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Communication Artifacts and Interaction Evaluation for Requirements Engineering

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COMMUNICATION ARTIFACTS AND INTERACTION EVALUATION
FOR REQUIREMENTS ENGINEERING

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ABSTRACT

Communication Artifacts and Interaction Evaluation

for Requirements Engineering

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This paper aims to answer an important question regarding the development of new information systems (IS): "What is the predominant factor for the selection of communication artifacts for requirements engineering (RE)?". Many researchers have focused on the RE and communication as separate disciplines, but little or no research addressed the RE communication issues. These problems are important because they often lead to misunderstanding and misinterpretation of the gathered requirements. We develop expectations about the RE communication process based on prior literature from both disciplines and we test them through several case studies. Our methodology consists of analysis of six case studies we investigated. We conducted interviews and then we used the data to answer the research question and to see if the data from the case studies were consistent with our expectations. The paper contributes to existing literature, as it provides evidence that organizational environment is the predominant

factor in the selection of communication artifacts, and that the motivation of the

participants plays a key role when determining the levels of interaction amongst

participants. And finally, we investigate the transitional RE phases and discover that they

are viewed as overlapping with the main RE phases and that there is some cross-

communication between the participants during those transitional phases.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1:

INTRODUCTION

The RE process occurs at the start of software development and involves the analysis and negotiation of what capabilities and features a proposed system needs to possess (Sommerville & Kotonya, 1998). Many researchers have studied the process of developing new systems and all have agreed that it is the most critical phase of the IS development (Browne & Ramesh, 2002; Peffers, Tuunanen, Rothernberger, & Chatterjee, 2008; T. Tuunanen, 2003). However, because understanding human and organizational needs is difficult and complex, RE is, in general, ad hoc (Watson & Frolick, 1993) and poorly understood (Turner, 1992; Vitalari, 1992). Further, the large number of completed systems that do not meet user specifications and expectations suggests that the determination of such requirements can be improved (Ewusi-Menasah, 1997; Valusek, George, & Hoffer, 2001).

The IS literature suggests that user participation in software development is beneficial, because it improves the requirements determination process, leads to greater buy-in, and keeps users informed about progress (Hunton & Beeler, 1997; Iivari, 2010; Newman & Sabherwal, 1996), leading to higher levels of user satisfaction, system quality, and system usage (Gallivan & Keil, 2003; Hwang & Thorn, 1999). User involvement is a process requiring significant interaction between systems specialists and users or their representatives (Newman & Noble, 1990). To better facilitate this important process, communication needs to be very well structured and systemized, since it is central to the organizing process (Orlikowski & Yates, 1994).

The RE communication process is problematic. For example, Kujala (2001) and Zin (2009) acknowledge the problem of adequately translating use contexts and user needs into user requirements. According to Curtis et al. (1988), the communication problem is considered to be a major factor in causing the delay and failure of software projects. These issues suggest that focusing on the communication between end-users, systems analysts and managers within an organization is likely to exert a positive influence on the RE process. Although there has been extensive research on the communication process (R. Daft, Lengel, & Trevino, 1987; Dennis, Fuller, & Valacich, 2008; Habermas, 1984; Miller, 2011; Sarker, 2011; Shockley-Zalabak, 2012), the problem of unmet customer expectations is still important (Abelein & Paech, 2012; Bjarnason, Wnuk, & B., 2011) and needs to be investigated more carefully.

Even though the RE communication process is so critical, little or no research has been done to investigate the main reason for the selection of communication artifacts for RE. This question is important to consider because answering it will help to avoid misunderstanding related to the features sets and functionalities for new IS, especially when end-users, systems analysts and managers are involved together. Focusing on these issues represents a significant topic in IS literature that needs to be investigated more thoroughly.

To answer this research question, we have to analyze the existing research approaches in both RE and communication. We look into the RE process by building upon the model Browne & Rogich (2001) have developed. We expand the discovery, analysis and verification phases in their model by considering not only them, but the decision making phase and the gradual transition between each phase. Next, we use a

2

categorization of metaphors for communication and organization developed by Putnam & Phillips (1996). This categorization provides consistency when evaluating the communication process for RE. Then we apply a methodology developed by Leonard-Barton & Sinha (1993) to categorize the levels of interaction amongst participants, which will help us to assess the dynamics during RE. And finally, we discuss the most commonly used communication artifacts by providing their main characteristics together with their advantages and disadvantages.

Based on the analysis of six case studies, we found that in the beginning the RE process is categorized with the highest levels of interaction and they decrease towards the end. We also discovered that the organizational policies, methodologies and guidelines regarding RE are the prime determination for the selection of communication artifacts and not the project itself or the levels of interaction. In addition, we found out which artifacts are more frequently used to communicate and to convey information among the various RE phases. And finally, we observed how each RE phase transitions into the next one, how participants view this process and its importance for the successful development of IS.

The overall contribution of our study to the RE and communication fields will be one of great importance. To our knowledge, this is the first known study to investigate the interaction dynamics in all phases of the RE process. By understanding them, we will be able to avoid some critical issues related to requirements determination. The study also explores the predominance of organizational methodologies, policies and guidelines related to RE, and existing methodologies on the selection of communication artifacts. Finally, we present an interesting correlation between participants' motivation and the

higher levels of interaction. Although there are many studies in the past regarding RE

and communication, this is the first one to address all of these issues and explore them

in depth.

CHAPTER 2:

MOTIVATION

Our research contributes to existing knowledge on both RE and communication and provides valuable advice to business professionals by investigating whether organizational methodologies, policies and guidelines regarding RE are affecting the selection of communication artifacts for the RE process. By observing the levels of interaction in RE phases and the most commonly used artifacts, we can better investigate their relationships and the influence organizational environment exerts on them. Also, by exploring the way each RE phase transitions into the next one, we can provide more insight on how to improve IS development and communication amongst the participants involved in it.

Many information technology (IT) projects faced the problem of inadequate requirements discovery, analysis, and business planning. This is known to be a leading cause of system failure, as voluntary users refuse to use applications with flawed functionality or usability or insufficient value (T. Tuunanen & Peffers, 2011). By focusing our attention on the requirements determination processes, we can investigate the communication dynamics in each phase and thus be able to provide possible improvements to existing practices.

RE is a complicated process which has been extensively investigated (Ali, 2010; Appan, 2012; Browne & Rogich, 2001; R. Daft & Lengel, 1986; Humayoun, 2011; Peffers & Tuunanen, 2004; Pohl, 1994; Stroh, 2011; T. Tuunanen, Peffers, & Gengler, 2004; Winkler, 2010; Yu, 2011), but the way each phase transitions into the next one has been overlooked. The current study aims to explore how participants proceed from one

RE phase to the other, what communication artifacts they use and how they evaluate the processes that happen in between requirements discovery, analysis, and the decision which ones to be included in the system. Our goal is to observe participants' views on these transitional phases, regarding the communication and artifacts used, and see whether they are significant to the RE process.

The issue of RE communication is important, because it often leads to unmet customer expectations, low motivation to contribute to requirements work, and developers controlling what is implemented. Also, there has been observed a lack of discussions between systems analysts, developers and managers regarding new system features. According to a recent study, communication gaps in IT projects are often caused by various factors, among which is the unclear decision structure in the organization (Abelein & Paech, 2012; Bjarnason, et al., 2011). This negative effect supports our view that the communication downstream during RE needs to be investigated more thoroughly.

The process of transforming user demands and feedback into functional features and specifications requires participants to be engaged in discourses about the usefulness or applicability of a concept. This discourse is defined by Wolf (2006) and in addition Vogelsang & Carstensen (2001) point out that there is a significant correlation between the success of software development and the value of tools for communication, artifact sharing, and collaboration explicitly created for RE. Mason & Leek (2012) define the communication artifacts as evidence of previous communications which can be referred back to and reinterpreted by the individuals originally involved in the communication or individuals new to the situation and used to support or negate arguments. This definition suggests that using the most appropriate artifacts for RE communication is

likely to increase the efficiency of the process and thus to improve customer satisfaction.

RE communication is a multifaceted process, so our study approaches it from several different perspectives. First, we pay attention to the interaction levels amongst participants. They need to be tangible in order to provide consistent evaluation. Therefore possible objectives to measure the interaction level can be: frequency, amount or length of documentation, information sharing, discussions, debates, etc. Second, we investigate which communication artifacts are most commonly used for RE in organizations and what is the rationale for their selection. Third, we extend the RE process defined by Browne & Rogich (2001). Previous studies have focused on the analysis and the general requirement gathering, however the decision phase has not been included in the RE process. This study encompasses all phases including the decision making. In addition, we add the transitions between those phases in order to have a better perspective on the RE process. So far, no one has done any research on how each RE phase evolves into the next one, and this will be the first study to elucidate on the issue.

CHAPTER 3:

LITERATURE REVIEW

The primary objective of this study is to identify the key factors suggested in literature that can influence the improvement of RE communication. Given our focus on communication artifacts and RE phases, we looked for constructs from both disciplines that were relevant to our research question. We combined the knowledge of each in order to investigate the influence organizational methodologies, practices and policies regard RE exert on the selection of communication artifacts for RE. Our literature review focuses on two main aspects – the extended RE process and the communication artifacts used for it. We approached the artifacts from the perspective of communication metaphors and levels of interaction to obtain more information relevant to our research problem.

Requirements Engineering Process

The *discovery* phase refers to the initial communication between the systems analysts and users and aims to get detailed and accurate data from the users. This will be the foundation of the new system. During this phase communication between users and analysts is very intense; it is very important for analysts to ask the right questions (Wilson & Sapsford, 2006). This phase can be considered iterative, because analysts go over and over the elicited requirements until they are able to design the initial model of the system.

Once the initial requirements are generated and defined by users in the discovery phase, the next step is to provide them to the analysts and designers who are

responsible for evaluating them and creating conceptual models for additional feedback and verification from customers. However, between those two phases there should be some gradual *transition*. Its purpose is to ensure that the elicited requirements are correctly understood by the analysts and designers.

Once there is confirmation from users about the initially elicited requirements, the next phase of the RE process is *analysis and verification*. During this phase the collected requirements are integrated and analyzed. Usually, this results in the identification of missing requirements, inconsistencies and requirement conflicts. The discovery phase generally has to be re-entered to find additional information to resolve these problems (Sommerville & Sawyer, 1997). The need to go back and reconsider the provided information requires more iterations to be used in this phase.

After the requirements have been determined, analyzed and verified, the last step of the RE process is to decide which of them are feasible and should be actually implemented. But transitioning them to the management team is also an important process which is often neglected. Many times systems analysts and designers just give the management team a list of requirements or a draft of the system logic. Although this helps them in making a decision, it is definitely not the best way to present the elicited requirements and give information about the work done on the project so far. Such an approach may cause misunderstandings or misinterpretations of the data. Therefore taking a closer look at the *transition* between the phases of analysis and feedback and decision making is so important. In this transitional phase user involvement is limited, since the requirements have been already analyzed and structured and what is left is to decide which of them will actually be implemented in the system. During the transitional phase the level of interaction among participants is expected to be lower,

because the systems analysts and designers have already prepared the results of the previous phases and they usually submit them in a written form to the management team.

The process of RE is not limited to only obtaining requirements from end-users. It is more complicated because once these requirements are determined, they need to be properly communicated to the management team responsible for the *decision making*. Most researchers consider the RE process complete once the requirements have been specified and verified (Byrd, Cossick, & Zmud, 1992; Hickey & Davis, 2004; Sommerville & Sawyer, 1997), so by expanding it to the decision making phase we will be able to provide more information on how the communication interaction evolves from the earliest phase of discovery to the point where the final decision has been made.

Communication Metaphors

Communication and organization can be conceptualized in terms of seven communication metaphors (Putnam & Phillips, 1996) of which we use five here: linkage, performance, symbol, voice, and discourse. The criteria for choosing these five metaphors is based on our research goals, the ontological basis of both communication and organization, and the phenomena that are central to our study – communication artifacts, levels of interaction and RE phases (Table 1).

The first metaphor we chose, the *linkage metaphor*, is focused on the connections between people and how these connections are used to form networks of relationships. This particular metaphor is suitable for categorizing the interaction amongst participants, because it views connections between individuals as a key element in the

communication process. The linkage metaphor relates to the discovery phase of the RE process, because in that phase it is essential to find end-users and customers which are interested in the development of the new information system. By having a network of early adopters or core customers, an organization can much easily find potential participants in the initial RE phase. The linkage metaphor is also appropriate to use for our current research, because it is centered on interorganizational networks. Since the RE process usually involves team members from multiple departments, looking at the fields or systems within the organization is crucial for exploring in depth the RE communication.

The second metaphor we chose to adopt is the *performance metaphor*. Its emphasis is on interaction and meaning. This approach treats communication as an outgrowth of a collaborative process in which social and symbolic interaction is dynamic, interconnected, reflexive, and simultaneous. During the analysis and verification phase of the RE process such an approach is important in order to facilitate communication between end-users or customers and systems analysts or developers. These categories of people usually have different backgrounds and diverse skills. Therefore to coordinate their actions and to verify that the requirements are understood properly, focusing on interaction and meaning is necessary.

The third metaphor applied in our study is the *symbol metaphor*. In this metaphor symbols are used to interpret the communication process. Narratives are a typical example of such symbols and they are prevalent in all organizations (Martin, 1982). Other symbols that organizations use can be: diagrams, animations or spreadsheets. Such documents are symbolic, because certain images or codes to transfer information are frequently used within the organization. They convey specific meaning

which can be understood only be the employees of the company. That is why the symbol metaphor is more appropriate to use for interorganizational purposes. This metaphor closely relates to the process of transferring the verified user requirements to the decision making phase, because this is an internal process and all participants are familiar with the meanings of the symbols.

The fourth metaphor we selected is the *voice metaphor*. Understanding it entails focusing on communication as the expression or suppression of the voices of organizational members. Such practice usually occurs at the end of the RE process, when a decision which new features to be implemented needs to be made. The decision making typically involves the project sponsor or manager and the systems analyst who was gathering the initial requirements and transforming them into actual functionalities. Depending on the company culture and traditions, this process can be more or less democratic (Bjerknes & Bratteteig, 1995). So, to be able to analyze it, we need to pay more attention to the factors that shape the role of communication during the RE process.

And the final metaphor we applied in our study is the *discourse metaphor*. In this metaphor, communication refers to a conversation as it focuses on both process and structure, on collective action as joint accomplishment, on dialogue among partners, on features of the context, and on micro and macro processes (J. R. Taylor & Van Every, 1993). We chose this metaphor, because it explains how participants share and learn from experiences (Eisenberg & Goodall, 1993). Also, dialogue is an essential part of the communication process and it is one of the most commonly used artifacts in business practice. That is why we expect to observe the discourse metaphor being frequently used in various RE phases.

Communication metaphor	Corresponding RE phase	Characteristics
Linkage	Discovery	Connections between people form networks and relationships
Performance	Transition, Analysis and Verification	Focus is on interaction and meaning
Symbol	Transition	Symbols are used to interpret the communication process
Voice	Decision Making	Focus is on expression or suppression of the voices of organizational members
Discourse	Various	Conversations and dialogues between people

Table 1: Communication Metaphors

Levels of Interaction

Based on the description of the metaphors for communication and organization provided by Putnam & Phillips (1996), we add certain levels of interaction from the methodology developed by Leonard-Barton & Sinha (1993). The focus of their study is on the critical direct interaction between developers of new software systems, and the users, within the bounds of single organizations and during initial implementation. Our study targets a similar population, and we believe their model would fit very well with our research goal. We use the model to define the levels of interaction for the RE phases and the communication artifacts used. We apply the Leonard-Barton & Sinha (1993) approach, but instead of observing the beginning and the end of the IS development, we are measuring the interaction levels for each phase separately. For that reason, we consider only three levels of interaction (low, medium, and high). The

purpose of this is to avoid confusion amongst the interviewees and make it easier for them to categorize the levels of interaction more precisely.

Our criteria need to be tangible in order to adequately measure the levels of interaction and to provide consistent evaluation. Therefore possible objectives to measure the interaction levels can be: frequency, amount or length of documentation, information sharing, discussions, debates, etc. These objectives can differ based on the adopted project methodologies, organizational policies, rules, regulations, and standards of communication and based on the specific characteristics of each IS project. One of the main goal of our research is to explore whether there is a relationship between the organizational methodologies, practices and guidelines regarding RE, and the selection of artifacts. So by observing the levels of interaction, we can see if there is a pattern between them and the communication artifacts used, or whether the existing policies and methodologies are central to the selection process.

Communication Artifacts

After having categorized the main concepts and levels of interaction in various papers on communication and RE, the next step is to define the most commonly used communication artifacts before connecting them to each of the communication metaphors and RE phases (Table 2). Communication artifacts represent evidence of previous communication (Mason & Leek, 2012). In order to be used successfully and provide media richness (R. Daft, et al., 1987), they need to be properly understood by all participants. We focused on the most commonly used communication artifacts in order to explore how are they applied in the RE process.

Requirements should be collected and organized from a number of different viewpoints (Sommerville & Sawyer, 1997), because information about system requirements cannot be discovered by considering the system from a single perspective, . This will ensure that various ideas and concepts will be taken into consideration and will provide different perspectives. Therefore *interviews and conversations* are very appropriate, since they require high interaction among participants. They will affect how the subjects view their own affairs and how they present that to the person who is conducting the interview. This, in turn, will have an effect on the kind of data obtained (Klein & Myers, 1999). Interviews and questionnaires are especially appropriate when gathering personal opinions, since they provide an opportunity to collect very detailed information from the participants. Also, the personal interaction between them and the interviewers helps to avoid misunderstandings, to better explain and comprehend new concepts. This intense communication dynamic signifies a significantly higher level of interaction. However, a possible implication of using interviews and questionnaires is the fact that they are time consuming and sometimes require additional resources in the form of incentives for participants.

Surveys and questionnaires also provide a very convenient and relatively inexpensive way to gather ideas, opinions and requirements from as many participants as possible. They usually require low to medium interaction and one of their main advantages is that most people are already familiar with their format and some of them do prefer this form of communication instead of participating in an interview (Russ-Eft & Preskill, 2001). These communication artifacts do not necessarily involve the actual presence of people, save time and resources, therefore they are a preferable method of communication. However, there are some disadvantages to using these artifacts - they do

provide comprehensive information on a certain topic, but this information can never be complete (Strang & Linnhoff-Popien, 2004). Another disadvantage is that it is impossible to control if the respondents are filling the surveys or questionnaires and surveys themselves and the data may not be absolutely accurate. However, they have a low cost and are a relatively easy way to obtain information from multiple participants.

Conceptual models and are especially useful in large and complex projects to avoid scope creep later on. These models usually require a medium level of interaction among participants. One of the advantages of having a goal-oriented conceptual model is the capability of representing nonfunctional aspects, such as confidentiality, performance, ease of use and timeliness (Cysneiros, 2001). Systems analysts and designers are expected to rely on their experience with previous projects in order to present the most accurate and detailed initial models of the system according to what they understood from user participation in the form of interviews, conversations, surveys, questionnaires, etc. Possible issues with these models can be the time and cost associated with their development. In addition, conceptual models do not necessarily guarantee a certain outcome and a solution to the requirements determination problems.

Ideation workshops are used to generate various ideas about a new product or service and support the management team in the decision making process. A key element is that such workshops require a mix of participants with diverse technical skills, telecommunications, and database management. Participation by business analysts and external customers may also be helpful (Peffers & Gengler, 2003). However, there are certain implications related to the coordination and facilitation of workshops for such a diverse talent pool. The main purpose of organizing workshops is to go over the design and eventually discover additional functionalities that might have been missed during the

discovery phase. Workshops are very useful for feasible idea generation. Also, post-workshop analysis is needed, since its purpose is to summarize and present the main ideas and document them for future implementation (Peffers & Tuunanen, 2005). Since participants need to be intensely involved in the workshop process, this demands also higher levels of interaction for the communication process.

Prototyping is another communication artifact used to specify in further detail user requirements and to provide constant communication with high level of interaction among participants. This method is based on an experimental procedure whereby a working prototype of the software is given to the user for comments and feedback. It helps the user to express his or her requirements in more definitive and concrete terms (Mohapatra, 2010). Prototyping is most effective in situations where users are unclear of their actual needs and elaborating the final requirements will take some time. Prototyping assists in identifying misunderstandings between software developers and users and thus avoiding dissatisfaction in later stages when the system is already developed and ready to launch. Alavi (1984) states that successful prototyping includes technological tools that facilitate fast response to user requests and motivated and knowledgeable users and designers. A disadvantage of this artifact is that it can be expensive sometimes depending on the project and a significant budget may be needed. On the other hand, prototypes help in gaining user confidence and increase user involvement and active participation in the development of the information system.

Narratives in the form of project documentation, status reports, minutes, etc. are widely used in many organizations (Martin, 1982). A narrative or a story is an embedded and fragmented process in which gaps are filled in by the teller and audience (Alvarez & Urla, 2002). Reports provided by analysts and designers can be considered narratives,

17

since they provide detailed information about the progress of the project in a story-like format. Narratives typically signify lower levels of interaction, because they do not require instant feedback from the participants involved in the communication. Some of the main advantages of narratives include participant familiarity with the format and the ability to keep track of documentation. However, an implication related to this can be the overwhelming with information and the problem of keeping an updated version of all records.

Spreadsheets are another useful artifact in the RE communication process. They also require low levels of interaction among participants which makes them especially appropriate for more organized and structured phases of the RE process . Spreadsheets are the most commonly used tool for end-user development of applications (M. J. Taylor, Moynihan, & Wood-Harper, 1998). Spreadsheets typically require lower participant interaction, since immediate response it not usually expected. They can be characterized as communication artifacts for organization and systematization of information. Spreadsheets can include a lot of details and their usage definitely provides the management team with an appropriate tool to measure and compare more easily different objectives and thus facilitate the decision making process. An advantage of the spreadsheets can be their unified format and structure within each organization. However, the spreadsheets require a certain level of knowledge, related to the specific details and the interpretation of data.

Diagrams and animations also usually require low levels of interaction amongst participants, because there is no need for immediate feedback. However, it is recommended that diagrams or animations are used as a supplement to another form of communication because without providing a context for them, they might not be

understood properly (R. Daft & Lengel, 1986). By applying diagrams and animations the most important aspects of the narratives and spreadsheets can be visualized and the readers' attention can be focused on them. A significant advantage of diagrams and animations is that they are easier to understand because they provide a visual representation of information.

Meetings, as tools for instant interaction among participants, are typically associated with higher levels of interaction. Unlike surveys or narratives, during meetings you receive immediate feedback from your audience. That is the main reason for conducting meetings during all project phases. In the past meetings were held only in person which made them very limited in time and participation. Nowadays technological improvements made it possible to substitute meetings with teleconferences and still have the same effect. This new approach makes communication between team members, end-users and management much easier and relatively inexpensive. The Media Richness Theory suggests that meetings might be richer than text because participants can observe cues conveyed through body language, facial expressions, and tone and lend meaning to words (R. Daft & Lengel, 1986; Peffers & Tuunanen, 2005). A possible implication of involving meetings in the RE process is that they need to be very well organized and have an agenda in advance. Otherwise they can become too chaotic and not produce the desired results.

And finally, *observations* are another communication artifacts used in addition to the ones described above. Observations are considered a qualitative research method and they usually require a lot of time in the field (Myers, 1997) and special skills which the person conducting the observations should possess in order to understand the behavior and attitude of participants. Observations can be used to monitor how participants use a

prototype, how they react to new features, what is easy or challenging for them. Observations as a communication artifact are usually combined with some other artifacts like prototypes, conceptual models, interviews, etc. Since the person conducting the observations must not interfere and is allowed to only monitor the actions of the participants, the levels of interaction are usually lower.

Communication artifact	Level of interaction	Advantages	Disadvantages
Interview / Conversation	High	Very detailed information, personal interaction	Time and resource consuming
Surveys / Questionnaires	Low to medium	Familiarity with the format, cheap, easy to conduct, fast	No control over participants, inaccuracy of data
Conceptual models	Medium	Representation of non-functional aspects	Time and resource consuming, outcome is not guaranteed
Ideation workshop	High	Generating ideas from a large talent pool	Hard to coordinate multiple participants
Prototype	High	Increase user confidence and involvement	Expensive and time consuming
Narrative / Story	Low	Familiarity with the format, keeping track of activities	Constant updates, overwhelming with information
Spreadsheet	Low	Familiarity with the structure	Specific skills to understand and interpret
Diagrams / Animations	Low	Easier to visualize and understand	Supplemental to other artifacts
Meetings	High	Instant feedback, relatively inexpensive, widely used	Need to be moderated, require agenda
Observation	Low	Information on user behavior	Require time in the field, expensive, supplemental to other artifacts

Table 2: Communication Artifacts Summary

From the concepts and methodologies developed in IS and communication literature, we infer that it is possible to develop certain expectations related to our research question whether organizational methodologies, practices and guidelines regarding RE exert influence on the selection of communication artifacts for RE. We drew inferences from prior theories that specific communication artifacts can be more commonly used in certain RE phases. This is due to the fact that there can be a relationship between the selection of artifacts and the levels of interaction amongst participants. We expect higher levels of interaction to require communication artifacts that can convey the higher communication dynamics. And finally, prior IS literature suggests that there should be some gradual transition from one RE phase to the other. However, to see if our expectations are valid we need to test them through several case studies.

Table 3 summarizes our assumptions about the RE communication process with respect to RE phases, communication artifacts and metaphors, as well as the levels of interaction and the rationale for our suggestions.

Phase	Communication artifacts	Communication metaphors	Level of Interaction	Rationale
Discovery	Interviews and Conversations[1] Surveys and Questionnaires[2]. Meetings[3]	Linkage, Discourse	High	Intensive communication, multiple participants and viewpoints, defining and asking the right questions[4]
Transition	Conceptual Models[5], Meetings[3]	Performance, Discourse	Medium	Additional feedback before designing the prototypes, verification that requirements are understood correctly
Analysis and Verification	Workshops[6], Prototypes[7], Meetings[3]	Performance, Discourse	High	Highly interactive communication, gathering additional requirements, remodeling the initially elicited requirements if needed
Transition	Narratives[8], Spreadsheets[9], Diagrams and Animations[10], Meetings[3]	Symbol, Discourse	Low	Structured and organized information, easy to measure and compare objectives
Decision making	Meetings[3], Observations[11]	Voice, Discourse	Medium	More structured and static communication, supporting graphical and text tools

Table 3: Interaction Evaluation and Communication Artifacts

[1] Sommerville and Sawyer (1997), Klein (1999)

[2] Russ-Eft (2001), Strang (2004)

[3] Daft (1986), Peffers (2005)

[4] Wilson & Sapsford (2006)

[5] Cysneiros (2001)

[6] Peffers (2003, 2005)

[7] Alavi (1984), Mohapatra (2010)

[8] Alvarez (2002)

[9] Taylor et al. (1998)

[10] Daft (1986)

[11] Myers (1997)

CHAPTER 4:

METHODOLOGY

We used qualitative methods to gather the data for our study. We believe case studies are more appropriate for our exploratory study. We chose them because we needed more detailed and thorough information rather than a larger sample with more general data. Also, we are investigating some relatively unexplored concepts and we need to obtain as much information as possible from our participants, and, if needed, we can provide them some additional explanations about regarding each question. Another reason for us to select case studies is the fact that there have been calls for more relevance and rigor when conducting empirically based research (Boyer, 2005; Eisenhardt, 2007; Fisher, 2007; Roth, 2007). When creating our case studies we referred to the methodology provided by Barratt et al. (2011) and we strived to address all the possible implications the authors consider relevant to RE process. Also, we want to point out that we are not using general case studies, but ones purposed to collect data on communication artifacts and the way RE process is conducted in various organizations. We did personal interviews with a project manager, a program manager, and a systems analysts from three different organizations – two public and one private. This gave us a wider range of projects and more qualitative information about each organizational environment.

To create the interview questions, we first summarized the information we gathered about both RE and communication processes. We first expanded the initial phases of the RE process developed by Browne & Rogich (2001) and we focused our attention specifically to the gradual transitions from one phase to the other. In many

cases, team members are rotated in or out during the RE process, and thus it becomes a crucial point to store and then retrieve knowledge within the organization. One of the purposes of the data collection is to investigate whether the transitional phases are viewed as cross-communication between the main RE phases or organizations regard them as an equally significant part of the RE process. This is an important consideration, since it provides more insight on the organizational processes and environment.

Second, we investigated how existing knowledge and data on communication can be summarized and categorized based on the level of interaction amongst participants. We adopted five of the metaphors of communication and organization defined by Putnam & Phillips (1996) and we also attached a certain level of interaction to each communication metaphor based on the methodology developed by Leonard-Barton & Sinha (1993). Using these classifications, we can explore during the data collection if our expectation that some communication artifacts are more commonly used than others in certain RE phases is valid.

And finally, we explored in prior literature the relationship between the levels of interaction amongst participants and the artifacts used in each RE phase. We believe that in order to provide the highest possible media richness (R. Daft, et al., 1987) communication artifacts and RE phases need to have similar levels of interaction. We also aim to explore to what extend are the organizational methodologies, practices and policies regarding RE exerting influence on the artifact selection and whether they are the prime determination rather than the levels of interaction. By applying previously developed methodologies related to both RE and communication, we are able to draw certain inferences on the relationship between organizational methodologies, practices and policies regarding RE and communication artifact selection.

24

To obtain these objectives we created a detailed interview guide (Appendix A). Its purpose is to collect data from the participants about the RE communication process in the projects we discuss. We have three main categories of questions: (1) Project characteristics; (2) Project communication; and (3) Project success. We applied only the questions that were relevant during each interview and, if necessary, we added more questions to gather the most important and detailed information possible about each project. This wide range of questions would help us look for patterns in the six case studies and draw valuable conclusions about the consistency of our expectations.

We contacted one employee each from the Office of Information Technology (OIT) at University of Nevada, Las Vegas (UNLV), the City of Las Vegas, and Caesar's Entertainment Corporation to participate in the data collection. They were chosen because of their experience with developing new IS and their relationship to UNLV. The OIT representative is a project manager, the City of Las Vegas' representative is a program manager, and the Caesar's representative is a systems analyst. Although their positions are different, they all meet the initial requirement to have experience with developing information systems based on input from end-users and customers. Each of the interviewees discussed two separate projects from their organization in order to provide a wider variety of company practices (Table 4).

Organization	Project name	Project goal
City of Las Vegas	Online Business Licensing Application (OBLA)	To allow citizens to submit their business licensing applications only online
	E-plans	To allow citizens to upload plans for licensing and building permits online
OIT at UNLV	Digital Millennium Copyright Act (DMCA)	To create the procedures for responding to DMCA notices, to store the information in a database, and to provide information about the violations on an annual-basis.
	Rebel Announcements Via Email (RAVE)	To consolidate all important announcements to students (deadlines, workshops, events, etc.) in a weekly newsletter format
Caesar's Entertainment Corporation	The New Rewards Card Mobile Sign-Up (NRCMS)	To allow employees to sign-up customers for the Total Rewards program via iPhone
	Tier Helper (TH)	To provide Caesar's customers tier credits every time they purchase a ticket from Ticket Master

Table 4: Case Studies Summary

In each study case, we demonstrated how the process of requirements discovery, analysis and verification, and decision making, along with the transitional phases between them, is consistent with the our expectations regarding the research question we are discussing. In the summaries that follow, we interpret the RE process actually used by professionals to determine how well the concept fits with the RE processes used.

The data collection for our research was conducted according to the requirements of the Office of Research Integrity - Human Subjects (ORI - HS) at UNLV. The memorandum in Appendix B: Research Approval Forms is a notification that our project has been reviewed as indicated in Federal regulatory statutes 45CFR46 and deemed exempt under 45 CFR 46.101(b)2. We have also developed an information sheet to inform the participants about the purpose of the study and obtain their consent prior to

taking the interviews. Since all interviews took place at the interviewees' offices, we also

asked them to sign forms regarding their written authorization to provide the company

facilities for the purposes of the current research.

CHAPTER 5:

CASE STUDIES

Here we describe the six cases we investigated. We use them to collect information and to reach some conclusions related to our research question whether the organizational methodologies, practices and policies regarding RE affect the selection of communication artifacts for RE. We contacted several business professionals from the City of Las Vegas, UNLV, and Caesar's Entertainment Corporation to gather their personal observations related to the development of new IS in the organizations where they work.

Case 1: Online Business Licensing Application Project

The City of Las Vegas is committed to providing quality services to its citizens. As such, they allow them to submit various online documents and applications in order to save time and valuable resources. There is a high demand for such online services, and that is why the IT department of the City of Las Vegas has developed a general process for developing new applications. The guidelines are based on the Project Management Body of Knowledge (PMBOK) Guide and Standards created by the Project Management Institute (PMI). This ensures that all employees follow the same principles and all projects are managed in a unified way with respect to both development and communication.

The goal of the OBLA project (Table 5) was to allow customers to submit their business licensing applications only online once the system was launched. This would save them time, and the City would be able to track each application easier and faster. In addition, the system would prevent document loss and accidental destruction. Users of

the system are considered the employees from the departments that were going to work with it.

The OBLA project was initiated by the need to improve the existing processes and save costs. Before this system was developed, all application were submitted on paper only. So for the requirements discovery process, the team members needed to go over the form and discover what kinds of relationships were there amongst the various fields in the form. They had the form, but they were not aware of the additional features that could be implemented. So during discovery, the team went over the main requirements such as preserving all the details from the current form but adding more functionalities and features. The system needed to save the application data in the City's database and make it available for their employees. The team had developed some similar online applications in the past, so they were able to refer to them for additional information and ideas. Additional features and requirements kept emerging the longer the team worked on the system. The communication artifacts they used for the discovery phase were interviews and conversations with the employees that were currently working with the paper applications. In addition, team meetings were regularly conducted with key staff from every department involved.

The transition between the discovery and the analysis and verification phases for the OBLA project was characterized mainly by investigating the possibilities of the system and the features that had to be added. There were interdepartmental meetings during this phase. Their purpose was to refine the initial requirements based on the existing application form and the work done on similar projects in the past. All participants in the project had to be together for the meetings, so that there were no misunderstandings and unanswered questions. During this transitional phase, the team

also reviewed the application and came up with additional questions about the system logic and data.

For the City of Las Vegas, the analysis and verification phase has become a routine procedure. Based on their project methodology, they required all documents to be reviewed and signed because this written approval was the final phase before the actual implementation of the system. Although this procedure was formal and there were not supposed to be any scope changes, the program manager reported that users kept adding new features and functionalities even after the documents have been processed. However, the documentation collected during the whole process allowed employees to more easily access the stored data even after a project was closed out. During the analysis and verification phase mainly meetings and narratives (in the form of official internal documents, written reports, etc.) were used as communication artifacts.

During the transition between the analysis and verification and the decision making phases in the OBLA project a prototype was developed, so that users could test the system themselves. Beside each user, there was an analyst to help with the testing and to observe the user behavior. This process gave the team the opportunity to monitor how the users interact with the system and figure out what needs to be modified or improved. Besides the prototypes, meetings were also used as communication artifacts. They ensured that all team members were on the same page, and there were no missed requirements.

The final phase of the RE process for the OBLA project was decision making. All decisions regarding the new system were made with the customers' agreement. The IT department could not make any decisions on their own, since the customers were the

ones who knew what the system should do. Customers were familiar with the business application process, and the IT department only had to help them transition it into an online environment. During this last phase, the main communication artifacts were emails and phone calls. The team members had to stay in constant contact with users, since the most important decisions about the OBLA project were done during this final phase.

Phase	Communication artifacts	Communication metaphors	Level of Interaction	Rationale
Discovery	Interviews, Conversations, Meetings	Linkage, Discourse	High	Users were most familiar with the features of the system and they explained it to the team
Transition	Meetings	Discourse	Medium	Refined initial requirements based on current paper form
Analysis and Verification	Narratives, Meetings	Symbol, Discourse	Medium	Routine procedure, official approval required
Transition	Prototypes, Observations, Meetings	Performance, Discourse	High	Users and analysts were working alongside one another
Decision making	E-mails, Phone calls	Voice	Medium	Customers' agreement was required before the implementation

Table 5: OBLA Project

Case 2: E-Plans Project

Another project developed by the City of Las Vegas is E-plans. Its purpose is to allow citizens to upload plans for licensing and building permits online. Before they had to make 15 sets – one for each department which was costly and inefficient, since if a change had to done, all 15 sets had to be replaced. The City of Las Vegas turned to the Development community to gather the requirements for this new pilot system.

The E-plans project (Table 6) was initiated by the main concept of the City of Las Vegas: "Customers online, not in line". This is their strategy and E-plans is a new pilot project for improving customer service. During the discovery phase City employees met with the development community to talk to them and ask for their requirements. Since end-users are usually not very familiar with technologies, the project team had to conduct several focus group meetings. During those meetings the team gathered as much information as possible about the user needs and what they think should be done to improve the process. The team together with community members also created flowcharts to visualize the system logic.

The transition between the discovery and the analysis and verification phases for the E-plans project was characterized mainly by investigating how to incorporate the discovered user needs into functional and feature requirements. The project team had to translate all the gathered data into system specifications. During this process they came up with additional questions which had to refine the gathered requirements. The team met a few more times with the community members to clarify the initially discovered requests and refine the system logic by using flow charts and case studies.

Since the City of Las Vegas had developed a routine procedure about the analysis and verification phase, they implemented it for the current project as well. The project team gathered customer feedback and made sure that all requirements are properly understood. The city used a vendor with an already developed similar software solution, so precisely gathered requirements was the key to successfully customizing the software. During the analysis and verification phase meetings with the community, document exchange, use cases and flow charts were the main communication artifacts used.

During the transition between the requirements analysis and verification and the decision making phases in the E-plans project a prototype was developed, so that city employees can test it and provide feedback about the functionalities that were related to their work. In addition, end-users from the community also tested the system. Analysts were supporting the process and providing explanations if needed. They were also observing what issues occurred with the system and what functionalities had to be improved. Regular meetings with end-users, city employees and the vendor were conducted to make sure that no requirements are skipped and there is no miscommunication.

The final phase of the requirements engineering process for the E-plans project was decision making. All decisions regarding the new system were made with the consent of the city employees who were going to use the system. Since the software was so configurable, the employees with the help of the IT department had to make the decision which of the many existing functionalities are needed and had to be implemented. The decision was based to a great extent on the customer feedback and the ideas from the focus group. At the end there was extensive interaction between all parties involved and again the communication artifacts used were phone calls and emails.

Phase	Communication artifacts	Communication metaphors	Level of Interaction	Rationale
Discovery	Interviews, Conversations, Meetings, Diagrams	Linkage, Discourse, Symbol	High	Focus groups were used to gather ideas from as many users as possible
Transition	Meetings, Diagrams and Narratives	Discourse, Symbol	Medium	Refine initial requirements and gather more information
Analysis and Verification	Meetings, Diagrams and Narratives	Discourse, Symbol	Medium	Routine procedure, user feedback was collected before submitting the requirements to the vendor
Transition	Prototypes, Observations, Meetings	Performance, Discourse	High	Users and analysts were working alongside, the vendor was also involved
Decision making	Meetings, E-mails, Phone calls	Voice	Medium	User feedback was used to decide which features to be included

Table 6: E-plans Project

Case 3: Digital Millennium Copyright Act Project

UNLV needs to be in compliance with many federal and state acts in order to meet certain requirements and provide quality education to its students. The output of the DMCA project was to first create the procedures for responding to DMCA notices, next to store the information in a database and finally to provide information about the violations on an annual-basis.

The DMCA project (Table 7) was initiated by changes in the legislation. The raw data about the IS was obtained from the DMCA and the HEOA (Higher Education Opportunity Act). However, this was not sufficient and many legal terms needed to be translated into understandable system requirements. The discovery phase was mainly concerned with this transformation and the committee members working on this project spent most of their time interpreting the new legislation changes. The communication artifacts that were used during this first phase were mainly narratives and meetings. Regular meetings were conducted every week and at each meeting there were minutes prepared. The narratives consisted mainly of weekly reports about the progress of each of the project tasks.

The transition between the discovery and the requirements analysis and verification phases for the DMCA project was characterized mainly by the continuous refinement of the gathered information. The transitional phase of the project was mainly focused on narrowing down the scope and discovering along the way additional requirements that were not initially considered or included. Some of these new requirements were not easy to implement, since they demanded changing all the processes developed so far. The communication artifacts used during the transition phase

were again mainly meetings and narratives. Whenever a committee member was unavailable to attend a meeting, a teleconference was conducted.

The analysis and verification phase in the DMCA project was critical to the development and implementation of the IS and even if one of the requirements had not been properly analyzed and verified, this could have caused a major problem for the whole system. The analysis and verification phase was described as the most important part of this project because it needed to incorporate all the new regulation requirements and at the same time to be adapted for the needs of UNLV. For this phase the communication artifacts used were not only narratives and meetings, but also diagrams. The diagrams were used mainly to present flow charts and the decision that each action (or violation of the DMCA) required.

The transition between the analysis and verification and the decision making phases in the DMCA project was very dynamic. Changes to the existing requirements kept coming along which made it hard to manage the RE process. As each new requirement occurred, all existing procedures needed to be reconsidered. The constantly made changes to the elicited requirements were very time consuming and significantly increased the complexity of the project. The communication artifacts during the transition phase were again narratives and meetings (both face-to-face and online conferences).

The final phase of the requirements engineering process for the DMCA project was decision making. The main decision regarding the DMCA project that needed to be made was whether an entirely new database should be build or the existing one should be updated and remain in use. Deciding which requirements were in scope and which were out of scope was done mainly throughout the whole RE process and it was not

considered by the committee members as a separate phase at the end of the process. The only technological decision was whether there was a need to create a new database or update the existing one. And finally, the communication artifacts used for the decision making phase of the DMCA project were again narratives and meetings.

Phase	Communication artifacts	Communication metaphors	Level of Interaction	Rationale
Discovery	Interviews, Narratives, Meetings	Linkage, Symbol, Discourse	High	Very intense interaction, employees from various departments had to work together
Transition	Narratives, Meetings	Symbol, Discourse	High	Additional features of the system kept immerging along the way
Analysis and Verification	Narratives, Diagrams, Meetings	Symbol, Discourse	High	Team members were pressed by time, the highest level of interaction
Transition	Narratives, Meetings	Symbol, Discourse	Medium	Requirements continued to immerge and changes were constantly made
Decision making	Narratives, Meetings	Symbol, Voice	Medium	Making a consensus about the technology used for developing the system

Table 7: DMCA Project

Case 4: RAVE Project

Another project developed by the OIT at UNLV was RAVE project (Table 8). Its purpose was to consolidate all important announcements to students (deadlines, workshops, events, etc.) in a weekly newsletter format. For a long time students felt overwhelmed by the constant daily notifications being sent to them. As a result a new information system was initiated and the Student Advisory Board (SAB) actively participated in shaping its features and specifications. Students also took part in developing the business process – how to collect the announcements, which ones need to be sent, who should send them, when is the best time for the bulletin to be distributed to students, etc.

The discovery phase of the RAVE project consisted of regular meetings (every other week) between the SAB and members from the OIT staff. Since the project was initiated by students, at this phase they showed the technical team what the problem was and suggested ways to improve the existing processes. The SAB was very concerned that students can miss an important announcement by being overwhelmed with unimportant or irrelevant information. Therefore the RAVE project was very significant for all students and that was why the participants' interest and level of interaction remained very high during all RE phases. This was a very dynamic project, its results would be almost immediate and it would improve the existing notification processes significantly.

After the initial problems and possible solutions were collected, the project transitioned into the next phase. During this phase a person from the OIT started working on the use case diagram. During the regular meetings some questions that needed more clarification were discussed. Also, shaping guidelines and rules about the

procedures had begun. The OIT team began working on the mock up system, to gather additional feedback from the participants before finalizing the requirements. The level of interaction was still relatively high, since all participants were actively involved into the process of shaping the features of the new system.

During the next phase, analysis and verification, the SAB reviewed the developed guidelines and policies. Since real people were going to moderate the announcements, the Board had to create very clear and precise rules about each possible case. Also, in this phase the OIT team showed the SAB a prototype system in order to walkthrough and test the business logic and interface. At that moment the technical team observed how the students were using the system in order to make some improvements to the design and features. The level of interaction was still high due to the increasing interest of the stakeholders.

The RAVE project then transitioned into its next phase, when the prototype system turned into a real and functioning website with all features and specifications gathered from the students. During this phase the regular meetings continued and their purpose was to debug the proposed prototype and make sure everything is working correctly before implementing the system. A few minor changes had to be made but this did not reflect the overall project design.

All of the SAB members, as well as the OIT team involved in the project participated in the final RE phase, decision making. The decisions involved finalizing the requirements documentation and the detailed description of the business processes. At this final phase the participants used mostly the regular meetings and narratives as communication artifacts. Since this project was initiated by the students, they wanted to

make sure that their original concept would be preserved and their requirements met. The importance of this project and the high interest from students are the main reason for having very high level of interaction during all phases of the project.

Phase	Communication artifacts	Communication metaphors	Level of Interaction	Rationale
Discovery	Narratives, Meetings	Symbol, Discourse	High	Provide justification of the project and discuss possible solutions to the problem of overwhelming students with information
Transition	Narratives, Diagrams, Meetings	Symbol, Discourse	High	Clarifying the initially gathered requirements
Analysis and Verification	Narratives, Meetings, Prototype, Observations	Symbol, Performance, Discourse	High	Develop detailed procedures and guidelines, students testing the prototype, OIT observing and improving the system
Transition	Narratives, Meetings, Prototype	Symbol, Discourse, Performance	High	Debug the prototype before implementation, make sure all features are implemented
Decision making	Narratives, Meetings	Symbol, Voice	High	Make a decision which requirements are out of scope and eventually implement them in separate systems

Table 8: RAVE Project

Case 5: New Rewards Card Mobile Sign-up Project

Caesar's Entertainment Corporation is one of the world's most diversified casino entertainment companies. It is highly focused on providing excellent customer services and building a loyalty and value for its guests. The NRCMS project (Table 9) was the first application the company created allowing employees to sign-up customers for the Total Rewards program via iPhone. This project was a Phase 2 component of a larger project aiming to improve existing systems and business processes and thus to increase customer satisfaction. This new system required changes to the existing systems of the company, since the Total Rewards Program involved information from over 40 casinos and resorts.

Caesar's Entertainment Corporation has adopted the waterfall methodology for developing its projects six years ago. The iterative approach is used rarely within the company, mostly on a case-by-case basis. All procedures and processes from the waterfall model are modified according to the specific requirements in the organization. In addition, all project managers and employees are trained and experienced with that model. That is why the iterative approach is not very popular at Caesars.

The NRCMS project was initiated by the business owner from the Marketing Department. The business owner from the Marketing Department, key IT stakeholders, and employees from Phase 1 were involved during the requirements discovery phase. The IT Department has systems analysts, who are familiar with the internal methodology of the company and are aware of the existing systems. These people are mainly the ones who contribute to discover the initial requirements for developing new systems. During the first RE phase the level of interaction was relatively high and the communication artifacts the team used were: 1:1 interviews between the systems analyst

and the business owner, standard internal RE documentation, spreadsheets, use case diagrams, and team meetings.

The transition between the discovery and the analysis and verification phases for the NRCMS project was characterized mainly by taking the end results of the previous phase and translating them into actual system requirements. During that phase the systems analyst was doing most of the work alone, clarifying the elicited initial concepts. Therefore the level of interaction was pretty low and the communication was conducted mainly via phone or email, mainly with the business owner to confirm minor details.

During the analysis and verification phase the same team as in the discovery phase got together. In one session all team members went over the functional and feature requirements for the NRCMS project that the system analyst had defined. There were no new requirements to emerge, so no changes were necessary. There was one single meeting during this phase, so the level of interaction remained low.

The transition between the analysis and verification and the decision making phases in the NRCMS project was also characterized with low levels of interaction. During that phase the systems analyst met with the business owner to get official approval of the requirements document. The team had a clear goal in the beginning of the project, so no further changes were needed for the gathered requirements.

The final phase of the RE process for the NRCMS project was decision making. In the beginning of the process the project owner had two project alternatives – either to implement all desired changes and miss the deadline, or to implement only some of the features and meet the deadline. Since they wanted the latter, the project had to be done in a specific time frame and meet the most critical requirements. Basically the

decision for this project had to be made in the beginning of the RE process. Again, the level of interaction was low and the business owner conducted a single meeting with the analyst to become familiar with the project documentation and decide whether the deadline or the features were more important.

Phase	Communication artifacts	Communication metaphors	Level of Interaction	Rationale
Discovery	Interviews, Narratives, Spreadsheets, Meetings, Use Case Diagrams	Linkage, Symbol, Discourse	High	Intense interaction, many people involved, strict deadlines
Transition	Phone Conversations, Email	Discourse	Low	Translate initial requirements into functional and feature specifications
Analysis and verification	Meeting, Narratives	Discourse, Symbol	Low	Single session to approve the requirements document
Transition	Meeting, Narratives	Discourse, Symbol	Low	Official approval from the business owner
Decision making	Meeting, Narratives	Voice, Symbol	Low	Decision had to be made in the beginning of the project, either to meet a deadline or to implement more requirements

Table 9: NRCMS Project

Case 6: Tier Helper Project

The final case study is again about a project developed at Caesar's Entertainment Corporation. The TH project (Table 10) is an application to integrate Caesar's Total Rewards Program with Ticket Master's website. The goal of this project was to provide Caesar's customers tier credits every time they purchase a ticket from Ticket Master. That way this integration will increase customer loyalty and satisfaction with Caesar's. This system was part of a bigger project and it had to be integrated not only with Ticket Master's systems, but with Caesar's existing systems as well.

The TH project was initiated by the business owner from Ticket Master. She participated actively in the discovery phase because she was aware of the box office perspective of the system. During the first RE phase the level of interaction was described as high, since there was a lot of intense communication. The artifacts the team used during the discovery phase were: 1:1 interviews between the systems analyst and the business owner, standard internal RE documentation, spreadsheets, use case diagrams, and a lot of team meetings.

The transition between the discovery and the analysis and verification phases for the TH project had a much lower level of interaction. During that transition the end results of the previous phase were refined and summarized in order to develop the final requirements and a prototype of the system. The main communication artifacts used in this phase were status meetings and narratives (reports).

During the analysis and verification phase the all team members (from Caesar's and from Ticket Master) worked together. They made sure that the developed prototype

was working correctly. Since employees from both companies were involved in the testing, the level of interaction was significantly higher than in the previous phase. During the verification phase the team had to confirm that the new system met the initial needs and goals and it was also technically sound. The communication artifacts used here were mainly meetings, narratives (reports) and a prototype system.

The transition between the analysis and verification and the decision making phases in the TH project had a low level of interaction. There was only a single meeting of the team in which all participants examined the end-user workflow processes. They had to be sure that the system would follow all steps in a logical order and it would perform as expected.

The final phase of the requirements engineering process for the TH project was decision making. During the previous phases some new requirements occurred related to the business processes and they had to be added to the initial requirements list. So during the final phase the system analyst met with the business owner for official confirmation of the final requirements. In addition, during the decision making phase the team had to make sure there are no additional questions and that the responsibilities of each member for the next project phases were clear. The level of interaction amongst participants was described as medium and the communication artifacts they used for this final RE phase were meetings and narratives (reports).

Phase	Communication artifacts	Communication metaphors	Level of Interaction	Rationale
Discovery	Interviews, Narratives, Spreadsheets, Meetings, Use Case Diagrams	Linkage, Symbol, Discourse	High	Intense interaction, people from different organizations involved
Transition	Meetings, Narratives	Discourse, Symbol	Low	Refine requirements and develop an interactive prototype based on them
Analysis and Verification	Meetings, Narratives, Interactive Prototype	Discourse, Symbol, Performance	High	Test prototype, confirm specifications and business logic
Transition	Meeting, Narratives	Discourse, Symbol	Low	Confirm end-user workflow processes
Decision making	Meeting, Narratives	Voice, Symbol	Medium	Official approval of the requirements documentation

Table 10: TH Project

CHAPTER 6:

DATA ANALYSIS

To evaluate if our expectations are consistent with current business practice, we do qualitative analysis of the gathered data using the categorizations we adopted from prior literature. The case studies present the RE communication process in both public and private companies, and the projects involve IS for: university students, employees at Caesar's Entertainment and the City of Las Vegas, as well as citizens. Based on the collected data we can draw several inferences related to our research question.

Levels of Interaction

We observed that the communication interaction varied for all RE phases in all six case studies. In each of the cases we noticed that during the discovery phase all participants evaluated the level of interaction as high. This is true regardless of whether the project managers were using iterative or the waterfall development processes. We can infer from this observation that there is support for our expectation that in the beginning most projects require a higher level of interaction in order to gather the initial requirements from the end-users and customers. Also, in four of the six case studies we noticed that the final phase (decision making) had a medium level of interaction. This information is consistent with our theory that the level of interaction varies and at the end of the RE process it is lower than in the beginning.

We were not able to distinguish other consistent patterns related to the level of interaction during the remaining RE phases (analysis and verification and the two transitional phases), for several factors. First, each company had implemented its own

project methodology and the team members were already familiar with its tools and processes. Second, every organization had different motivations for the development of new information systems. In cases, such as RAVE, where the IS was directly initiated by the customers, we can infer that there were higher levels of interaction throughout the whole RE process.

In two of the case studies (NRCMS and TH) the waterfall development process was applied, since this was the main project methodology for the organization. These two projects were characterized by much lower levels of interaction compared to the other four. Although this is a relatively small sample, this inference is quite interesting and it is worth investigating the relationship between the waterfall development processes and the lower interaction levels amongst participants.

Communication Metaphors

The communication metaphors used in the six case studies were: linkage, symbol, performance, discourse, and voice. They all correspond to the initial five that we applied from the categorization developed by Putnam and Phillips (1996). We did not include the conduit and lens metaphors, as we expected they would not be part of the RE process. This idea was confirmed by the interviewees in the case studies they described.

Table 11 summarizes the data we gathered from the six case studies about the application of communication metaphors.

The linkage metaphor was used only in the discovery phase in five of the six case studies. This observation confirms our initial expectations that in order to start the RE process, there needs to be a group of experts or end-users with sufficient experience

and knowledge. We learned from the interviewees that networks of such people are very useful to gather participants for requirements determination. The discourse metaphor was used interchangeably in all RE phases which is also consistent with our expectations. This shows that meetings and conversations between the parties involved were occurring throughout the entire RE process. Such an observation can be explained by the fact that the discourse metaphor provides immediate feedback and issues and conflicts are resolved much faster. The voice metaphor was used in all six cases during the decision making phase. From this observation we can infer that the voice metaphor is relevant to the managerial process. There is a relationship between making a decision about which requirements to be implemented and the demonstration of power and superiority from the project managers.

The only inconsistencies we found, related to the communication metaphors, involved the use of the symbol and the performance metaphors. We expected them to be related to only one RE phase, but in the case studies we conducted, these two metaphors were used in multiple phases. For example, the symbol metaphor was used in all phases. Possible explanation for this observation can be the fact that the symbol metaphor is closely related to project documentation and diagrams, which are very frequently used regardless of the methodologies adopted in organizations. Documentation is regarded as the most accurate evidence of the activities conducted during the system development, therefore the symbol metaphor is one of the most commonly used, together with the discourse metaphor. Also, we expected the performance metaphor to be used in analysis and verification only, but in practice (in three of the six case studies) it is also associated with the transitional phase after it. This can be explained by the fact that some processes are conducted in more than one phase, that some activities overlap

in certain areas, and that performance tests can be conducted multiple times in order to provide the best results.

Phase / Project	OBLA	E-Plans	DMCA	RAVE	NRCMS	TH
Discovery	Linkage	Linkage	Linkage		Linkage	Linkage
	Discourse	Discourse	Discourse	Discourse	Discourse	Discourse
		Symbol	Symbol	Symbol	Symbol	Symbol
Transition	Discourse	Discourse	Discourse	Discourse	Discourse	Discourse
		Symbol	Symbol	Symbol		Symbol
Analysis and Verification	Discourse	Discourse	Discourse	Discourse	Discourse	Discourse
	Symbol	Symbol	Symbol	Symbol	Symbol	Symbol
				Performance		Performance
Transition	Discourse	Discourse	Discourse	Discourse	Discourse	Discourse
	Performance	Performance		Performance		
			Symbol	Symbol	Symbol	Symbol
Decision Making	Voice	Voice	Voice	Voice	Voice	Voice
			Symbol	Symbol	Symbol	Symbol

Table 11: Communication metaphors summary

Communication Artifacts

In five of the six case studies, participants indicated they used interviews and conversations during the discovery phase. Therefore we can infer from this information that our expectations are confirmed. A possible reason may be that interviews and conversations provide more detailed information and are a useful tool when interviewees are not familiar with the topic. In addition, these communication artifacts provide a much more personal contact and participants are probably more likely to propose ideas and features for new IS.

Based on the gathered data, we were not able to infer confirmation of our expectation that artifacts can be associated with specific RE phases. The six case studies provided us no distinctive pattern that specific communication artifacts can be used in certain RE phases only. We observed that most of the artifacts were used interchangeably throughout the entire RE process in all of the presented case studies. In addition, we noticed that meetings and narratives (progress or status reports, project documentation, minutes, etc.) were used in all RE phases. This can be due to the fact that companies have already developed their project methodologies. Also, interviewees explained their criteria for selecting the communication artifacts were based on factors other than the level of interaction, for example the company methodologies and established practices. We observed that, for example, the OIT uses the same artifacts regardless of the RE phase. Others, like the City of Las Vegas and Caesar's Entertainment, have created a set of standards and guidelines to follow for all IT projects.

At the end of the interviews all participants were asked to evaluate the success of the projects. Although interviewees characterized them as successful, all of them confessed that the projects were behind schedule and experienced scope creep. In addition, participants reported communication problems during the RE process. For example misunderstandings between users and systems analysts (OBLA, RAVE), unrealistic customer or end-user expectations (NRCMS, TH, E-Plans), too strict deadlines (DMCA), all lead to increased pressure amongst the team members working on the system requirements. From the provided information we can infer that there is a the need for improving the current RE communication process at the participating organizations. This process is closely related to the overall project success and it should not be overlooked.

Table 12 below summarizes the data we obtained from the six case studies related to the application of communication artifacts in business practice.

Phase / Project	OBLA	E-Plans	DMCA	RAVE	NRCMS	TH
Discovery	Interview	Interview	Interview		Interview	Interview
	Conversation	Conversation				Conversation
		Diagram				
	Meeting	Meeting	Meeting	Meeting	Meeting	Meeting
				Narrative	Narrative	Narrative
					Spreadsheet	Spreadsheet
Transition	Meeting	Meeting	Meeting	Meeting		Meeting
		Diagram		Diagram		
		Narrative	Narrative	Narrative		Narrative
					Conversation	
					Email	
Analysis and Verification	Meeting	Meeting	Meeting	Meeting	Meeting	Meeting
	Narrative	Narrative	Narrative	Narrative	Narrative	Narrative
		Diagram	Diagram			
				Prototype		Prototype
				Observation		
Transition	Meeting	Meeting	Meeting	Meeting	Meeting	Meeting
			Narrative	Narrative	Narrative	Narrative
	Prototype	Prototype		Prototype		
	Observation	Observation				
Decision Making		Meeting	Meeting	Meeting	Meeting	Meeting
			Narrative	Narrative	Narrative	Narrative
	Phone call	Phone call				
	Email	Email				

Table 12: Communication artifacts summary

Transitional Phases

From the data we collected, we can infer that participants did not make a clear distinction between the main RE phases and the transitional phases. In all six case studies, the communication artifacts used during the intermediate phases overlapped with artifacts used for the three main phases (discovery, analysis and verification and decision making). For example, participants stated to have used in all six case studies meetings, diagrams, narratives, prototypes and observations in a transitional phase and at least one

of the three main phases. We can infer from this observation that in practice transitions are viewed as a cross-communication between phases, rather than as a separate part of the RE process. Possible explanation for this can be again the influence of organizational practices, policies and adopted methodologies regarding RE in each of the three organizations.

CHAPTER 7:

CONTRIBUTION

We find, based on the data results we have from the six case studies, that artifacts are chosen not so much to meet the need of interaction, but rather because there is a cultural niche for them in the organizations. We also discover that participants consider the transitional RE phases rather as a way to cross-communicate within the main RE phases, than as a separate process requiring the same degree of attention. In addition, we infer that the motivation of the participants plays a key role when determining the levels of interaction amongst them. We believe these two conclusions are very important, since this is the first study on RE communication artifacts and the collected data gives us a strong foundation to build upon.

Many authors in the past have considered the implications of organizational environment (R. Daft, 2008; Frank & Fahrbach, 1999; Leifer, 1988), but what this paper adds to existing knowledge is the discovery that organizational methodologies, practices and guidelines also affect the decision of which communication artifacts to be selected for the RE process. We believe this is a valuable finding, because now that we know about this correlation, we can do further research, improve our expectations and suggest improvements to the RE communication process. By focusing on the company environment, instead of on the level of interaction, we will be able to build upon the current expectations we developed and provide companies with ideas that better meet their needs.

Motivation is the other significant factor that we observed to have influence on the level of interaction in each RE phase. From the six case studies we conducted, we

can infer that when end-users or customers are proposing the development of an IS, the interaction levels were much higher. User involvement has been previously explained in literature (Burnett, Cook, & Rothermel, 2004; Robey & Farrow, 1982), but the current study adds more information to what researchers have discovered in the past. We are able to distinguish a pattern involving end-user or customer motivation and the levels of interaction for RE. We observe this relationship best at the two cases that involved UNLV students. Our discovery is not only consistent with prior theories, but it also provides more in depth information about behavioral patterns in end-users' and customers' interaction and attitude during the development of new IS.

CHAPTER 8:

CONCLUSION

The current study focuses on providing an answer to our research question: "What is the predominant factor for the selection of communication artifacts for RE?" Prior literature on both RE and communication suggests that there are certain artifacts that can be more frequently used in RE, and that some artifacts are more common than others. In addition, there can be a relationship between the levels of interaction and the communication artifacts used. However, we discover that in practice there are some implications related to the organizational environment that exert significant influence on this selection. And finally, prior literature suggests that transitional phases can be added to the main RE phases, but in practice there is an overlap between them and there is not a very clear distinction amongst the team members.

Our results suggest that the prime determination for the selection of communication artifacts and models is the organization and not the project itself or the levels of interaction. It takes organizations a lot of time and resources to adopt a certain methodology and train their employees on it. Once a practice has been approved and accepted by the employees in the company, introducing any new practice is likely to lead to resistance to change among the staff (Baddoo & Hall, 2003). These facts can explain why organizations have also adopted certain communication artifacts and metaphors regardless of the individual project characteristics. However, this can turn into a problem, because not all communication artifacts are capable of providing the same media richness (R. Daft, et al., 1987). Therefore we believe if organizations apply some

of the practices we propose, that will require strong upper management support and employee training in order to provide the expected results.

Also, we investigate how participants view the problem of transitioning from one RE phase to the other. Based on the data we gathered, we can infer that for the interviewees there was no clear separation between each RE phase. They view them as general processes, and for them the transitions represent a way to cross-communicate between the main RE phases. This suggests that in practice it is sometimes difficult to make a clear distinction when one phase is over and when the next one begins. Although this can be due to specific organizational methodologies, it is worth paying more attention to this process in the future, since it can assist in the improvement of the overall communication process for RE.

Next, we came to the conclusion that participant motivation plays a more important role than communication dynamics in determining the levels of interaction for each RE phase. This can be explained by the fact that participants who initiated the system feel much more related to its development. As stakeholders, their responsibilities increase and their role in the project becomes more important. The personal motivation that end-users or customers have reflects the levels of interaction in four of the six case studies we explored. Personal motivation and interest made the RE process more dynamic, with more iterations of the systems and more document exchange.

Finally, another inference we draw from the case studies is that meetings and narratives (in the form of project documentation, status reports, minutes, etc.) are used interchangeably regardless of the project and organization type. We believe this is due to the fact that meetings provide attendees with instant feedback and the probability of

miscommunication is minimal. Documentation, on the other hand, is a way to physically preserve knowledge which is an important organizational resource (M. Alavi & Leidner, 2001). These two artifacts and their corresponding communication metaphors (discourse and symbol) seem to be so universal also because they do not require any special skills or employee training, since they are widely adopted already.

We should emphasize that our expectations and findings are based on a relatively small sample size and although we collected very detailed data from all of the participants, further research with a larger sample size can be done to evaluate our current findings and avoid possible bias in the respondents. When selecting the participants in the data collection, we strived to contact organizations with diverse structures and goals. We also approached employees at different positions, so they could give us a wider variety of viewpoints related to the requirements elicitation and IS development.

We also believe that further research should be done to examine our expectations and improve them. What needs to be taken into consideration can be: the type and structure of the organization, the project methodology implemented, and the practices and traditions related to selecting the communication artifacts. In addition, RE communication is a relatively new area of study and not many researchers have focused on it yet. However, we expect that in the future more theoretical models will be developed and we can use them to improve our expectations as well.

In conclusion, although all participants characterized their projects as successful, they also explicitly indicated that team members experienced various communication issues during the RE process. Interviewees admitted their current methodologies may be

working, but they do not always provide them with the desired results. They also expressed interest in the concept of connecting artifacts with interaction levels and were intrigued by the expectations we drew based on prior literature. This evidence suggests that in general, our expectations are valid, but when applying them to each organization we need to take into consideration additional factors as well.

APPENDIX A:

INTERVIEW GUIDE

PROJECT CHARACTERISTICS:

1. What was the name of the project?

2. What was the goal of the project?

3. What was the project category (process improvement, cost saving, customer value, etc.)?

4. Was the project driven by the need of innovation?

5. Was the project developed in house?

6. How would you evaluate the complexity of the project?

7. Was the developed system independent or did you have to integrate it with existing software systems in your company?

8. How much money did the project cost?

9. How much time did the project take?

10. Who initiated the project?

11. What was your role in the project?

12. How many people were involved in the project team?

PROJECT COMMUNICATION:

13. Did you talk to customers or stakeholders to gather their requirements? Why? Why not?

14. What kind of communication artifacts did you use and why (interviews, surveys, conceptual models, workshops, prototypes, narratives, spreadsheets, diagrams, meetings, observations, etc.)?

15. How would you describe the level of interaction among participants in the requirements discovery phase?

16. What did you do after you gathered the initial requirements? How did you proceed to the next phase?

17. During this transitional phase how would you describe the level of interaction among participants?

18. What kind of communication artifacts did you use in this transitional phase and why (interviews, surveys, conceptual models, workshops, prototypes, narratives, spreadsheets, diagrams, meetings, observations, etc.)?

19. Did you verify your requirements analysis with the customers or stakeholders? Why? Why not?

20. During this phase how would you describe the level of interaction among participants?

21. What kind of communication artifacts did you use in this phase and why (interviews, surveys, conceptual models, workshops, prototypes, narratives, spreadsheets, diagrams, meetings, observations, etc.)?

22. What did you do after you verified your requirements analysis with the customers or stakeholders? How did you proceed to the decision making phase?

23. During this transitional phase how would you describe the level of interaction among participants?

24. What kind of communication artifacts did you use in this transitional phase and why (interviews, surveys, conceptual models, workshops, prototypes, narratives, spreadsheets, diagrams, meetings, observations, etc.)?

25. Did you involve the customers or stakeholders in the decision making phase?

26. During this transitional phase how would you describe the level of interaction among participants?

27. What kind of communication artifacts did you use in this phase and why (interviews, surveys, conceptual models, workshops, prototypes, narratives, spreadsheets, diagrams, meetings, observations, etc.)?

PROJECT SUCCESS:

28. Did the project fit within the initial budget? Why? Why not?

29. Was the project completed within the initial scope? Why? Why not?

30. Did you change any of the requirements during the development of the project? Why? Why not?

31. Was the project completed within the expected time frame? Why? Why not?

32. Were the project objectives achieved? Why? Why not?

33. How would you evaluate the overall project's success?

34. Is the developed system still in use? Why? Why not?

35. Have you made any upgrades to the system so far? Why? Why not?

APPENDIX B:

RESEARCH APPROVAL FORMS

Social/Behavioral IRB – Exempt Review
Deemed Exempt

DATE: February 13, 2013

TO: **Dr. Ken Peffers**, Management, Entrepreneurship, & Technology

FROM: Office of Research Integrity – Human Subjects

RE: Notification of IRB Action
Protocol Title: Communication Artifacts and Interaction Evaluation for Requirements
Engineering
Protocol # 1302-4371M

This memorandum is notification that the project referenced above has been reviewed as indicated in
Federal regulatory statutes 45CFR46 and deemed exempt under 45 CFR 46.101(b)2.

PLEASE NOTE:
Upon Approval, the research team is responsible for conducting the research as stated in the exempt
application reviewed by the ORI – HS and/or the IRB which shall include using the most recently
submitted Informed Consent/Assent Forms (Information Sheet) and recruitment materials. The official
versions of these forms are indicated by footer which contains the date exempted.

Any changes to the application may cause this project to require a different level of IRB review.
Should any changes need to be made, please submit a **Modification Form**. When the above-
referenced project has been completed, please submit a **Continuing Review/Progress Completion
report** to notify ORI – HS of its closure.

If you have questions or require any assistance, please contact the Office of Research Integrity -
Human Subjects at IRB@unlv.edu or call 895-2794.

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64

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

EXEMPT RESEARCH STUDY

INFORMATION SHEET

Department of Management, Entrepreneurship and Technology

TITLE OF STUDY: Communication Artifacts and Interaction Evaluation for Requirements Engineering

INVESTIGATOR(S) AND CONTACT PHONE NUMBER: Dr. Ken Peffers at 702-895-4897 and Miloslava Plachkinova at 702-882-5053

The purpose of this study is to propose the most appropriate communication artifacts for each phase of the requirements engineering process based on the level of interaction amongst participants. You are being asked to participate in the study because you meet the following criteria: project manager with experience in developing new information systems based on end users' requirements.

If you volunteer to participate in this study, you will be asked to do the following: answer questions related to the development of a new information system.

This study includes only minimal risks. The study will take *60 minutes* of your time. You *will not* be compensated for your time.

For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794, or via email at IRB@unlv.edu.**

Your participation in this study is voluntary. You may withdraw at any time. You are encouraged to ask questions about this study at the beginning or any time during the research study.

<u>Participant Consent:</u>
I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

Deemed exempt by the ORI-HS and/or the UNLV IRB. Protocol 1302-4371M
Exempt Date: 02-13-13

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