An Empirical Study of Distributed Technologies Used in Collaborative Tasks at Statoil ASA

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***Abstract*—This paper presents results of a survey, related to the theoretical Task-Technology-Fitness framework. The survey was conducted in a large Oil and Gas company in Norway, namely Statoil ASA. The Task-Technology-Fitness framework indicates which groups of medium or technology are appropriate to choose according to the task to be performed, when collaborating with others. We have here presented the extended version of the Task-Technology-Fitness framework, according to how Statoil ASA's employees use SMS, e-mail, Instant Messaging and Audio (phone call), in different collaborative tasks. In total, there were 333 out of 747 respondents who participated in the survey. The results reveal that SMS and Instant Messaging are not seen as efficient or well suited communication channels for collaborative tasks. E-mail seems to be favorable among the respondents for the collaborative tasks, while audio (phone call) follows closely. The results are important in that they indicate when SMS, e-mail, Instant Messaging and Audio (phone call) are appropriate to use. The purpose of the survey was to discover potential area of improvements for Statoil ASA.**

Keywords-empirical study; distributed technology; group collaboration

I. INTRODUCTION

The use of e-mail has had an explosive growth and has improved the effectiveness in many organizations. One of the reasons for this is that e-mail is easy and intuitively to use, contents can be conveyed fast, as well as it is flexible related to availability as it supports asynchronous communication. The mobile phone has also gained ground and gradually substitutes landline in organizations. It has also many of the same functionalities as the e-mail, regarding that the mobile phone is (relatively) easy to use. Mobile phone also provides services for both synchronous and asynchronous communication, as well as exchange of information. Additionally, a growing use of Instant Messaging (e.g. ICQ, Microsoft Messenger etc.) and SMS (Short Message Sequence) can also be seen in and between organizations and business partners. These aforementioned communication channels and others are being used in organizations to support collaborative processes, and workflow in and between processes.

However, little empirical research exists on the effect of different communication channels on collaboration. Reporting on a survey of the employment and preferences for choosing communication channels for collaborating in a large, Norwegian oil company, Statoil ASA[1], we employ and expand the Task-Technology-Fitness framework [5] [6] for studying how employees in a large, Norwegian oil company, use SMS, e-mail, Instant Messaging and phone in different collaborative tasks. The purpose here is to present the extended version of Task-Technology-Fitness framework adapted towards Statoil ASA, and hence our research questions were:

1) RQ1: Which communication channels are chosen among the employees in Statoil ASA?

2) RQ2: Which collaborative tasks are these communication channels seen most fit for?

To this end, the paper is structured as follows: Section II has related work, Section III introduces research context and method, and Section IV contains the results of the survey related to Task-Technology-Fitness framework. Furthermore, Section V discusses the results, while Section VI concludes.

II. RELATED WORK

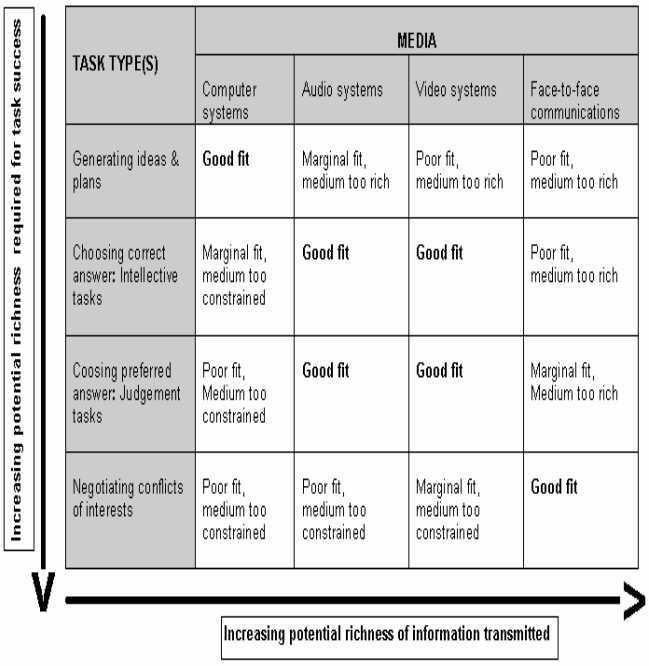
Daft and Lengel's *media richness theory* [2] [3] is the basis for the theoretical framework presented here. In the media richness theory the term *information richness* stands central, and it refers to the capacity the information has to: (1) transmit a large volume of data, and (2) transmit the meaning of the message. More specifically, the media richness theory refers to the possibility a communication channel has to transmit information, which can contribute to increase knowledge related to the task and its context. Thereby, it reduces the risk for misunderstanding and ambiguity of the context of the message.

According to Daft and Lengel, a communication channel will be decided based on the context of the message. This means that the message to be sent, must be adjusted to the communication channel and hence reduce ambiguity of the message. Ambiguity is different from uncertainty, which is lack of information. However, ambiguity demands a common understanding between the respective partners, and this interaction is dependent on the communication channel. The more ambiguity that exists in the task to be performed in collaboration with others, the richer medium is needed to

[1] ASA stands for "allmennaksjeselskap", meaning Incorporated.

perform the task. Trevino, Lengel and Daft [9] indicates that the communication will be more effective when the communication channel corresponds to the context of the message. Furthermore, the communication channels' impact on a group is related to the task to be performed.

McGrath and Hollingshead [6] have integrated the media richness theory and the task typology [5] into the theoretical framework, namely Task-Technology-Fitness. The framework is presented in Figure 1.



TASK TYPE(S)	MEDIA			
	Computer systems	Audio systems	Video systems	Face-to-face communications
Generating ideas & plans	**Good fit**	Marginal fit, medium too rich	Poor fit, medium too rich	Poor fit, medium too rich
Choosing correct answer: Intellective tasks	Marginal fit, medium too constrained	**Good fit**	**Good fit**	Poor fit, medium too rich
Coosing preferred answer: Judgement tasks	Poor fit, Medium too constrained	**Good fit**	**Good fit**	Marginal fit, Medium too rich
Negotiating conflicts of interests	Poor fit, medium too constrained	Poor fit, medium too constrained	Marginal fit, medium too constrained	**Good fit**

Figure 1. Task-Technology-Fitness framework [6]

From Figure 1 we can see that along the vertical axis in the matrix is the four task typology (collaborative tasks), while the horizontal axis in the matrix consists of four groups of medium or technology (computer, audio, video systems and face-to-face). The mediums or technologies are arranged descendingly here. This means that computer systems provide low information richness to the collaborative tasks, while face-to-face communications provide high information richness. The same descending arrangement goes also for the collaborative tasks along the vertical axis. Figure 1 shows which groups of medium or technology are appropriate to choose according to the task to be performed, when collaborating with others (see **good fit** in the figure). In our study the communication channels SMS, e-mail and Instant Messaging correspond to "C*omputer systems*" in the framework. This is due to that computer systems in the framework refer to CMC/CMCS (Computer-Mediated Communication/Computer-Mediated Communication Systems), which includes e.g. e-mail, network communication, instant messaging, text messaging, hypertext etc. [10]. Mobile phone, provides the communication channel audio, which corresponds to "*Audio systems*" in the framework. Video systems and face-to-face communication are not included in this study. It is worth mentioning that some groups do not have many communication channels to choose from, and they have to select the ones that are available for them. This means that the selected communication channel might not be the most ideal one for the particular situation.

III. RESEARCH CONTEXT AND METHOD

The following is a presentation of the research context and the data collection method.

A. Research Context

Statoil ASA is a large, multinational company, in the oil & gas industry. It is represented in 33 countries, has a total of about 25,000 employees, and is headquartered in Europe.

The former literature [4] [8] has various definitions for *collaboration*. In dialogue with Statoil ASA, we have chosen to use the following definition for collaboration: "*Two or more people who are communicating and interacting to achieve a common goal, through coordination, production and decision-making processes".*

We wanted to compare the findings of the survey with the Task-Technology-Fitness framework. Such a comparison is important, as it gives us the possibility to compare theory vs. practice of the Task-Technology-Fitness framework. Former literature [5] [6] [7] indicates which communication channels have a poorer fit for complex collaborative tasks (e.g. conflict situations and face-to-face) than for less complex collaborative tasks (e.g. simple arrangements via e-mail). The Task-Technology-Fitness framework indicates which groups of communication channels are appropriate to choose according to the task to be performed, when collaborating with others. Here, we are interested in looking at the results from [1] related to the theoretical framework (Task-Technology-Fitness). The purpose here is to confirm whether the ranking of the "Computer systems" and "Audio systems" in Figure 1 can be seen with a similar pattern in Statoil ASA. The "Computer systems" column in Figure 1 has been extended to include SMS, e-mail and Instant Messaging (see section II).

B. Data Collection

This paper is based on the survey results from the research project of Asperheim and Gupta [1]. However, in this paper we have only presented the extended version of the theoretical Task-Technology-Fitness framework, adjusted towards Statoil ASA. The remaining survey results from the research project will be presented by us elsewhere.

The respondents were all the employees in Statoil ASA who had been affected by the new telephone solution, and who had chosen mobile phone as their solution. The survey is, therefore, a non-probability sampling, based on convenience as described in section "C. Respondents". The survey was distributed among the employees, who were then allowed to complete the questionnaire within 3 weeks. The employees answered the questionnaires separately, and they were filled out by them on the web interface (were the questionnaire was available). Filling out the questionnaire took 12-14 minutes, as estimated from the test runs. For more thoroughly descriptions of the data collection see [1].

C. *Respondents*

In spring 2004, when the survey was performed Statoil ASA had 11189 employees in Norway. 83% of the employees who have been affected of the new telephone solution have chosen mobile phone as their solution. Those employees working in the offshore have not been affected by the new telephone solution, and they constitute between 4000-5000 persons. In the research project Asperheim and Gupta wanted to receive answers from approximately 300 respondents, since this amount of respondents were seen as representative for the survey, so they invited about 700 respondents to participate. This is due to that the experience reports from former surveys done in Statoil ASA indicated that only 50% of the invited respondents normally participate in surveys. The number of invited respondents was 747, and the actual number of respondents who participated was 333 from the respective units in Statoil ASA, namely: 34 respondents from F&M (Manufacturing and Marketing), 49 respondents from NG (Natural Gas), 21 respondents from INT (International Exploration & Production), 154 respondents from KTJ/KS (Corporate Services/Corporate Center) and 75 respondents from TEK (Technology). There were 32% (105/333) women and 68% men (228/333) and the majority of the respondents 34% (114/333), were between the age 40-49. For more thoroughly information about the respondents, see [1]. It is also worth mentioning that the purpose of the survey was not to generalize the results, but rather to discover potential area of improvements for Statoil ASA.

IV. Presentation of the Results

In this section, we present the survey results related to the Task-Technology-Fitness framework. Data from the question related to the theoretical framework were aggregated. Thereafter, the aggregated results were evaluated with the Task-Technology-Fitness framework presented in Figure 1. The result of this evaluation led to an extended Task-Technology-Fitness framework, which can be seen in Figure 2. The communication channels SMS, e-mail, Instant Messaging and audio are arranged descending here. This means that SMS as a communication channel provides low information richness to the collaborative tasks, while audio provides high information richness. The same descending arrangement goes also for the type of task along the vertical axis.

Type of tasks	MEDIA			
	SMS	E-mail	Instant Messaging	Audio (phone call)
Generate: Generate ideas and planning tasks and/or allocate responsibility and deadlines for process.	Poor fit	Good fit	Poor fit	Medium fit
Choose: Make decisions which have clear and evident solutions.	Poor fit	Good fit	Poor fit	Good fit
Choose: Make decisions which require consensus, discussion of "best-practice" among several possible good answers.	Poor fit	Medium/Good fit	Poor fit	Medium/Good fit
Negotiate: Resolve and discuss different points of view.	Poor fit	Medium fit	Poor fit	Good fit
Execute: Create a dynamic and including atmosphere (dialog and flow in communication) between group members.	Poor fit	Medium fit	Poor fit	Medium fit
Execute: Co-ordinate tasks and work with each other.	Poor fit	Good fit	Poor fit	Medium fit

Figure 2. Task-Technology-Fitness framework extended for Statoil ASA

V. Discussion

As opposed to McGrath, Asperheim and Gupta have chosen to include "Execute" in the extended version of the framework in Figure 2. Based on the work of McGrath and Hollingshead [6] Asperheim and Gupta have defined two tasks related to execution (see Figure 2), which they think are appropriate for measuring execution in collaboration.

From Figure 2 we can see that communication channels SMS and Instant Messaging are seen on the whole as not an efficient or well suited communication channels for the aforementioned collaborative tasks. One of the reasons that SMS has gained a poor ranking, might be due to that this communication channel is perceived as ineffective – the display is too small, it takes longer time to pass on information, which is limited in both volume (160 signs per message) and information type (format). Even though the capacity for storing information will depend on the individuals' type of mobile phone and SIM (Subscriber Identity Module)-card, the capacity for storing large amount of information will be inadequate. 64.9% of the respondents replied that they never or less than 1-2 times a day use SMS at work [1]. The poor ranking of Instant Messaging might be related to that this communication channel has no tradition in Statoil ASA (at the time the survey was conducted). It was not implemented as an official communication channel, and this communication channel was used based on private initiative. At the time the survey was conducted, 90.1% of the respondents' answered that they never or less than 1-2 times a day used Instant Messaging at work [1]. So, there were few employees using this communication channel. However, recently Statoil ASA implemented Instant Messaging (MSN

Enterprise version) as an official communication channel, so if the survey was repeated in Statoil ASA now the results might be different. Age can also be a factor, since the respondents are not young people who are used to SMS and Instant Messaging.

However, e-mail seems to be favorable as a communication channel among the respondents in Statoil ASA (90.1% of the respondents' use e-mail as their primary communication channel at work [1]), despite that it is a pure text based channel and has limited bandwidth related to transmitting information richness. We can also see that e-mail makes it much better on the aforementioned collaborative tasks, compared to the original Task-Technology-Fitness framework (see Figure 1). From Figure 2 we can see that the respondents consider e-mail as "Good" fit for the first task related to "Choose" (2nd row), "Medium/Good" fit for the second task related to "Choose" (3rd row), and "Medium" fit for the task related "Negotiate" (4th row). Hence, compared to the original Task-Technology-Fitness framework (see Figure 1), then "Computer systems" has respectively "marginal", "poor" and "poor" fit for the same tasks. We can also from the extended framework see that e-mail is consider as a better communication channel than audio, when it comes to the tasks related to "Generate" (1st row in Figure 2). Based on the survey results e-mail and audio have got the same outcome for both of the tasks related to "Choose" (2nd and 3rd row in Figure 2), while e-mail makes it poorer when it comes to "Negotiate" (4th row in Figure 2). When it comes to tasks related to "Execute" (excluded from the original Task-Technology-Fitness framework, see Figure 1), both e-mail and audio as communication channels are perceived as "medium" fit when it comes to create a dynamic and including environment (dialogue and flow in communication) between group members (building relations). When it comes to co-ordinate tasks and work with each other, then e-mail makes it better then audio as a communication channel.

That, e-mail is considered better for tasks like generate ideas/planning and co-ordination tasks rather then audio, can be explained by e-mail's possibility for storing information. Audio/phone call will as opposed to e-mail be much more based on the respective person's memory, since there are limited possibilities for storing information directly and user friendly as in e-mail. Tasks such as generate ideas/planning and co-ordination have often the need for written documentation, and the chance of retrieving it later. This is, first and foremost a result of that few of us have the possibility to store detailed and large quantities of information like this in our memory (specifically over longer time), with guarantee for "retrieving" it from the memory later. When it comes to storing information, e-mail as a communication channel has a clear advantage compared to the other communication channels in this study. E-mail is also more advantageous related to user-friendliness, volume and robust treatment of different types of data. This can be the reason for the deviation (seen in Figure 2) between e-mail and the remaining communication channels, despite that e-mail basically provides for low information richness compared to e.g. audio or instant messaging. E-mail is also more suited for user friendly distribution of information, compared to SMS, Instant Messaging and audio.

Additionally, we can also see that respondents' perceptions of audio as a communication channel (phone call) correspond somewhat with the original Task-Technology-Fitness framework. However, there is a difference regarding the task in the 3rd row in Figure 2. Here the respondents see the communication channel phone call (audio) as "medium/good" fit. This means that from the survey findings we cannot place phone call as either "medium" fit or "good" fit, but the results points towards a combination of these to alternatives. While in the original framework the same task is ranked "good" fit (see Figure 1). When it comes to the task related to "Negotiate", the respondents' rank phone call as "Good" fit in Figure 2, while McGrath and Hollingshead framework has indicated that audio as a communication channel is a poor fit for negotiation tasks. Hence, for audio we found a small deviation from the original framework, but can confirm most of the ranking in the original framework (see Figure 1).

As aforementioned, we have in the extended framework for Statoil ASA decided to include the tasks related to "Execute". Therefore, we do not have a basis for comparison with the original Task-Technology-Fitness framework. From Figure 2, we can see that both audio and e-mail are perceived as "medium" efficient or well suited for the first task related to "Execute" (5th row). However, there is an exception for the second task (6th row). Here, e-mail is perceived as a better communication channel ranked "good" fit, compared to audio ranked "medium" fit. The remaining communication channels in the survey, SMS and Instant Messaging, have both got a poor ranking for the same tasks related to "Execute" (5th and 6th row in Figure 2).

VI. Conclusion and Future Work

We have presented the survey results related to the theoretical Task-Technology-Fitness framework. Specifically, we have here presented the extended version of the Task-Technology-Fitness framework, according to how Statoil ASA's employees use SMS, e-mail, Instant Messaging and Audio (phone call), in different collaborative tasks. The results reveal that SMS and Instant Messaging are seen on the whole as not an efficient or well suited for the collaborative tasks. E-mail seems to be favorable among the respondents for the collaborative tasks, while audio (phone call) follows closely. The poor ranking of Instant Messaging might be related to that this communication channel was not implemented as an official communication channel, and was used based on private initiative. However, Statoil ASA recently implemented Instant Messaging (MSN Enterprise version) as an official communication channel, so if the survey was repeated in Statoil ASA now the results might be different.

The results are important since there have been none published empirical studies of how the Task-Technology-Fitness framework has been extended for collaborative processes in organizations. It should be noted that the purpose of the survey was not to generalize the results, but rather to discover potential area of improvements for Statoil ASA. Hence, our study is a contribution in that context. The results

can also be used as a baseline to compare future studies of how to extend the Task-Technology-Fitness framework in other organizations.

The results are presented to Statoil ASA and contribute towards their understanding of when SMS, e-mail, Instant Messaging and Audio (phone call) are appropriate to use, according to the collaborative task to be performed. The results are important for Statoil ASA to decide how to invest on communication channels or extend the services. All these insights represent explicit knowledge, and will be important for deciding how to manage future collaborative processes in the company. The results will also be combined with other research in the company to further explain our findings. Another interesting viewpoint would be to investigate the combination of different communication channels (in case where one is not considered enough). Additionally, we plan to expand our dataset with more respondents and to refine the research questions based on our initial findings here.

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