Effective Information Processing between Users and Developers during Information System Project Development

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Abstract

When users participate in information system (IS) project development, the lack of linkage between developers and users may hinder the achievement of effective information processing. The purpose of this study is to explore the effect of various linkages on information processing capacity. This paper studied information flows of seven projects in an IT company in Singapore. Analysis archival data revealed that different patterns of communication nets were employed during development. The use of different communication channels is observed at different stages. However, the results should be considered tentative as only archives were studied.

Keywords: IS project development, information processing, communication net

1. Introduction

The effective management of software development projects remains a central problem for both practitioners and researchers in information system (IS). Complex software applications are rarely developed “on time and within budget” [14, 24]. Fortunately, both researchers and IS professionals generally agree that user participation is an important factor in the successful development of system [10, 16]. The issue that IS project development managers must grapple with is not whether users\textsuperscript{1} should participate in the development process, but how they should participate.

The literature on user participation has developed along two conceptual levels. The macro level acknowledges that user participation is beneficial and provides general approaches for achieving this objective [15, 25]. The micro level focuses on providing a wide variety of specific techniques to aid in the process of determining user requirements [6, 17]. However, the existing literature fails to study how developers\textsuperscript{2} exchange project-related information with users.

Studies show that effective information processing is achieved by matching information processing requirements with information processing capacity [4, 11, 19, 22, 28]. However, such a match is not achieved easily when users participate in project development for two reasons. First, it is unclear how the communication network is structured when users participate. Second, even though communication channels have been studied thoroughly on their capacity of processing information [8, 23], no research was found on the role that communication channels play at each stage of project development process. Hence, the purpose of this study is to examine above questions.

This paper explores ways by which information processing between users and developers during development was carried out by examining communication patterns of seven projects. It employed analysis of secondary data as research method by examining archives of seven projects in an information technology company in Singapore.

2. Research Framework

Information processing refers to the gathering, interpreting, and synthesis of information in the context of organizational decision [28]. The uncertainty faced by a project determines the need for information processing. It is defined as the difference between information possessed and information required to complete a task [7,

\textsuperscript{1} Similar to other studies on IS projects users include project sponsors and end-users in this paper.

\textsuperscript{2} The term “developers” in this paper means the various individuals who are directly involved with the development of IS project, including the project manager and team members.
The higher the uncertainty is, the higher is the need for information processing.

Information amount and information richness are two dimensions related to information processing capacity. Information amount is defined as volume or quantity of data about organizational activities that is gathered and interpreted by organization participants [5]. Information richness is defined as the ability of information to change understanding within a time interval [4]. Information processing capacity is affected by project structure, project formalization, project centralization, and climate [4, 23, 27, 28]. In this paper, the impact of project structure on information processing capacity is going to be discussed.

One way of thinking about the impact of project structure on information processing capacity is by focusing on the impact of project structure on patterns of communication [28]. A highly connected communication network provides a higher level of information processing capacity than a hierarchical structure. Recently, most projects are organized as project teams [2, 20]. One of the benefits that teams provide to project managers is the increased information processing capacity because a highly connected communication network could be structured in a team [20].

During IS project development, a project team includes at least two hierarchical levels: the project manager and team members [1, 12, 21]. The project manager is the one who has the authority to make the final decision in a project team. Team members are those who are directly involved with the development of IS project. A deputy project manager and sub-groups may be required in a project with staff exceeding 20. This paper assumes two hierarchical levels exist in a project team for analysis convenience (see figure 1).

![Figure 1. IS project organizational chart](image)

Similarly, at least two hierarchical levels exist in the users’ organization (the project sponsor and end-users). A third party sometimes exists for collecting end-user’s requirements and transferring them to the project sponsor. To make the problem simple, the structure with two hierarchical levels is analyzed in this paper. It is assumed that the project sponsor is responsible for gathering requirements from end-users and transferring them to the project team, and is the one who makes the final decision among users. The term ‘project sponsor’ may refer to a group of people in this paper when more than one person attends the work of collecting end-user’s requirements. Thus, the communication between users and developers is the communication between two groups, each of which has two hierarchical levels.

The network analysis reveals three possible links between these two groups [18]. They are the link between managers, the link between a team member and the project sponsor, and the link between a team member and an end-user. Each of them employs the different capacity to process rich information. The leanest information is processed between users and developers when the communication between two groups occurs only at the manager level. Richer information is processed when team members can exchange information with the project sponsor directly. The richest information can be processed when all of three links exist in a communication net.

Information processing between users and developers is driven by the frequency of communications and the communication channels used when they exchange project-related information [10, 11]. The amount of information processed between users and developers is related to the frequency of communications, while the need for richness is related to the selection on communication channels because communication channels vary in the capacity to process rich information [4]. In the order of decreasing richness, the channel classifications are team meeting, telephone call, email, presentation and formal report [8][23].

The choices of communication channels and the frequency of communication are different at each stage of the development process because project teams face different levels of uncertainty over the development process. Stages are defined in terms of focus and dominant activities in this paper [11, 13]. A project may go through stages indicated by specific landmarks or events that cause project members to shift focus though activities that characterize one stage may continue into the next stage or be revisited at later stages.

Three stages of IS project development process are defined in terms of focus and dominant activities in this paper. They are R&D stage, implementation stage, and integration and system testing stage. Two tasks will be done during R&D stage. First, user’s requirements will be collected and analyzed. Second, a detailed description of the system to be developed will be given and the implementation methods will be determined. During implementation stage, those requirements will be coded and tested. Finally, the software modules will be combined into a single system and be tested at integration and test stage.

Developers face the highest requirement uncertainty at R&D stage [3, 26]. Such uncertainty can only be reduced through frequent information processing between users...
and developers. In addition to requirement uncertainty, developers face the greatest equivocality of information at R&D stage too because of the different terminology and different focuses between users and developers. Thus, the richest information processing is required at R&D stage in order to avoid problems caused by equivocality. Therefore, besides selecting communication channels that can process rich information, project structure should also match the intensity of information processing required. All three links are required in order to process rich information. First, the project sponsor transfers user’s requirements to the project manager and his team members. Second, team members sometimes communicate with the project sponsor directly when they meet on an ad-hoc basis to discuss the requirements. Finally, in order to understand user’s working process and avoid mistakes, team members gather needed information from end-users directly sometimes.

After the user requirements and the system have been specified and confirmed, team members will realize them at implementation stage. The need for information processing between users and team members is the lowest. A detailed and well-structured design specification leads to relatively smooth and straightforward coding or programming unless users propose additional requirements on the system. Furthermore, the cooperation between developers and users during the R&D stage provides learning that results in the decrease on the equivocality of information processed. Therefore, lean and less information is processed between users and developers at this stage. The communication occurs at the manager level unless the users have additional requirements. When this happens, team members may join the communication net. However, since requirement uncertainty may still exist, the unmanaged uncertainty will be problematic at the next stage, which results in an increased need for information processing at integration and testing stage.

Users need to acquire a detailed level of understanding and skill in order to conduct user testing at integration and testing stage. In addition, the problems discovered during testing should be solved as soon as possible to avoid prolonging the testing period. Thus, the need for rich information is higher than the need for the amount of information. In order to match the need for rich information, developers must select communication channels with the higher capacity of processing rich information. The communication net at this stage is somewhat different from those at the last two stages. The need for the communication at the manager level is low since few significant decisions will be made at this stage. On the contrary, the need for communicating with testers or end-users directly is the highest. Thus, the link between a team member and an end-user plays the most important role at testing stage than the other two links.

3. Methodology

This study employed the analysis of secondary data as the research methodology. Archives, as a kind of secondary data, have following strengths [29]. First, archives provide researchers stable information, which can be reviewed repeatedly. Second, reading archives is unobtrusive for the studied subjects, because archives are not created as a result of the study. Third, archives contain exact names, references, and details of an event. Finally, the whole process can be understood because archives cover the long span of time and record many events.

The field site of our research is an information technology company in Singapore. Before reading archives, we talked to a deputy director and a team manager about our project’s objective and gained access to the archives on seven projects. The projects were selected randomly. The items studied include project correspondence file, project quality records file, project working papers file and some deliverables such as project brief, project plan and project history document.

The characteristics of seven projects were collected. The data were obtained from project briefs, project plans and project history documents. Project briefs and project plans were made at the beginning of the projects, while project history documents were made when the projects were completed. From project briefs and project plans, we knew the participants, the target customer, and project constraints. Project history documents were the summaries of the projects, which included brief description of projects and the evaluation of the projects.

Project performances were known through reading the questionnaires the organization sent to customers when the projects were completed. The questions included the degree of satisfaction with the coordination activities with the company, with the product, and with the overall project management. However, such questionnaires were found for only three projects.

Information about project structures and communication networks was collected from the following sources. Project structures were stated clearly in project plans. From project plans, we identified the names of project manager and project members, their roles and responsibilities in the projects, and the relationships between them. After that, the communication networks were identified from correspondence files, which included records of team meetings, emails, and faxes. Since we had known the names of project managers and project members, it was easy to identify communication nets from the records of their correspondences. Additional information about communication patterns was obtained by interviewing the
deputy director and the team managers, who had been in charge of or had taken part in the projects that are studied. The interviews revealed the way information was exchanged between people in this IT organization and its clients.

Data about the media used, the purpose of communication, and the frequency of communication were collected from project correspondence files. The minutes of team meetings noted the decisions made in the meetings, the tasks that had been done in the last week, the tasks that were to be done in the next week and the persons who were responsible for the tasks. In addition to minutes of team meetings, the records of emails provided a lot of information too. These included the nature of the problems, the person who first identified the problems, and the responses to the problems. Therefore, it was easy to trace the flow of information through reading the records of emails and team meetings.

However, archives did not indicate the frequency of communications through telephone calls and informal communications. Thus, this paper did not study the informal communication and the telephone call although they have impact on the information processing between users and developers, too. In addition, it was not known whether records of emails were complete. Hence, the calculation on the frequency of communication between developers and users may be on the conservative side.

4. Results and Discussion

4.1. Description of projects

A brief description of seven projects is given before the findings are presented and discussed in the next section. The company that was studied is denoted as company A. The customers that took part in the development are called company B, C, D, and E respectively.

A resource based learning system for home users was developed for Company B in project 1. The whole project lasted 19 months. The project team was composed of eleven people. Three of them were from the customer (Company B). The project sponsor (who was called “the representative of the customer” in the archive of project 1) was in charge of collecting user’s requirements, solving problems in users, and being the coordinator between the developers and the users. The project manager from Company A was in charge of transferring user’s requirements and problems to the project team, responding to users, and being the bridge between team members from Company A and users from Company B.

Project 2 was developed for Internet users of Company C. The development period was two months. The project team was composed of seven people. Three of them were from Company C. End-users were assumed to be familiar with the standard web browser in this project. The project sponsor (i.e. representative of Company C) had the authority to sign off the project deliverables and was responsible for higher level tracking, management and review of the project. The project scope and the project resource were most flexible, but the project schedule was least flexible in project 2. After the project was completed, Company C evaluated the coordination activities with company A as 5 out of 7 (7 means the most satisfied).

A timetable planning system for schools was developed for Company B in project 3. Company A cooperated with Company B for the first time in Project 3. The user’s characteristic was described as “the end-users are those who are familiar with their work but need the education of using software”. Project 3 was developed twice because of frequent requirement changes. Phase I and phase II stand for these two development periods respectively. The duration of Phase I was 11 months, and the duration of Phase II was 13 months. In phase I, the project team was composed of eight people. Three of them were from Company B. People from Company B were responsible for providing Company A all data needed for development. Unfortunately, “the project failed to be delivered on time because the requirements were changed many times during development”. Some procedural changes were made in Phase II. One of them was that team members gathered user’s requirements from end-users directly in Phase II. A questionnaire was sent to the customer after the project was completed for evaluation. User’s satisfaction on the product was evaluated as 5 out of 7 (7 means the most satisfied).

In project 4, an upgrade version of an information retrieval system was developed. It enhanced the features provided by the last version and provided more complete reusable core components. The project had been developed in 9 months by Company A solely. The team was composed of seven people. The users were assumed computer literate. The project constraint was that one of core components must be completed before March 1996.

In project 5, a schedule system for a port was developed for Company D. The project lasted 23 months. Programmers must know as much as the users about the user’s domain first in Project 5. Seven people from Company D participated in the development. They were responsible for providing data needed for the development and testing the developed system.

Project 6 was developed for users of some Internet applications for Company E. The development period was 10 months. End-users were “computer literate, but needed to be trained to understand the input requirements and results produced by the software”. The development of the software was dependent on the reliability and
stability of the tools/algorithm selected and data availability. Company A developed the project alone, but a project sponsor from the customer (Company E) was responsible for reviewing and approving major deliverables.

A resource based learning system was developed for company B in project 7. It was an overhaul and redesign of the previous version. The duration of the project was 14 months. Six people from Company A and six people from Company B took part in the development. The end-users of the system needed to be trained on the use of software. The assumption on requirements was “requirements of the system specification are stable and changes to it are minimal after baseline”. The project sponsor was responsible for gathering and transferring requirements and was the one who asked for the changes to the requirements. A prototype was written and used for requirements specification during R&D stage. End-users were invited to participate in the usability test of prototype and provide feedback.

4.2. Discussion

The findings on communication patterns are going to be presented and discussed in this section. The communication nets discovered in the archives will be discussed first. Next, communication channels used at each stage will be discussed.

Two types of communication nets were observed in the archives. The first type of communication net reflected the communication within the studied company only. In the second type, the linkage between developers and users was showed.

The communication flow in project 4 is an example of communication within the studied company. The communication patterns were known from the correspondence records. Since the users did not participate in the development, few records were found on the communication between users and developers.

Figure 2 described the communication network when no user participated in the development as in the case of project 4. The project leader was the one who facilitated communication among team members. Team members usually exchanged the project-related information directly with each other via email but they always sent a copy of their communications to the project leader and their direct supervisor using the function “CC” at the same time. An open communication was achieved in a project team in this manner. The lack of records on the communication between users and developers makes it impossible to ascertain how the requirements were gathered from users. However, it was known from the project history document that “the customer is very pleased with the deliverable”, but the customer wished that “there should be more meetings (between developers and users)”. Different from project 4, communication nets in the other six projects showed the communication between developers and user. Users participated in the development among these six projects. They exchanged project-related information with developers and were well informed during development process. Their names were always on the correspondence list. Thus, the communications in these six projects should be seen as the communication between users and developers.

Users participated in the developments of these six projects in different manners. The project sponsors were responsible for gathering user’s requirements and transferring them to the developers in project 1, project 3(phase I), and project 5. The user’s characteristics were assumed at the beginning of the project in project 2 and project 6. The project sponsor from the customer was responsible for reviewing and approving major deliverables in these two projects. In the second phase of project 3, team members from Company A gathered requirements from end-users directly. Although team members did not pick up requirements from end-users directly, end-users were invited to participate in the usability test of the prototype and provide feedback in project 7. Thus, there are two kinds of communication nets in these six projects.

In the first kind of communication net, there are two links between users and developers, which were the link between the project manager and the project sponsor (see link 1 in figure 3) and the link between a team member and the project sponsor (see link 2 in figure 3). The communications in project 1, project 2, project 3(phase I), project 5 and project 6 belonged to this one (see link 1 and link 2 in figure 3). In the second kind of net, all three links exist. Such a net was found in project 3(phase II) and project 7 (see link 1, link 2 and link 3 in figure 3). Figure 3 showed the communication network when users participated in the development. Project sponsor here
could be a person or a group of people responsible for the project in users.

Developers collected requirements from the project sponsor via team meeting or email in the first kind of net (i.e. only link 1 and link 2 were observed). However, the capacity for information processing could not match the need for gathering user’s requirements sometimes when the project sponsor was the only source of requirements. Following statements were found in archives of project 3 (phase I).

“The requirements given to the developers were not the requirements needed by the end-users.” In project 3 (phase I), the project sponsor was responsible for gathering user’s requirements and transferring them to developers. Obviously, such a mechanism did not work well in project 3 (phase I). More links were needed to increase the capacity of information processing between users and developers.

In fact, the company learned from its experience on developing project. On the second phase of project 3, team members gathered user’s requirements from end-users directly, which helped them understand user’s problems and avoid some changes later. The team members spent one month gathering requirement from end-users. They went to the field site and talked to end-users personally using a questionnaire as a guide. The items asked during the site visits included requirements on setup, movement, block slot, and so on. The system was developed for 14 users, and fourteen requirement lists were found in archives. The diversity on requirements discovered through such a requirement collection process ranged from scheduling breaks at different times to different definitions of what constitutes a day. After the diverse requirements were identified, some constraints were made in requirement specification document, which was approved by the project sponsor from company B. For example, the break was designed as “Break and lunch are to be treated as two different subjects if specified. Breaks are generated due to the maximum number of continuous period constraints.” After delivery of the system, the company sent questionnaires to the end-users to check the satisfaction. The user’s satisfaction on the product was graded as 5 out of 7.

Besides differences in communication nets, differences also were found in the use of communication channels at each stage. Three channels were studied, namely team meeting, email, and reports.

At R&D stage, two communication channels were selected when developers communicated with users. One was the team meeting and the other was email. Minutes of the team meetings indicated that they were held once a week. During the meeting, developers showed the project sponsor the work that had been done and the work that should be completed in the following week. User’s requirements were transferred from the project sponsor to developers in the meeting. For example, the project sponsor provided input data the system needed to developers on team meetings in project 5. In addition, the design problems were discussed and decided in the meeting. For example, in project 6 the type of date that the model will generate was discussed in a team meeting. However, team meetings sometimes could not match the developers’ need for gathering requirements. For example, the requirement collection should have been completed in January 1996 in project 5, but “the developers could not proceed straight into the development phase because the data required is not available” (Known from progress report of February 1996). Actually, the user requirements and system proposed documents were completed three months late.

In addition to team meetings, email was another communication channel used at R&D stage, except for project 5 and project 3(phase I). No email records were found in the archives for these two projects. Since there was no opportunity to talk with the project manager, the reason that the email was not used could not be determined. Ad-hoc issues were solved via emails. For example, the ideas on the selection of tools and algorithms were discussed via email among all participants from both companies in project 6 although the decisions were made in the weekly meetings. However, there were occasions when email could not match the need for information processing. For example, a team member in project 1 complained: “Email is terrible for holding a conversation, esp. if it’s 3-party/4-party talk. Too many messages flying too often, bloody confusing, half the time I lose of whether I am involved or
just another name in the long CC list". Such a situation exists because every member had to email a copy to his/her supervisor when he/she discussed problems with people from other groups or other companies.

After the user requirements and the system have been specified and confirmed, developers realize them at implementation stage. No minutes of team meetings and the records of emails were found at implementation stage after requirements had been confirmed. The monthly progress reports were found in project 1, project 3 (phase II), project 5, project 6, and project 7. The development period of project 2 was two months and no progress report was made during development. The project did not go into implementation stage in the first phase of project 3. Several issues were included in the progress reports. The reason for deviation from planned target and the major work completed in a month were reported. For example, it was known that "development was delayed due to redesign of some of the C++ classes" from one of progress reports of project 5. In addition, the accumulated change request for a month and other useful information for project management were found in the progress reports. For example, changes on entry problem were reported in a progress report of project 3. Several defaulted codes were defined in the system. However, such definitions may lead to testing problems because the defined mode may not be what that users are familiar with. For example, end-users believed that "the input data should be 0,1,2,3 instead of 0, 1" in an input module of project 3.

A project enters the testing stage after the major modules have been developed. During testing stage, email became the major communication channel between users and developers again. In project 7, weekly team meetings with test team were held, but such statements or minutes of meetings were not found in other five projects. Team meetings were held for the sign-off of projects, which was known from the emails for meeting arrangement. Besides the arrangement of meetings, following information was transmitted via email: testing plan (who, when, how and expected results), changes on testing plan and testing results. Sometimes, the extra file needed for testing was sent by email, too. For example, a DLL file was sent to the tester via email when it was found missed in the original package in project 3 (phase II) and the instruction to installing it was given at the same time. However, not all problems at the testing stage could be solved via email. In some cases, team members needed to visit the field site. A typical unsuccessful example for using email at testing stage was testing loading model in project 3. Team members first informed the representative of users on the testing procedure. Two days later, the tester sent an email to the project leader telling him that the model did not work. After finding out that a file was missed when the system was installed, the leader sent the file and instructions to the tester via email. However, the problem could not be solved yet after several iterations of communication via email. Finally, a team member went to the field site personally to solve the problem.

5. Conclusion

This paper studied information flows of seven projects in an information technology company in Singapore. Analysis of secondary data was employed as the research method.

The analysis of archival data revealed that different patterns of communication network were employed during IS project development. Three possible links exist in a communication net when users participate in project development. Different communication channels are used at different stages of project development process. At R&D stage, team meetings and emails play an important role in the communication between users and developers. However, routine project progress reports take their place at implementation stage after user requirements and system specification have been confirmed. After the confirmed user requirements and system specification are implemented, a project enters the testing stage. At that time, email becomes a major communication channel between users and developers again.

Since this study employed the analysis of archival data as the research methodology, the results of this study are affected by the weakness of archives. First, only three communication channels were studied: team meeting, email and formal report although other channels such as informal communication and telephone call have impact on the information processing between developers and users too. Second, we assumed that the archives include all records of communication via team meetings, email and formal report. Hence, the calculation on the frequency of communication between developers and users may be on the conservative side.

6. References


