2308***	***4.2308***	***3.0769***
Local Community Management Center	***3.4615***	***4.1538***	***4.0769***	***3.0769***	***3.3077***	***2.3846***
Local Borough Office	***4.1538***	***4.4615***	***4.0769***	***3.4615***	***3.6923***	***2.7692***
Local Financial Sector	***3.4615***	***4.3077***	***3.3077***	***3.2308***	***3.5385***	***3.8462***
Average	**4.4708**	**5.0369**	**4.7538**	**4.6585**	**4.7754**	**4.6000**

As indicated in TABLE 3, there are 7 stakeholders whose score for each attribute is less than the average value. The score of the attribute for Power in Material Suppliers is 4.3077, which is less than the overall average for Power at 4.4708. Meanwhile, the score of the attributes for Interest, Influence, Impact, Legitimacy, and Urgency in Material Suppliers are 4.3846, 4.0000, 4.0769, 3.9231, and 3.6923, respectively. They are less than the average values of their corresponding attributes: 5.0369, 4.7538, 4.6585, 4.7754, and 4.6000. Therefore, these 7 stakeholders are classified into a group. Another 7 stakeholders with higher-than-average values for each attribute are sorted into one group. No clear pattern is identified in the remaining 11 stakeholders and therefore, theyare temporarily grouped together. Because of the classification result in the first step, the initial group numbers of k-means is determined as 3. The simple k-means of WEKA is then adopted to classify the 25 stakeholders with high dimension attributes. According to the classification result from k-means and the significance of each group in terms of communication, the 3 final groups are identified, which are Intensive, Intermediate, and Standard. TABLE 4 shows the result from the final classification and the average value of attribute (standard deviation) of each group.

The values of nearly all attributes of stakeholders in Group Intensive are higher than the average. Some of the stakeholders in Group Intensive are under Taipei city departments, which have the authority on project changes and hold significant influence over the project. Other stakeholders have the jurisdiction over more than 70% of the utility lines in the city that are closely associated with the residents' daily lives. The major stakeholders in Group Intermediate are the public utility entities. There are fewer utility lines under their jurisdiction and the lines are smaller in size, which makes it easy to maintain and to change initial placements. Group Standard includes stakeholders such as local residents or businesses. Basically, stakeholders in this group support the MRT project because it will promote local business opportunities and convenience. Their needs require attentions and should be addressed appropriately during construction.

TABLE 4. CLASSIFICATION RESULT AND THE ATTRIBUTE AVERAGE (STANDARD DEVIATION) OF EACH GROUP

Group	Stakeholders	Power	Interest	Influence	Impact	Legitimacy	Urgency
Intensive	1. Taipower Power Supply Station 2. Taipower District Office 3. Chunghwa Telecom District Office 4. Storm Drainage Section of the Hydraulic Engineering Office, Public Works Department, Taipei City Government 5. Natural Gas Companies 6. Engineering Division, Taipei Water Department 7. Client (Department of Rapid Transit Department, TCG) 8. Sewage Systems Office, Public Works Department, Taipei City Government	5.1923 (0.2979)	5.6250 (0.4376)	5.7885 (0.4029)	6.0769 (0.2692)	5.7788 (0.2157)	5.9135 (0.8199)
Intermediate	1. The Parks and Street Lights Office, Taipei City Government 2. Traffic Engineering Office, Taipei City Government 3. Network Transmission Squad of the Signal Group, Army Corps 4. Taipei City Fire Department 5. Fixed Line Companies 6. Telecommunication Companies 7. Utility Contractors 8. Cable Companies	4.3558 (0.2273)	4.9615 (0.3102)	4.5481 (0.2291)	4.5385 (0.2528)	4.9038 (0.5255)	4.8750 (0.5516)
Standard	1. Local Representatives and Council Members 2. Local Businesses 3. Local Residents 4. Material Suppliers 5. Local Traffic Police 6. Local Police 7. Local Community Management Center 8. Local Borough Office 9. Local Financial Sector	3.9316 (0.3672)	4.5812 (0.5247)	4.0171 (0.3531)	3.5043 (0.304)	3.7692 (0.3419)	3.1880 (0.428)

B. *Coordination Issues*

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This section covers the common communication and coordination issues during utility relocation. Questionnaires with large sample size were conducted to assess the significance of these issues, which are then analyzed against the clusters of stakeholders to determine their relationships. TABLE 5 reveals 16 important issues, which often occur during utility relocation projects. The issues, if not properly resolved, may pose negative effects of various degrees on the projects. The questionnaires were sent to 62 engineers who have been involved in utility relocation projects in the past. Among which, 32.26% are with over 20 years of experience; 38.71% with 10 to 20 years of experience; 29.03% with 2 to 10 years of experience. The public sectors account for 33.87% and the private sectors 66.13%. In terms of education, 1.61% have high school education or below, 50% have college degrees and 48.39% have master degrees or PhDs. The issues raised are common and yet significant. However, over partitioning the level of significance will not be beneficial and may cause confusion. Thus, the three-point Likert scale is used for the questionnaire. The significance of each issue is determined by the percentage of each among the 62 questionnaires. TABLE 5 shows the relationships between the issues and the groups. For Issue 2 in TABLE 5 – damages to the fiber optics network, 16.13% of those who filled out the questionnaires think that its significance should be rated at the level of standard; 33.87% think it should be intermediate; 50% think it should be intensive. The significance of this issue is determined as intensive. Similarly, for Issue 15 – construction induced hazards, 56.45% of those who took the questionnaires rated this issue as standard. Thus, the significance of this issued is determined as standard. The connections between each issue and each stakeholder are then used to establish the matrix. For example, Issue 2 is related to Group Intensive and Group Intermediate and therefore marked with a "◎" where the issue intersects with each group. TABLE 5 shows the key issues which each group must deal with. Overall, the issues related to Group Intensive are relatively more critical and sensitive, which may cause construction delay or increase in costs if not addressed properly. Therefore, Group Intensive should receive more support and resources during the communication process.

TABLE 5. MATRIX OF SIGNIFICANT ISSUES AND GROUPS

No.	Issues	Level of Significance			Groups		
		Standard	**Intermediate**	**Intensive**	**Standard**	**Intermediate**	**Intensive**
1	Damages to the existing facilities and utilities from the dig, especially the old gas lines, may be disastrous, and it is difficult to define the responsibility.	8.06%	33.87%	***58.06%***	-	-	◎
2	Damages to the fiber optics network.	16.13%	33.87%	***50.00%***	-	◎	◎
3	Delineation of responsibilities for damages to nearby houses.	14.52%	40.32%	***45.16%***	◎	◎	◎
4	The stakeholders are unable to control the time for the switch from the old electric power lines to the new.	22.58%	37.10%	***40.32%***	-	-	◎
5	During construction, fire hydrants are often overlooked and damaged as a result. In addition, space for the fire fighting apparatus to maneuver is not enough.	12.90%	***59.68%***	27.42%	-	◎	-
6	The network of underground utilities is complicated. The new utilities need to be constructed before the old utilities are demolished. The space for construction and for the traffic to function normally is inadequate	9.68%	***53.23%***	37.10%	-	-	◎
7	Not every telecommunication company can attend all communication meetings during construction, which may lead to communication gap.	32.26%	***51.61%***	16.13%	-	◎	◎
8	For national defense and security reasons, the utility network under military jurisdiction is not known to the public. Hence, the possibilities of damaging the military utilities are higher.	37.10%	***50.00%***	12.90%	-	◎	-
9	It is difficult to acquire properties that can accommodate the utilities deep under city roads.	22.58%	***46.77%***	30.65%	-	-	◎
10	The result of hydraulic analysis does not meet the new regulatory requirements, which are reviewed and updated every year.	27.42%	***46.77%***	25.81%	-	-	◎
11	Street lights and traffic signals need to function normally during construction.	12.90%	***45.16%***	41.94%	-	◎	-
12	Jurisdictional distinctions are complicated and responsibilities are unclear, which require additional time spent on coordination.	19.35%	***43.55%***	37.10%	-	-	◎
13	Most stakeholders often ask the authority to deal with the utility conflicts. The contractor needs to use many different types of equipment to deal with minor problems. The process and financial obligations may be confusing.	33.87%	***40.32%***	25.81%	-	-	◎
14	It may take up to 6 to 8 months to prepare for the amount of materials required. A large quantity of materials needs to be reserved in advance but the material cost fluctuates greatly on the international market. Price adjustments stipulated in the contract cannot keep up with the fluctuation during construction.	27.42%	***40.32%***	32.26%	-	-	◎
15	Construction induced hazards.	***56.45%***	32.26%	11.29%	◎	◎	-
16	Local residents often ask for additional local benefits, which may be causes for plan modifications, additional costs or project delay.	***46.77%***	37.10%	16.13%	◎	-	-

VI. Recommendations

What to inform, when to inform and what type of inputs are to be sought from the stakeholders depend on the nature and level of stakeholders' participation [29]. Shohet and Frydman [4] investigated the communication patterns, and found that 48% of communications at the construction manager level were carried out through verbal means, while 52% were performed using formal technical means. In fact, the choice of communication methods is closely related to the complexity of the problems and stakeholder's characteristics.

A Guide to the Project Management Body of Knowledge [8] listed several communication methods for sharing information among project stakeholders. They can be broadly classified into Interactive Communication, which is a multidirectional exchange of information between two or more parties; Push Communication, which is sent to specific recipients who need to know the information; Pull Communication, which is used for very large volumes of information or for very large audiences where the recipients' own discretion is required when accessing the information. The former is the most efficient way to ensure common understanding among all participants on specific topics.

Based on the different communication requirements of each group, Fig. 3 shows the relationship among the utility relocation processes, different groups of stakeholders, and recommended communication methods based on those listed in PMBOK. During the initial planning stage, entities responsible for the construction should study the contract, construction drawings, and check the number and locations of utilities. Meanwhile, they also need to collect all related information and use formal or informal communication modes to deliver the information to Groups Intensive and Intermediate. If necessary, it is suggested that the stakeholders are invited to survey and confirm the actual site condition. The objective is to provide enough information to the significant stakeholders to reduce uncertainty. Hence, Interactive communication is a key method to communicate with Groups Intensive and Intermediate. During the construction stage, the responses of Group Standard should be considered. It is important to hold public meetings before the construction begins so that stakeholders in Group Standard can understand the construction schedule and the traffic and environmental impacts of construction through the meetings. The stakeholders can even comment and raise questions about the construction. If the entities can communicate with each other as early as possible; complaints and oppositions can be minimized. In order to save time after the public meetings, it is recommended that the Push and Pull communication methods be adopted first with Interactive communication as the supplement when communicating with Group Standard.

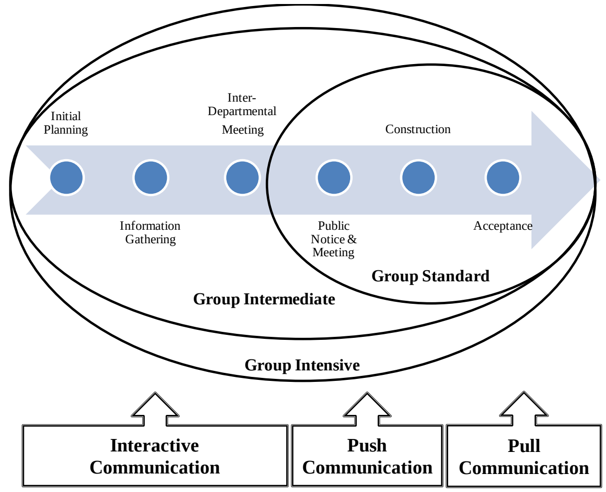

Figure 3. Relationship among the processes, stakeholders, and communication

VII. Conclusions

Stakeholder analysis is yet to see increasing academic exploration in the field of CEM and this study will hopefully serve as a reference. The research adopts expert investigation, 2-round Delphi method and simple k-means clustering technique to identify 25 related stakeholders and evaluate their significance level with six key attributes - power, interest, influence, impact, rationality and emergency. With the result of the analysis, the 25 stakeholders are classified into 3 groups. Group Intensive includes governments and major public infrastructure. The scores of the 6 attributes in this group are the highest, which indicates that this group requires more attention and resources and take priority in utilizing project resources. Group Intermediate includes basic infrastructures and they directly impact the local residents. Therefore, the expectations and needs of this group should be dealt with cautiously. Most stakeholders in Group Standard are local residents and entities. Although the scores are the lowest among the three, Group Standard should be kept informed and monitored. In addition, key issues that typically arise during coordination among the stakeholders in each group have been compiled. For the sensitive issues including those listed in TABLE 5, the coordinating unit may formulate corresponding strategies and determine resource allocation in advance according to the characteristics of each stakeholder to improve communication efficiency. The communication methods were briefly discussed in this paper with initial recommendations. However, these are areas that may be further explored in future studies.

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About Author (s):

Good communication is vital to the success of a project, and good communication depends on whether you understand the stakeholders.