An Examination of Computer-mediated Communication for Engineering-Related Tasks

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Abstract

This study aims to understand the course of communication media selection in cross-organizational engineering teams on high-tech product development. We argue that, although collaborative engineering tasks have been highly internationalized, communication media development for the pervasive global technological activities has not been sufficient, and thus when complex product design in connection with numerous technological issues is discussed on computer-mediated communication, the challenges can be more. This study conducted a multiple-case study approach, involving four case studies regarding inter-organizational collaborations on high-tech product developments. Participant observation was employed as the primary method of data collection, and extensive data was collected and analyzed. This research has found that high reliance on email communication among the participant organizations ultimately contributed to conflict occurrence, and the research findings for theoretical and practical implications are discussed.

1. Introduction

Computer-mediated communication (CMC) with its potentials to overcome temporal and spatial barriers has become a prevalent communication platform for individuals and organizations alike [20, 39]. This is important in an increasingly globally distributed environment and the emergence of inter-organizational virtual collaborations. However, interactions in a virtual communication environment are deemed more challenging than in face to face (FTF) communications due to the lack of social cues [12] and the often “lean” media characteristics [10].

There are various forms of CMC media available, and several media selection theorists have investigated why and how different communication media are selected, e.g. [9, 14, 31, 38]. Most of the previous researchers in this field have studied one communication medium or have compared two different media: mainly FTF meetings versus an electronic medium, such as email [39, 40]. However, employees often use various communication media, both traditional and electronic simultaneously rather than solely traditional media (e.g. FTF meetings and telephone calls) or electronic media (e.g. email and teleconferencing), to collaborate with colleagues who are geographically dispersed. The premise of this paper is that both FTF and CMC means exist commonly in business settings and, in this regard, little research has explored distinct communication behavior in the combined use of communication media [3].

This study takes a focus on the use of CMC in globally distributed cross-organizational engineering teams that work on high-tech product development. Collaborative engineering tasks have extensively been internationalized and dispersed [2], nonetheless the development of effective communication technologies for the pervasive globalization of technological activities has not yet reached an advanced state. One of the challenges for cross-organizational engineering teams is related to the adaption of their task-oriented communication in connection with complex technological issues into a virtual communication environment. Hence, this study investigates email, teleconferencing, telephone and FTF meetings, each representing a different level of media richness, and remains open to any other effective communication tools that emerge during the course of the fieldwork.

Appropriate media selection can make the difference between effective and ineffective communication, and thus it can even improve or impede group task outcome [19] and organizational relationships [37]. For this reason, it is important to understand why team members choose different media to manage their projects, particularly for high-tech product designs.

In what follows we present the conceptual foundations of the study which are based on media selection theories. Then, we present the research sites comprising four case studies, and the main research method, participant observation, that was adopted primarily for data collection and interpretative analysis. The findings show that in these cases there has been an increasing use of email communication in engineering projects, despite the complex nature of the tasks involved; nevertheless, the results have also revealed
that FTF though rare is still highly valued by the globally-dispersed project teams.

2. Communication media selection theories

Several theories have been developed to explain the phenomenon of communication media selection. Three key theories are information richness theory [9], social influence theory, e.g. [16, 35, 44] and situational determinants [37]. These are discussed below.

2.1. Information richness theory

Information richness theory identifies rich and “lean” media by their objective properties and the invariant characteristics of the media themselves. According to this perspective, the FTF meeting is considered the richest medium, whereas the CMC tools are judged to be rather lean. The theory explains that the different attributes of communication lead to choices of media depending on the level of information richness required [9]. For instance, higher information richness media are chosen for equivocal communication and lean media are selected for that with less equivocal content [9, 10, 33]. The information richness theory has been extended to channel expansion as proposed by Carlson and Zmud [4]. In this, the relationship between quality of communication and the attributes of the media is considered. Te’eni [36] reviewed the relevant studies and divided the impact of communication on organizations into that which is action-oriented and that which is relationship-oriented. This claim implies that organizations cannot exist without social communication.

Previous studies related to information richness theory present inconsistent results with regards to the impact of communication media. For example, rich channel capacity can speed but also slow down communication [34] and multiple cues can improve but also hinder understanding [11]. These inconsistent results indicate that the information richness theory offers limited explanation for media selection and, consequently, the theory has been criticized by several researchers. Some scholars have argued that the characteristics which influence the choice of communication media should consider social activities. Communicators possess different understandings of the capability and potentials of a particular communication medium based on their prior experience, not only with the communication technology itself but also with the communication partners, messaging topics and their organizational context [4]. For example, email is seen as a low-richness medium [18, 32], but it can improve information gathering and information dissemination strategies [5] and by so doing increase the richness of the communication from the users’ point of view. As a consequence, social influence theory was introduced to explain the interaction between social activities and communication media selection.

2.2. Social influence theory

The social influence theory has focused on discussing the role of social actors in the process of media selection [16, 35, 39, 44]. For example, peer group pressure amongst groups of people can determine the type of media adopted for communication within a group. Several studies in connection with social influence theory have provided significant insights into the phenomenon of communication media selection, which include social influence model [15], network theory [7], adaptive structuration theory [28], gains and losses model [25], communication genres model [26, 42], cognitive-affective model [36], psychobiological model [20] and so on. The extensive studies have put forward to describe how and why people choose a medium for communication that also appears to reveal the phenomena that communication is not just about information interchange but also about the way how information is communicated [5].

Nevertheless, “the dichotomy between ‘rational’ and ‘social’ influences seems artificial and perhaps unnecessary” [31]. Thus, both the objective characteristics of media which information richness theorists focus on, and the effect of social actors on media selection that social influence theorists emphasize, are reasonable explanatory factors.

2.3. Situational determinants

A number of previous researchers [8, 30, 35, 37] have identified that situational elements, such as geographical and temporal factors, can determine media choices. Such situational determinants can lead to users choosing a lean communication tool rather than the richest medium available [20, 29, 37]. That is to say, “situational determinants” [37] appear to be influential of making CMC appropriate in today’s workplace. Such research highlights that people’s media choice is not always their intention.

The CMC media which are available in the business environment are constantly developing. Email allows information to be disseminated and to arrive almost simultaneously in the receivers’ inboxes, without the need for posting large bulks of paper documents. Teleconferencing provides the functions of audio- and video- connections so that group meetings become effective without the need for tiring journeys from one country to another. Instant messenger offers the
possibilities for synchronous text-based communication, without the anxiety of waiting for email replies at a later point in time. However, all of these CMC tools can create confusions and misunderstandings, with varying degrees of severity [1, 3, 13, 27]. This underlines the need for a clear understanding of the course of CMC for complicated issue discussion, such as engineering related issues.

To synthesize, this research aims to explore the course of communication media selection for complicated technological issue discussions and the impact of the selected media on the cross-organizational engineering tasks.

3. Research methods

This study adopted the multiple-case study approach. The evidence from a multiple-case study is often considered more compelling [43] and thus it is regarded as being more robust [17]. This research examined four cases of inter-organizational collaboration between a large high-tech corporation in Taiwan (Tcom, a pseudonym) and its four supplier companies in Korea (AK, BK, CK and DK, pseudonyms) for five months and an extensive useful dataset was obtained.

Moreover, participant observation, which allowed the researchers to collect data in a direct way [23, 24], was employed as the main approach for gathering data in this research. The collected data included: (1) daily logs recorded while the first author observed participants’ daily routines, including both formal and informal events and activities. In this regard, records were taken from: conventional meetings, CMC including 1359 emails, a large number of telephone conversations, some involving the researcher and others not, and five audio-conferencing meetings; (2) interview records and notes based on an unstructured interview design; (3) documentation, such as product specification sheets. This resulted in an extensive amount of useful data being collected and analyzed.

Table 1 provides an overview of the sources of data collection.

Table 1. An overview of data collection information

<table>
<thead>
<tr>
<th>Case</th>
<th>FTF meeting</th>
<th>Video-conference</th>
<th>Audio-conference</th>
<th>Telephone communication</th>
<th>Email</th>
<th>Company documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tcom/ AK</td>
<td>5 people on 2 visits</td>
<td>None</td>
<td>5</td>
<td>Frequent</td>
<td>510</td>
<td>8 projects</td>
</tr>
<tr>
<td>Tcom/ BK</td>
<td>10 people on 4 visits</td>
<td>None</td>
<td>None</td>
<td>Frequent</td>
<td>190</td>
<td>7 projects</td>
</tr>
<tr>
<td>Tcom/ CK</td>
<td>12 people on 4 visits</td>
<td>None</td>
<td>None</td>
<td>Frequent</td>
<td>224</td>
<td>1 project</td>
</tr>
<tr>
<td>Tcom/ DK</td>
<td>2 people on 1 visit</td>
<td>None</td>
<td>None</td>
<td>Relative infrequent</td>
<td>210</td>
<td>1 project</td>
</tr>
<tr>
<td>Total</td>
<td>11 visits</td>
<td>5</td>
<td></td>
<td></td>
<td>1359</td>
<td>17 projects</td>
</tr>
</tbody>
</table>

In this study, the arrangement of business collaboration between two companies is the unit of analysis. Data was collected from the four cases respectively (i.e. Tcom/AK, Tcom/BK, Tcom/CK and Tcom/DK). The four supplier firms collaborated with Tcom for the same product named PL (a pseudonym) and, because of different product functions, budgets, target markets, etc., a total of 17 projects (Tcom/AK:8, Tcom/BK:7, Tcom/CK:1 and Tcom/DK:1) were taking place during the five-month data collection. However, none of them operated the same design criteria and quality evaluation standards that led to the complicated product design being even more difficult due to the inconsistencies involved.

Given that the research participants were widely distributed in terms of place and time, it was not possible to collect data from different companies simultaneously. Hence, the first author, who has an engineering background, participated in Tcom headquarters as a temporary engineer within the R&D department and she was in charge of product specification discussions and negotiations with the four supplier companies. In this capacity, she collected valuable data from the communication exchanges between Tcom and its four suppliers.

4. Research findings

The research findings have revealed that email had replaced FTF meetings and became the most important communication tool despite the fact that there were a number of other CMC tools available. In what follows, we will explain this dominance.

4.1. The shift from FTF meetings to email

In the case studies, the use of media has shifted substantially from FTF meetings to email. This agrees with Markus [22] who suggested that email can be used for complex communication and hence FTF meetings may not always be preferable.

Here is one of the examples from the research that shows that email communication is useful for discussions about technology issues.

[Quoted from the researcher’s daily logs]
I (the researcher) called Sam (AK’s senior manager) to explain that the pixel pitch information that they provided was wrong. Sam was angry and grumbling, “Your request is ridiculous. The spec has been issued to the other customers, they are all happy with it. Only your company is not satisfied… OK! OK! I will change to whatever you want. You are customer. The customer is always right.” Then I received an email from K (AK engineer) with the revised spec. sheet attached. The pixel pitch was revised but it was still wrong. I called K and
explained that what he had written on the spec was actually “sub-pixel pitch”, not “pixel pitch”. I doubted that he really understood the mistake in the spec description. After the phone conversation, I sent this email to K to explain the formula of the resolution and a picture to illustrate the pixel pitch.

Dear K
The active area of this product is 1018.08x572.67(mm). If the pixel pitch is 0.17675x0.17675, the resolution must be 5760x3240.(1018.08/0.17675=5760, 572.67/0.17675=3240)
This spec is incredible. I haven’t heard any supplier can make such a high grade spec. Are you sure that the spec is right?

After a few seconds, I received K’s email saying that he apologized about the incorrect information “I didn’t understand your concern till I read your email. I am sorry and I will correct the spec immediately.”
At last, the spec was corrected.

One BK engineer described the usefulness of email discussions when an FTF meeting could not be held promptly from another viewpoint.

[Quoted from the daily logs]
So far, we can’t give you the solutions for the issues…I can’t hold a meeting now because our engineers are working in different offices and some are on business trips. I need some time to collect their thoughts and think of the solutions……. As soon as I have solutions, I will write you an email with analysis reports. It will be the same as having a meeting. If we need further discussion, we could arrange a meeting then.

The above implies that if a FTF meeting was not possible then a video-conferencing meeting would not be the next best medium either, i.e. there was a preference for email. In theory, video-conferencing is the medium which like has similar features to FTF meetings, in that it uses audio and video telecommunications to bring people in different places together to simulate the latter. This can take the form of a simple private conversation between two persons or a large group meeting. However, the extension from a one to one exchange to an official group meeting though video-conferencing has not proved to be effective, because the bustling working norm makes it difficult for people to gather together at the same time.

With regard to the use of email, it changes the pattern of communication by making it widely distributed and flexible. In addition, because of their characteristic of simultaneous information sharing, emails reach the receivers almost immediately. Further, its feature of asynchronous communication allows for the receivers to read and reply anytime and anywhere.

4.2. Multi-party email communication chaos

The research has found that email had replaced FTF meetings and became the most important communication tool for highly complex engineering related discussions, and that almost every email communication included two or more recipients. In the four cases of this study, email was mainly employed as a multi-party discussion platform rather than for personal contact. However, multi-party interaction through text-based communication easily causes confusions and misunderstandings, and the biggest problems arise from asynchronous multi-party discussions. In the past, personnel tended to be confined to their offices which were the main place for interaction. Nowadays, team members rely on email for almost all office work discussions, in order to get work done faster and more efficiently.

When a number of people are engaged in an email discussion, information is exchanged asynchronously and the time lapse can lead to confusion, complaint and the laying of blame. The protracted email discussion between Tcom and AK about the product specification approval is one such example. There were actually a total of 33 emails with four attached documents sent back and forth to discuss ten controversial technology issues. Six people from five departments in two companies were involved in the discussion. The lengthy email content and the versions of attachments were kept up-to-date every day, which made the technological issue discussion even more difficult to understand. For instance, while an AK engineer in customer service department (CS) was working on the specification sheet version D, AK R&D engineer had already updated information on a new version E and emailed it to Tcom. Moreover, the two departments provided different mechanical drawings, which seriously affected Tcom’s mechanical design, and other engineers working on this project were very confused about information that was lacking in clarity. At the same time, AK sales department did not understand the details of the technological issues but were still pushing Tcom’s engineer for specification approval. After dealing with one problem after another, participants involved in the email discussion became impatient and started to complain.

[Email from Tcom to AK]
Dear Bob
The files you attached with the last email were all old versions which were updated by Sam a long time ago.
Please see the attached file (ver.E) and update the information into this file……

Dear Bob and Sam
Could you co-work closer to clarify the contradiction of the chassis gap spec? Why do you have different drawings for the same product?
JL

[Email from Tcom to AK]
Dear Jamie
Please help with your internal co-working. We've spent much effort communicating with your R&D and CS in order to bring all your information and documents together. The business schedule is our concern for sure. I believe our request about the spec is quite reasonable. You should have prepared your documents ready before sending them to customers, shouldn't you?
We've been trying very hard to review your spec. If you could correct the spec, we could approve your spec by today. This is now in your hands, Thanks!
Best regards,
Stephen

Due to market pressures, those who work in the commercial sector often require speed and efficiency in communication. In the above example, participants’ impatience and anxiety escalated into complaints and conflicts while working under time pressure.
Email’s communication difficulties still exist commonly, as the above event demonstrated. Moreover, these communication difficulties may be further complicated when they are influenced by organizational authorities. That is, competition between powerful managers in the different departments and/or companies has emerged as having the potential to disrupt multi-party email discussion.

Tcom R&D and CK CS in the Taiwan branch office were discussing a "quality guarantee letter", regarding a design issue. At the same time, it appeared that Tcom’s factory was dealing with the same issue with CK headquarters through another document which was entitled the “quality agreement". Inadvertently, the emails from CK’s headquarters in Korea were delivered to Tcom’s R&D engineers who were confused when they read these emails. Whilst Tcom’s R&D was considering the content of the quality agreement, which they were not happy with and hence were preparing a revised agreement, everybody involved received another email from the Tcom factory authorizing acceptance of the quality agreement, with these few words: ‘accept it from Dan (the leader of Tcom factory)’, thus pulling rank over the R&D manager.

In this context, the evidence shows that when senior figures became involved in such discussions the stakes were raised somewhat because their subordinates tended to group around them, and this led to power blocs with a greater likelihood of conflict occurring. The event is presented as an example of where the overlap of organizational authority interrupts the course of events, and leads to the group email communications becoming even more complicated because the people involved are unclear as to who has the decision making powers.

4.3. Communicating product designs by email

Fast communication is essential for immediate problem solving in such engineering workplaces and pictorial expressions including graphic-, audio- and video- applications appear to support email’s inherent text-based communication that provides both a quick and informative means for problem solving. However, explaining high-tech design issues by email is particularly difficult. In fact, it can be almost impossible to present a tangible issue adequately even though through varying electronic forms of communication. The example below gives an account of a cable/connector incompatibility issue, whereby on the assembly lines in Tcom’s factory some products were displaying abnormal pictures on their screens and unfortunately this problem was not happening with any predictable frequency. Analyzing and discussing this problem among different departments and organizations could be troublesome.

[Email from Tcom factory to Tcom R&D]
Hi all,
Please see the attached photos. This is the cable which has caused the incompatibility issue.

Best wishes
Yang

[Quoted from the researcher’s daily logs]
…Based on the email which Yang sent us, I couldn’t understand what the problem of cable disconnection was. I made a phone call to Yang for asking for more details. Yang answered “the email was from my engineer and I couldn’t understand it either. I was about to call you, see whether you can understand it or not”. (……)

I then phoned a product engineer who might know the issue. The engineer tried to explain the phenomenon but it’s not really helpful. He said, “……it’s very difficult to explain it by email. I would post you some problematic samples of the cable and we could discuss it after you see the samples.”

(Note: After all that, I took a picture of my own to have a better understanding.)
Dear all

Please see the attached analysis report for the cable/connector incompatibility issue. (Note: This was originally a 10-page report. This example next page only shows part of it.)

Best wishes,
FC

[Quoted from the researcher’s daily logs]
After a number of emails sent back and forth, the team members became impatient and began to complain, “What’s wrong with FC? Does she expect that we would understand the pictures without any explanation?” “Damn! What are these all about!” “I am so confused.”

Companies generally use email with multi-format attachments to exchange information. However, the electronic format based nature of an email message can be a problem when discussing obscure technological phenomena. Moreover, tangible phenomena sent by email cannot be physically experienced by the recipients (heard, smelt, felt and touched) although information may be shown pictorially.

This is another example which shows how an email communication difficulty can deteriorate into a miscommunication. Tcom factory was dealing with a “click noise” issue, which caused many complaints from the USA market. According to Tcom’s USA branch office, customers complained that a click sound was heard when the machine (produced by Tcom) was turned on. Because the volume of the noise was too low to be recorded and thus hard to express in electron form, a written description was the only information Tcom Taiwan received from Tcom USA. Without waiting for the problematic display units to be returned from the USA, the engineers at Tcom Taiwan informed BK, the product supplier that they had to investigate the problem immediately. BK hence arranged a group of their audio design engineers to study this issue and extensive information was discussed and exchanged by email between Tcom in Taiwan and BK in Korea. After a week, an analysis report with resolutions was produced by BK. However, it was titled ‘Humming Noise Analysis Report’, and the report did not refer to the click noise but another noise which was totally different.

Email’s characteristic of being able to attach multiple diagrammatic representations has led to an improvement in electronic communication efficiency. However, as much of the above has demonstrated the farrago of semantic and pictorial descriptions often takes a substantial amount of time to comprehend and can lead to the communicators being involved in chaotic misunderstandings.

4.4. Highly rated expectations on FTF meetings

According to the literature, FTF meetings are preferred when equivocality is high [10]. In these case studies, FTF meetings were held after lengthy email discussions in these case studies. The conversations presented below consist of quotes from different events which indicate the communicators’ deep dependence on FTF meetings and their high expectations that such meetings would benefit their discussions.

[Quoted from the researcher’s daily logs]
Tcom’s purchasing manager: Why don’t you hold a meeting to sort this problem out? It is more efficient!!

Tcom’s R&D senior manager: (......) call for a meeting to get the issues done quickly!!

BK CS manager: The report is well-written but I still don’t understand it clearly. Shall we have a meeting to discuss more details?

CK CS senior manager: Could you arrange a meeting for us with Stephen so that we could sort out the issue a.s.a.p?

There were eleven formal FTF meetings taking place in Tcom during the five months of the fieldwork (see Table 2). Most of these meetings were held for the purpose of design issue discussions in connection with complex technological phenomena (e.g. meeting #1, #2, #3, #4, #5 and #7) and some of them (e.g. meeting #6 and #11) were aimed at improving personal relations. It stands to reason that for the purposes of complex communication and relationship improvement, alternative electronic communication tools may be less-appropriate.

With regard to complex communication, it could be argued that the dependence on FTF meetings is inherent to collaborations on engineering tasks. That is, in these types of collaborative works, the multi-faceted subject matter can often be too complex to explain clearly through electronic forms of communication and, therefore, FTF meetings are preferable. Meeting #1 and #4 (Table 2) present effective examples of these situations. The report on meeting #1 had the aim of demonstrating abnormal uniformity phenomena that were impractical to capture by camera. The report on meeting #4 presented the discussion regarding click noise, which was too quiet to be recorded and conveyed by electronic means. In sum, in these cases, FTF meetings provided a direct and effective way for discussing technical phenomena and for clarifying issues that were difficult to describe by other methods.
Although there was no guarantee that discussions through FTF meetings can lead to a positive outcome, it appeared that participants in these cases had high expectations regarding this communication method. Table 2 shows that the results of two of the meetings (meetings #1 and #2) remained pending, and five (meetings #3, #4, #5, #8 and #10) were finalized with the immediate results of requiring subsequent reports or document preparation. Within a FTF meeting, participants share a considerable amount of signals regarding the content of conversations [6, 41], which improves efficiency of communication even though the outcome is not always that which was expected. Speakers are able to sense the impact of what they are saying on listeners, and the latter can respond with their understanding of what is being discussed immediately and thus, information is exchanged and conveyed quickly and efficiently. This perhaps explains why the participants in these cases still had great expectations and hopes regarding FTF meetings, regardless of the meetings’ actual outcomes.

Table 2. FTF meetings in the case-studies

<table>
<thead>
<tr>
<th>Case</th>
<th>No.</th>
<th>Venue</th>
<th>Subject</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tcom</td>
<td>1</td>
<td>HQ</td>
<td>AK product design discussion (abnormal color blocks on the screen and low-uniformity phenomenon)</td>
<td>Pending</td>
</tr>
<tr>
<td>Tcom</td>
<td>2</td>
<td>HQ</td>
<td>AK product design discussion and general document management discussion</td>
<td>Pending</td>
</tr>
<tr>
<td>Tcom</td>
<td>3</td>
<td>HQ</td>
<td>BK product test evaluation discussion</td>
<td>BK to provide testing result in a week</td>
</tr>
<tr>
<td>Tcom</td>
<td>4</td>
<td>HQ</td>
<td>BK product design discussion (customer complaint for click noise)</td>
<td>BK to provide analysis report in 3 days</td>
</tr>
<tr>
<td>Tcom</td>
<td>5</td>
<td>BK</td>
<td>Tcom factory</td>
<td>BK to provide resolution in a week</td>
</tr>
<tr>
<td>Tcom</td>
<td>6</td>
<td>HQ</td>
<td>BK to introduce new members joining Tcom/BK projects</td>
<td>N/A</td>
</tr>
<tr>
<td>Tcom</td>
<td>7</td>
<td>HQ</td>
<td>CK engineers came to support design issue</td>
<td>N/A</td>
</tr>
<tr>
<td>Tcom</td>
<td>8</td>
<td>HQ</td>
<td>A quality guarantee letter discussion for CK product</td>
<td>CK to provide the other versions of agreement</td>
</tr>
<tr>
<td>Tcom</td>
<td>9</td>
<td>HQ</td>
<td>Discussing guarantee letter (Pre-meeting for top management meeting next week)</td>
<td>N/A</td>
</tr>
<tr>
<td>Tcom</td>
<td>10</td>
<td>HQ</td>
<td>Further discussion for guaranteed letter</td>
<td>Re-discussion would be held after 6 months</td>
</tr>
<tr>
<td>Tcom</td>
<td>11</td>
<td>HQ</td>
<td>Design change on pre-existing product and DK to officially introduce a new member to Tcom team members</td>
<td>DK to provide more documents for Tcom approval.</td>
</tr>
</tbody>
</table>

FTF contact may improve personal relationships among collaborators, which can be influential in reducing the development of conflict. Meeting #6 and #11 (Table 2) were specifically used for the official introduction of new team members, with the aim of improving relationships. However, these new members joined the project collaboration at a late stage and so there is no direct evidence to show the benefit of these two FTF meetings in enhancing team relationships. However, positive comments regarding official visits were given by the participants.

[Quoted from the researcher’s daily logs]
Lee (Tcom project manager): Actually, official introductions for new members are not necessary, but it shows that BK is willing and sincere to strengthen our relationships.

[Quoted from the researcher’s daily logs]
Helen (BK CS engineer): After the meeting, I have a more concrete image of your office and the people whom I am working with and that makes me feel more confident.

Apart from the signs of relationship improvement in the two meetings, a favorite example of an FTF meeting’s impact is shown in the evidence from meeting #2. This shows how an FTF meeting can critically influence the development of business relationships. That is, the participants in Tcom used to dislike talking with one of AK’s managers as his expressions in emails looked imperative and tough; however, during this meeting, Tcom people’s impressions about this manager was entirely changed.

[Quoted from the researcher’s daily logs]
After the meeting, Alan told me that Sam didn’t behave as badly as he did in the emails and on the phone. I agreed with him. I had a different feeling about Sam after the meeting. In the meeting today, I didn’t feel that bad because he always smiled when he was speaking. (……) “Looking at him is better than just listening to him”, Alan said.

Stephen joined the meeting for just five minutes. When Stephen walked into the meeting room, Sam suddenly stood up and came to shake hands with Stephen. I could see that Stephen’s noticeable anger faded, although he still looked unhappy and complained a lot about AK’s design criteria in the meeting…

After the meeting, the specification for this project, which had been debated for a month, was conditionally approved and Sam made a phone call to Tcom R&D to express appreciation.

Therefore, based on our findings, we would argue that media selection is compelled to shift to email from FTF meeting, although the frequency of FTF meetings was low compared with the magnitude of email and telephone communication. Instead, in our high-tech case studies, email has emerged as being the next best choice for the discussion of highly technological details in a highly competitive market when FTF meetings are not able to be held promptly.
5. Discussion

There are various forms of CMC media available in the virtual business environment, but as this study found, email is still the dominant tool in the workplace. This finding has reflected Byron and Watson-Manheim et al’s studies [3, 39] in which it has been argued that email is the most important communication tool employed in contemporary business, despite the availability of extensive choices of CMC.

Markus [22] has suggested that FTF meetings may not be necessary because email can be used for complex communication. To some extent, the research findings have supported this claim; however, evidence in this study has also revealed that FTF meetings, though used infrequently, are still considered to be the most preferable medium for complex communication. In particular, in our case studies, FTF meetings were often held when issues reached the point of frustration and could not be resolved even after lengthy email discussions. FTF meetings provided a direct way for communicators to discuss engineering issues which were difficult to be described in electronic forms. Consequently, the participants placed high expectations on FTF meetings that were aimed at solving complex issues.

Although our observations showed that FTF meetings did not always clear the problems or misunderstandings between the different project team members, they did enable the participating organizations to move forward by building at least some understanding of the reasoning behind the problems occurred via emails.

This finding supports the Information Richness Theorists’ claim about rich media being chosen for those communications when ambiguity is high [9, 10, 33]. Two reasonable explanations appeared to explain this phenomenon of participants’ high expectations for FTF meetings. Firstly, this direct form of communication is considered highly appropriate given the inherent features of the engineering-related tasks, in that often there is numerous subject matter and the phenomena can be too complex to express via electronic forms. Secondly, FTF contact can be used for relationship improvement and this, in turn, can make a positive impact on communication effectiveness. Moreover, the evidence of the research appeared to show that many of the participants were of the belief that alternative communication tools could not compete with FTF meetings, with regards to both complicated engineering tasks and relationship improvements. Even in the cases where FTF did not alleviate the conflict occurred by email, this means of communication remained highly valued. This therefore adds to the argument of the information richness theory by positing that FTF communication is not only preferred because it can resolve ambiguous and complex situations, but also because of the expectation that this will be the case.

Given the difficulties of holding FTF meetings, as discussed above, although to many they were the preferable means of communication, they had to a large extent been superseded by email. However, from these case studies, it has been found that discussing complicated engineering by emails can easily increase misunderstandings and confusions, mostly because of email’s inherent text-based communication and asynchronous interaction.

Text-based discussions complemented with pictorial representations were a common form of email communication in all four cases. However, as the compilation of the attachments was often very time-consuming, work efficiency was impaired. In other words, although such means of communication allowed for participants’ interaction to be more effective and informative than other CMC tools, they had a tendency to accentuate the disadvantage of email’s asynchronicity and thus feeding potential conflict situations.

On the issue of asynchronicity we would specifically like to argue that there is a lot of subjectivity involved what should be considered a reasonable amount of time in replying to an email, as compared to an unreasonable one. For example, one member of Tcom complained that he had not received a reply from AK within two hours, which to some it may appear as unreasonable. Unfortunately, these inherent properties would appear to be inevitable in email discussion.

To sum up, earlier research has seen email as a “lean” medium and posited that communicating by email may impose “high understanding cost” [13, 21] and inhibit business relationships between cooperating organizations [1, 3]. However, these previous depictions of the difficulties of communication by email, arguably, have missed a crucial point: communication effectiveness is not necessarily jeopardized by the use of email, but when email becomes the only medium carrying complex forms of interaction, the difficulties of communicating effectively would grow. Therefore, it is important to recognize that communication media selection can be vital in the course of communication and complicated tasks, engineering-related work in particular.

6. Conclusion

The findings elicited from this study have made a contribution to the realm of CMC selection studies, in particular with regard to the matter of complex engineering-related tasks for high-tech product design. With the consideration that engineers often have to
communicate with dispersed colleagues for details of technological issues, the virtual communication environment leads to an increasing complexity of the collaborative engineering tasks. Recognizing the importance of understanding CMC in relation to complex tasks, this study was undertaken to add to the limited amount of knowledge in this field of research. Moreover, the research findings have set out its implications for management practitioners and scholars.

Firstly, communication media selection involves more than just common sense by the users and, in fact, involves a complex process of social factors, including both task- and relationship-orientated communication. Taking this into account, this study has offered systematic and integrated views from three previously defined perspectives: information richness theory, social influence theory and situational factors that influence participants’ media selection. Although these theoretical perspectives are not new ideas created by this study, the research findings have outlined the predicted interrelations between complex engineering tasks and media selection in a global context and as such could be used to form guidelines for those managers who intend to manage their business relationships through CMC.

Although this study has offered theoretical and practical contributions, it is not without limitations. The researchers were initially open to observe any form of CMC that occurred in the research setting, email appeared to be the dominant communication tool observed in the workplace during the fieldwork. Further research is needed to understand the use of multiple media and the choices regarding these in the complex communication. In this vein, it is recommended that the cases selected are ones where multiple media are being extensively used. The emergence of the use of instant messenger in the business environment is one form of media that deserves such attention.

7. References