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Project Complexities in a Public Sector IS Project: Case Peppi

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ABSTRACT

Objectives of the Study

The problems in IT projects are well-known and the public IT projects and their failures have been in focus lately. The Peppi project is a public IT project. The complexity of the project is enormous, and it includes organization complexities on different dimensions (e.g., Metropolia's internal, TAMK's internal, between TAMK & Metropolia). In addition, there are complexities in design, implementation and testing phases.The objective of this research is to find out the factors that contribute project complexity of public IT project.

Academic background and methodology

In the literature review, the concepts of a project, project management and project complexity were introduced to provide a picture of the issues related to IS project complexities. In this literature review, the focus lies in taxonomy and assessment methods of project complexities. The empirical part of the study is based on the literature review about project complexities and it has been carried out as interviews. The interview data is grouped, analyzed and reflected against the literature, and the conclusions are drawn.

Findings and conclusions

This study gives an insight on the aspects of project complexity in a public sector project and it also shows the challenges related to the size of the organization and the hierarchies inside the main organization. Communicating with others, informing about changes, collecting information and understanding the organizational "culture" of different organizations and sub-organizations increase the project's complexity in an immense way. The more agents there are, the more complex a project will be.

Keywords

Project management, project complexity, ISDP, SOA

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ABSTRAKTI

Tutkimuksen tavoitteet

IT-projektien haasteet ja erityisesti julkisen sektorin IT-projektien ongelmat ovat merkittävä ilmiö. Metropolian ja TAMK:in yhteishanke, Peppi-projekti on merkittävä julkisen sektorin IT-projekti ja siihen sisältyy organisaation tasolla useita kompleksisuuden dimensioita, kuten suunnittelu-, käyttöönotto- ja testausvaiheisiin liittyvät haasteet. Tutkimuksen tavoitteena on selvittää projektin kompleksisuuteen vaikuttavia tekijöitä julkisen sektorin IT-projektissa.

Kirjallisuuskatsaus ja metodologia

Kirjallisuuskatsauksessa esitellään tarkemmin projektihallinnan ja projektin kompleksisuuden käsitteitä. Osiossa selvitetään myös taksonominen jaottelu projektin kompleksisuudesta sekä projektin kompeksisuuden arviointimetodeita. Tutkielman empiirinen osuus pohjautuu kirjallisuuskatsaukseen ja se on toteutettu henkilöhaastatteluina. Haastattelumateriaali on ryhmitelty ja analysoitu taksonomisen jaottelun perusteella sekä sitä on analysoitu kirjallisuuden pohjalta.

Tulokset ja päätelmät

Tutkimus osoittaa julkisen sektorin IT-projektissa vaikuttavien kompleksisuutta lisäävien tekijöiden merkityksen sekä haasteita, jotka liittyvät osallistuvien organisaatioiden kokoon, diversiteettiin sekä hierarkioihin. Kommunikointi sekä projektien etenemisestä viestiminen, muutoksista tiedottaminen, tiedonkeruu sekä organisaation toimintatapojen ymmärtäminen lisäävät projektin kompleksisuutta. Mitä enemmän projektissa on mukana muuttuvia tekijöitä sekä yksilöitä ja yksiköitä, sitä kompleksisempi projekti potentiaalisesti on.

Avainsanat

Projektinhallinta, projektin kompleksisuus, ISDP, SOA

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1. INTRODUCTION

The objective of this research is to find out the factors that contribute project complexity of public IT project. There are background & motivation, research questions, methodology and thesis structure in this section.

1.1. Background and motivation

The public IT projects and their failures have been in focus lately. For example, Valda (Valtion yhteinen asian- ja asiakirjahallinnan ratkaisun kehittämishanke) cost over 9 million euros without any actual result (YLE). Another example comes from health management. A patient database project, which cost nearly 500 million euros without yet being finished, although over 10 years was spent with the project (Taloussanomat). These were just few examples of similar kind of stories about public IT projects failures.

In the literature, problems in IT projects are well-known. For example, study by Liu et al (2009, 319) argue major problem which causes IT project to fail is senior executive commitment. Nelson (2007, 74) emphasizes that avoiding the classic mistakes such as poor scheduling, insufficient risk management and short-changed quality assurance are the main reasons why the IT projects fail.

My employer, Helsinki Metropolia University of Applied Sciences (Metropolia) and Tampere University of Applied Sciences (TAMK) are currently working on a big information system project, spanning total over 4 years and affecting over 25 000 students and personnel. This project called “Peppi” where separate educational resource planning and design systems will be transformed to a single service level architecture (SOA) based system. For an outsider, the project seems very complex and time-consuming.

This Peppi project is a very public IT project. The complexity of the project is enormous, and it includes organization complexities on different dimensions (e.g., Metropolia’s internal, TAMK’s internal, between TAMK & Metropolia and so on). In addition, there are complexities in design,

implementation and testing phases. Based on theory of complexities, how do they fit here? If they fit, discovering them and confirming them would be crucial in making the project a success. Does a public IT project contain something different and why do they generally fail? One may asked that are the IT projects generally so complex that most of them indeed eventually fail.

The empirical part of the study is based on the literature review about project complexities. In this literature review, the focus lies in taxonomy and assessment methods of project complexities. After this empirical part, the research framework is created. This framework is applied to collect and analyse the empirical data.

1.2. Research questions

- What are the IS project complexities?
- How are the complexities managed?
- What kind of factors contribute to a public IS project complexity?

1.3. Methodology

Research method is qualitative and interpretive. The empirical part of the study was done using interviews among the project personnel with different kind of responsibilities in the project. The researcher had no control of the events in the selected organization – the project was a contemporary phenomenon in real-life context (Yin, 2003, 5-7). This research is a case study based on a single case. Although multiple case study in several of similar projects could have provided more coverage and robustness (Yin, 2009, 46-47), this was not practical in this case. This was due the fact that similar kind of projects is very hard to find in Finland in a given timeframe to this study.

1.4. Structure of the thesis

There is a literature review of the existing literature in section 2. This literature review concentrates on theoretical framework of project complexities, earlier studies on project complexities and their key findings. Section 3 of the thesis contains empirical part of the thesis. This includes description of methodology and data collection. Empirical data analysis, key findings and reliability analysis can be found from the final sections of the thesis, sections 4 and 5.

2. LITERATURE REVIEW

In this chapter, there is an exploration of IS project complexity literature. At first, project management research is explored in general level. Then, two of the research questions – what are the IS project complexities and how are the complexities managed – are inspected based on earlier literature. This inspection is then summarized as a theoretical framework in section 2.3. This theoretical framework is used as a basis for empirical part of the study.

2.1. Definitions

In this modern world, it seems that there are projects everywhere: one's work, home activities and even a leisure trip can be defined as a project. In historical perspective, the Manhattan Project is typically thought to be starting point of modern project thinking, and typically very large construction programs were among in modern way of thinking of projects (Meredith & Mantel 2009, p. 9).

The definition for project is somewhat vague; still everyone has a clear opinion what a project is. According to Kerzner (2009, p. 2) a project is series of activities that have an objective or objectives which must be completed in within certain specifications containing defined start and end dates. In addition, Kerzner (2009, p. 2) includes expenditure of human and nonhuman resources as define characteristics of project. If one wish to define a project in a one sentence, Project Management Institute (2004, p. 5) gives it: "A temporary endeavour undertaken to create a unique product or service".

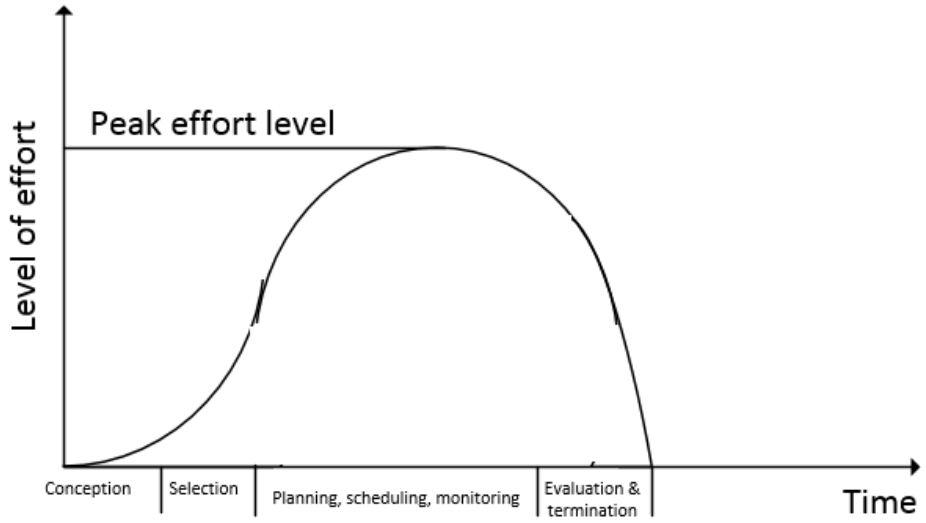
In any project, some kind of project management is needed. This project management can be actualized five processes: initiation, planning, execution, monitoring & control and project closure. In initiation phase, the best project for the given resources is decided, and project manager is appointed. In planning phase, work requirements and scheduling is done. As project moves to execution phase, managing and directing the work in the project is in centre of the activities. During all phases of the project, but especially in execution, project monitoring and

progress tracking are important and executed in parallel with other phases. At project final stage is closure, where project work is verified and the project is shut down. (Kerzner, 2009, p. 3.)

Moreover, in project management, terms program, task, work packages and work units are usually made distinct of each other. Program means very large object, which contain many projects and sub-projects. A project itself can be divided into tasks. Task itself contain work packages, which consists of work units. (Meredith & Mantel, 2010, p. 9.)

Terms project life cycle, level of effort and peak effort level are important in terms of resource allocation in the project. Project life cycle means how much time is allocated to the project. Level of effort is the intensity, how much project's resource is allocated during certain time. Peak effort is the highest level of project's resource spending. The Figure 1 below shows relation between these three terms.

Figure 1. Relation between project life cycle, level of effort and peak effort level



(Meredith & Mantel, 2010, p. 15)

The project is created in order to get *deliverables.* These deliverables are tangible and they can be measured. Deliverables can be hard, software or interim. Hard deliverables are such which exist physically. Software deliverables are the kind that does not usually have a physical form.

For example, study of something etc. Interim deliverables can be hardware of software, but these are produced in different phases of the project. One should notice that not all companies make a distinction between hardware and software deliverables. (Kerzner, 2009, pp. 5-6.)

2.2. Understanding project management

To be able to understand project complexities, we must first understand project management. This is necessary, because project management can be seen as a part of project complexity (Austin et al., 2002, p. 192). For example, degree of complexity in the project has a direct impact how to plan, control and co-ordinate project requirements (Bubshait, 1992, p. 43).

Project management in general is a big issue and of course it is not related to just IS projects. For example, World Bank (2012) has stated that one fifth of world's gross domestic product (GPD) is gross capital formation, which is almost entirely project management related (Anbari & Ashurbekov, 2007, pp. 122). Over the years project management research has had different focus depending on various theoretical influences.

Project management can be seen through nine research orientations. These orientations affect how the project management is handled in the project. These orientations include optimization, modelling, governance, behaviour, success, decisions, process, contingency and marketing. (Bredillet, 2008c, p. 2.)

Optimization orientation of project management sees project as a mathematical model which can be optimized. These optimization methods include critical path method (CPM), program evaluation and review technique (PERT) and Gantt charts. In optimization, the project is broken into smaller and smaller components and subcomponents so that it can be managed with greater accuracy. (Bredillet, 2007, p. 2.)

When adding into optimization research approach methodology found in soft systems, we find new research approach called modelling (Yao, 1993, p. 111). For example, in order to project manager to track changes in project proactively, one can use soft systems approach with the project management (Neal, 1995, p. 8). As another example, sociology and social psychology are

considered as soft-approaches, but they can be effectively mixed into hard-approached project management methods to achieve new kind of model to solve long, service-led projects (Alderman et al, 2005, 381).

When including surrounding society, its laws and contracts, project management takes a new dimension: governance. Contracts can be seen as a method for owner to establish a project organization and allocate and control its resources (Turner, 2002, p. 75). Risks in projects can be taken as an example of how contracts stipulate project management (Ibid., p. 81).

Putting more focus on people and their relationships and behavior in project leads to think project as a social system. Organizational behavior and human resource management in this social system is in focus (Bredillet, 2008c, p. 3). More recently, there has been extensive research working in teams, due to globalization and more complex projects (Thamhaim, 2004, p. 534).

Typically, projects have many objectives. In terms of business objects, project success (or failure) consists of two components: project success factors and project success criteria. Project success factors are the factors which increase rate that project can be successful. Project success criteria are the business objectives – the objectives, which the project must achieve in order to be successful. (Bredillet, 2008a, p. 2.)

Measuring project success with business objectives leads to think project as a creator (or destructor) of business value. Companies need project management to tackle issues of how to create business value, ergo, improve their competitiveness. Concrete tools in project management are various quality management techniques. (Judgev & Müller, 2005, p. 20.)

Defining project through decision-making and process, one can see the analog to computer and algorithm running inside it. Decision-making in projects emphasizes different factors including project start, funding of projects, termination and conclusion whether its success or failure. There are two stages, where decision-making focuses: beginning of the project (why certain decisions are necessary; what are their impacts to the project as a whole) and general information

processing, how to process information so that uncertainty in the project reduces. (Bredillet, 2008b, p. 2.)

In addition to decision-making, which has analog to computer, process has analog to algorithm running inside this computer. This algorithm analog comes from influence from information systems. The idea is to think project as an algorithm, which "computes" appropriate steps in project when desired outcome is fixed. (Bredillet, 2008b, p. 2.)

In the nineties, "one size fits all thinking" in project management were challenged by an adaptive project management. This adaptive approach recognizes the fact that every project is different, ergo; different project management techniques must be used to deal with various project complexities and managerial issues. For example, development project and support project are examples of two different types of projects. They require different competencies, for example, from leadership styles. (Müller & Turner, 2007, p. 22.)

Finally, in project management research, there is a research branch, which emphasizes marketing in project management. Marketing issues are important, because in every project, there stakeholders for which project is responsible. In general understanding, managerial and stakeholder support is crucial for project to succeed. These marketing efforts are needed to gain this support. (Cova & Salle, 2005, pp. 354-355.)

Project management research is very diverse, as shown in this sort walk-through. Project management itself is in focus, because project based management seem to be de-facto in everywhere. For example, in Finnish technology industry, projects are the only way to allocate time and resources within the company (Ruuska, 2005, p. 59).

Depending which level you examine certain organization and its operations, you can see it from micro or macro level. At micro level, you may think that organization is manufacturing, engineering or marketing based. When you look the organization in macro-level, you have either a project-driven or non-project driven organization. At the macro-level, organizations are project-driven or non-project driven. (Kerzner, 2009, p. 22.)

If comparison between project-driven and non-project driven organizations is made, one notices that non-project driven organizations typically exists in low-technology manufacturing. In this kind of organization, projects are in most cases created only to support the production itself – not to manage the priority resources. If the project management methods are applied to a non-project driven organization, one may expect following problems: the managed project usually have a different kind of project management requirements, executives usually have no additional time to manage these projects (and executives are reluctant to delegate), projects may encounter additional delay because of non-project organization's vertical approval chain is too long. In additions to these, a project management personnel tends to be isolated from the rest of the organization, which is not project driven. (Kerzner, 2009, p. 22.)

Finding factors, which account for a success project, have been and still are under heavy research interest. Åstebro (2004) has been focusing on this. He states that although there are numerous factors, 68 factors to be exact, which has an effect for the project to be successful, four of them raises above others. These are expected profitability, technological opportunity, technological uncertainty (i .e. development risk) and appropriability conditions. First three are self-explanatory, fourth appropriability conditions mean how well the project fits the organization. (Åstebro, 2004, p. 320)

There is no silver bullet in project management. Different research branches illustrate very vividly, how extensive is the project management research. There are many approaches to project management. For example, combining governance and project management is interesting research field where modern project management research focuses. When thinking project complexities and project management, one cannot escape from the fact that these are interrelated. Unsuitable project leadership method for particular project may cause even in relatively less complex project to be too hard lead. Gaining stakeholder support for the project is crucial even less complex projects, as the project management research shows.

2.3. Complexities in information systems projects

Dealing with complexities in projects is not a new issue. One can think that it is old as project and project management itself. As stated in the previous chapter, project complexity and project management are interrelated. Poorly managed project will add complexity to simple project, and with good project management, it is possible to reduce complexity in project.

Defining what project complexity is a quite difficult task. Baccarini (1996) has investigated project complexity definition through terms differentiation and interdependency. Both of these are defined in terms of organizational complexity and technological complexity. In organization complexity dimension, differentiation means how many hierarchical levels, number of organizational units and divisions of tasks there are in the project. Interdependency in organizational complexity means how big is the degree of interdependencies in these organizational units. In technological complexity, differentiation means how many different tasks, and how diverse are project's inputs and outputs, for example. Interdependency complexity in this technological dimension means interdependencies between these tasks and technologies used in the project. In a complex project, there are many varying interrelated parts. The problem with this definition is that it has not caught up to the project management literature, because it might be difficult to know, which kind of project complexity is meant. (Baccarini, 1996, p. 202-203.)

It is possible to describe project complexity more practical manner. This means that one can give the reasons why project is considered too complex. According to Murray (2000), IS project fail because they are too complex. The complexity itself is due to many factors: the scope of the project, extensive use of new technology, business, vendor, and phenomenon called "scope creep". (Murray, 2000, pp. 33-34.)

Wrongly scoped project means that expectations of the project outcomes by project responsible people are wrong in terms of resources and project development skills in the organization. This may cause complexity of the project to increase, because the project responsible people may

react to the situation by adding more people, for example outsiders, to the project. This does not necessary improve the situation. (Ibid., p. 34.)

New technology might also be adding further complexity to project. For example, taking new management system in the use at the same time with the new project can be very risky, and increase complexity, because this new management system adds more variables to manage in addition to project management itself. (Murray, 2000, p. 34.)

Complexity increases also due to business issues. This is very typical in the situation, where the project is purely based on specialty other than business. When this specialty project is then exposed to business issues, project faces increasing complexity. This is because there is no expertise in the project to take account complex business aspects. (Ibid., p. 34.)

Vendor's effect to project complexity is not necessary straightforward. At first, it may seem that vendor's promises from certain project software or application seems excellent for project needs. However, after a while, it may be that this software promised too much. Considerable amount of project resources and effort has been put to usage of this software, it is difficult to change this. In a way, the project is held hostage by this vendor and its software. This increases complexity requirements for the project, because this risk must be calculated in the project's resources, although it may be difficult. (Ibid., p. 34.)

Phenomenon called "scope creep" is interesting, how it increases project complexity. Especially in IS projects, the project's scope may expand during when the project goes forward. This means that the project is allowed to expand more or less freely during the project lifetime. The reason for this is that IS projects are typically complex, and it is difficult to calculate exactly how much time and resources must be allocated to the project. Scope creep increases project complexity simply because project size increases from the original, ergo, scope creep management is needs more projects resources. (Ibid., p. 34.)

When work is organized through a concept of project, one can think that ultimate challenge to project's success is various level of uncertainty. Turner & Cochrane (1993) have introduced term uncertainty, and how this will affect project's complexity. They assign two parameters for the

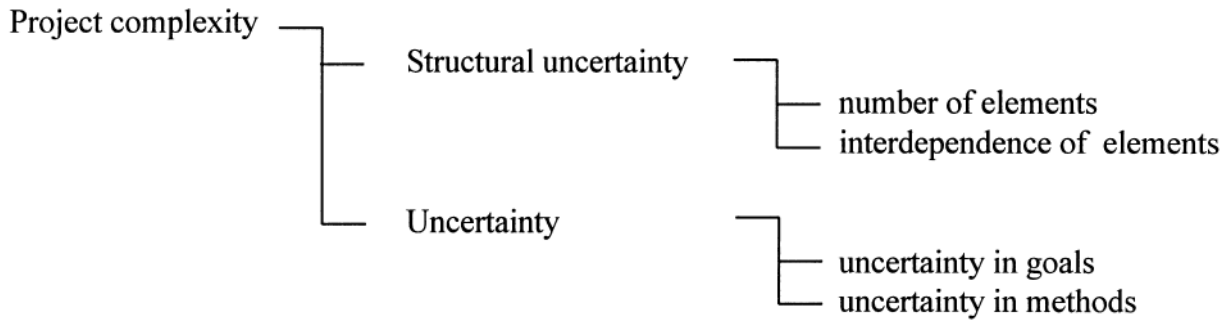
project: goals and methods. Goals in this context mean that how well the goals are assigned, and methods mean the accuracy of the definition of these project management tools. (Turner & Cochrane, 1993, pp. 94-96.)

Uncertainty in goals is typical for IS projects. This uncertainty rises from the fact the especially in IS projects, the user's requirements are uncertain, they might be hard to specify or are in flux, for example, after the first prototype of the software. Complexity increases when the requirements are not frozen, feedback-loops cause constant changes. How much these actually increase complexity, is hard to measure by, for example, quantitative methods. One quantitative measure for example for changes in goals could be how many contract changes happen during the project. (Williams, 1999, p. 271.)

There is also uncertainty in the methods of how to achieve the goals of project. These methods tend to increase project complexity, because uncertain methods cause problems for example in work breaking down structure, task allocation and task sequencing. You have to notice that there is difference in uncertainties. For example, in case of project body and previous knowledge exists may encounter different kind of uncertainty that in the project, where is no previously working prototype. (Williams, 1999, p. 271.)

When combining Baccarini' (1996) findings about differentiation and interdependency and Turner & Cochran's (1993) findings about uncertainty, these can be combined into the following Figure 2. As can be seen from the Figure, there is classification how the project complexity is affected by different dimensions. These dimensions are not all measurable for example in quantitative means.

Figure 2. Different dimensions of project complexity



(Williams, 1999, p. 271)

In this chapter, a closer look for project complexities was provided. As seen from the review, the subject has been under very comprehensive study in the recent years. A complex project is multi-dimensional issue, which, nevertheless, has quite straightforward elements. These elements has in most cases, direct influence of project complexity. To mitigate project complexity, project must be managed so that these factors must be taken account.

2.4. Framework of project complexity

In their article "Grasping the Complexity of IS Development Projects" Weidong Xia and Gwanhoo Lee (2004) analyse the key measures of project complexity and the ways in which they affect project outcomes. As they point out, the complexity of IS development projects (ISDPs) can be understood and measured according to two dimensions: organizational/technological and structural/dynamic (p.69). Organizational aspect of complexity can be defined to refer to the types of and number of relationships among hierarchical levels and organizational units and technological aspect of complexity can be defined as referring to types of and number of relationships among inputs, outputs, tasks and technologies (Xia & Lee, 2004, p.71).

Literature on software project risk factors has provided for Xia and Lee a basis for examining the dynamic or uncertainty-based aspects of ISDP complexity (Ibid., p 71). According to Xia and Lee, ISDP managers can think about the project complexity by analysing the organizational and

the technological aspects of ISDP complexities in terms of structural complexity among the project components or the dynamic/uncertain characteristics that result from the potential changes that may occur during the project (Ibid., p. 71).

In the created taxonomy, each dimension suggests two aspects of ISDP complexity (Ibid, p. 71). The taxonomy consists of four components that can describe project complexities: Structural organizational (project elements in the organizational environment, e.g. project resources, project staffing, skill proficiency levels of project personnel), Structural IT (relationships among IT-related elements, e.g. software environments, variety of technology platforms, diversity of external vendors and contractors),

Dynamic organizational (the pattern and rate of change in ISDP organizational environments, e.g. changes in user information needs, business processes and organizational structures, and on the other hand, the project's effect on the organizational environment), and Dynamic IT (the pattern and rate of changes in ISDP's IT environment, e.g. changes in IT infrastructure, architecture and software development tools). (p. 72).

Xia and Lee also examined the relationship between overall ISDP complexity and project performance and after that, they analysed the effects of the four ISDP components on overall project performance (Xia & Lee, 2004, p. 72). They analysed the ISDP performance based on four measures: project delivery time, cost, system functionality and end-user satisfaction (Ibid, p. 72). They found out that higher amount of ISDP complexity is connected with delayed project delivery, cost overruns, reduced system functionality, and lower end-user satisfaction (Ibid, p. 72).

Xia and Lee made use of regression analysis in their study to find out the effects of the four complexity components on the four measures of project performance (Ibid, p. 72). They found out that Structural organizational aspect was the most important complexity component affecting all four measures of performance (Ibid, p. 72). Dynamic organizational aspect negatively affected project cost performance and in many cases that might be seen in e.g. cost overruns (Ibid, p. 73). However, Dynamic IT aspect influenced only system functionality and on the other

hand, Structural IT did not have any significant direct effect on the project performance measures (Ibid, p. 73).

To sum up the results, end-user satisfaction and project delivery time are mostly influenced by Structural organizational aspect of project complexity. Project cost performance is most affected by Structural organizational and dynamic organizational complexity aspects. System functionality, on the other hand, is most affected by Structural organizational and Dynamic IT aspects of complexity. (Ibid, p. 73).

2.5. Service-Oriented Architecture

Peppi project makes use of a system architecture paradigm called SOA, Service-oriented architecture. The earlier architecture was a combination of different systems that were connected to each other. The aim in using SOA is to make it possible to streamline interfaces so that different systems can be added and removed flexibly according to the organization's needs. In addition to that, different system components can be updated independently from other systems that are part of the chosen architecture pattern in the organization.

Service-oriented architecture (SOA) can be defined as a software design and software architecture design pattern that is based on structured collections of software modules that are known as services, which provide functionality of a software application. Service-oriented architecture is a system architecture paradigm for designing and developing distributed systems. Service-oriented architecture solutions have been created for business goals, including flexible integration with legacy systems, streamlined business processes, lower costs, innovative service to clients and customers, and agile adaptation to competitive threats. (Bianco et al., p.1).

It is typical for SOA solutions that there are two categories that are not mutually exclusive: service providers and service users. A service provider may use other services and on the other hand, a service user may provide a service interface (ibid.). SOA is an architectural style, whereas web services is a technology that can be used for implementing SOAs (ibid., p. 4).

The purpose of SOA is to allow relatively easy cooperation of several computers that are connected over a network. It is important to point out that in a large network of computers, SOA has the same kind of role and duties as an operative system on a single computer. (Wikipedia, Service-oriented architecture).

In SOA, services are loosely coupled units of functionality. In it, each service implements one action and the services use defined protocols that describe how services pass and parse messages with help of metadata. In SOA the developers associate software functionality in a relatively non-hierarchical arrangement using a tool that contains a list of all services and their traits for building an application. XML has been used in SOA for structuring the data, WDSL (Web Services Description Language) is used for describing the services and SOAP protocol is used for describing the communications protocols of SOA.. (Wikipedia, Service-oriented architecture).

The flexibility of SOA is seen in the way in which it allows users to combine large chunks of functionality to form ad hoc applications which are built using the existing software services. The larger the chunks are, the fewer interface points are needed for implementing functionality. In addition to that, interaction cannot exist between the specified chunks or the chunks themselves, but the people specify the interaction of the services. The SOA services are more loosely connected than e.g. functions linked from libraries to form an executable file. The services are developed by programmers using traditional programming languages such as Java, C, C++, C#, Visual Basic, COBOL or PHP. (Wikipedia, Service-oriented architecture).

3. DATA AND METHODS

3.1. Data collection

The aim was to study the questions of complexity in IT projects and the data were collected by using semi-structured interviews. The interviewees were selected based on their position in the project and their expertise level and experience in the organization. The participants represented different positions from project managers, project planners, customer service managers, chief information officer and steering group members to the head of the specialist team. The different positions might help in finding also different perspectives on the studied problems. The interviewees represent the IT management department of Metropolia University of Applied Sciences, and more specifically, they represent the helpdesk, product development and network team of the IT management department. There were conducted seven interviews in total.

The interviews were conducted in person and they lasted approximately half an hour in general. All interviews were recorded. The purpose was to collect information according to the idea of organizational complexity in terms of Structural organizational complexity, Structural IT complexity, Dynamic organizational complexity, and Dynamic IT complexity.

The interview questions were based on those categories, but the questions were about the practices of the studied project. The interviewees' comments have been cited and analysed with the emphasis on the project complexity issues. The findings from the interviews seemed to support the expectations and hypothesis about the framework I have studied in this thesis. I was aware of the possibility that my expectations might affect the way I analyse the data, but I have tried to make my analysis process as transparent as possible and describe it alongside the analysis of the data.

My motive for studying the project complexity was the pragmatic interest of knowledge in the studied area and the fact that I have been in the team for developing the project tools in our organization. The findings might help in developing comparable tools in future as it could be possible to find a model to tackle the possible risks and find the possibilities when complex IT projects are concerned.

3.2. Content analysis

The method of interpreting and analyzing data in this thesis is content analysis. The interviews were done according to a theme and the questions were based on themes that could shed light on the project complexity related reasoning in the studied project. The emphasis which the interviewees had on different themes were found by analyzing the qualitative expressions and adjectives the interviewees made use of. The words were counted and different synonyms were found about the same objectives. A table about the expressions was made to make the analysis process clearer and more explicit. The interviewees' opinions and viewpoints were 'found' and analyzed more deeply by making use of that pattern.

Content analysis is a methodology for studying the content in communication. (Wikipedia, Content Analysis). In it, researchers analyze artifacts of social communication which typically are written documents or transcriptions of recorded material. Content analysis is "any technique for making inferences by systematically and objectively identifying special characteristics of messages" (Holsti, 1968 in Content Analysis, p. 240).

As Klaus Drippendorff (2004 and 2008) has put it, six different questions must be addressed when making use of content analysis:

1. Which data are analysed?
2. What is the population from which they are drawn?
3. What is the context relative to which the data are analysed?
4. What are the boundaries of the analysis?
5. What is the target of the inferences?

A central assumption in content analysis is that the words and phrases that are mentioned most often are also reflecting important themes in a communicative act. Thus, content analysis in its quantitative form starts with counting word frequencies, space measurements (e.g. column

centimetres in a newspaper), time counts (e.g. for television air time) and keyword frequencies. In addition to that, words can be analyzed in their context and the synonyms and homonyms can be isolated and analyzed. (Wikipedia, Content analysis).

3.3. Description of the project

The Peppi project is about defining, designing and implementing a service entity created by design tools for the education planners and teachers. The new service entity will replace the Toisu year planning system and combine the existing Totsu and OPS editor as parts of the new service entity. The aim of the project is to map both organizations' service and information needs and to create other services according to requirements engineering. The project is being carried out in co-operation with Tampere University of Applied Sciences (TAMK). (Metropolia Wiki).

The currently used Toisu / Year planning system has been defined and taken into use according to the previous organization's needs. The system does not serve the users' needs in the current organization. For example, the system does not support data transfer between different systems (e.g. STTS, OPS editor, WinhaPro). In addition to that, copying the same data units to different informations sources increases the need for maintenance and the risk for scattered information between the sources. Raporting and composing is also at times challenging, as different sources of information are constructed according to different data models. (Metropolia Wiki).

In the current system, services are shattered in different parts so that they are difficult to maintain.Thus, making changes leads to new errors in the systems' functionalities. During the summer 2009 an inquest was made about the current state of Toisu system and development possibilities. As a result of that in addition to the inquest about the current state, a decision was made about building the current services using new architecture and techniques. (Metropolia Wiki).

The phases of the project are (Metropolia Wiki):

Phase 1

1. The project plan
2. Proof of concept and the choice of technology
3. Agreement
4. Initial definition and planning

Phase 2

The definition, implementation, testing and piloting

1 . The education planner's services

2. The teacher's services.

3. The monitoring, reporting and publishing services

Phase 3

1. Testing

2. Piloting

3. Deployment and training

4. Final report and the termination of the project

In the project, we are currently in the 3. part (deployment and training) of the phase 3.

The first phase is based on Proof of Concept to assure that the chosen technology is suitable. In addition to that, the aims and restrictions are made and the project organization has been gathered. As a result preliminary definitions are made about the needs and wishes by the users and the organization. During that phase a concept design is made and the products created by the system are described. (Metropolia Wiki).

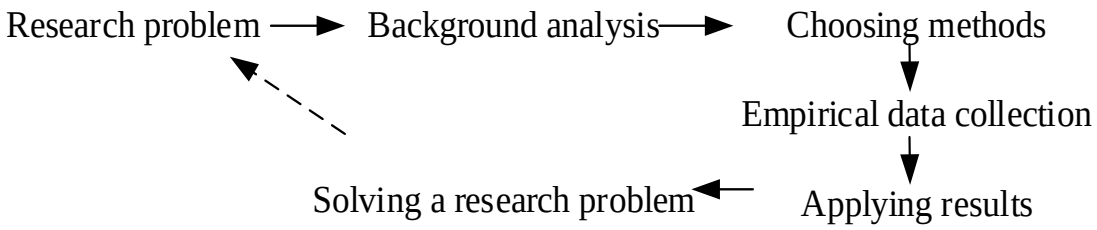
The second phase of the project consists of defining and implementing different modules. In it, the project model is iterative program development method. In that method, the project and the systems are divided to different modules, which all contain definition, design, demo phase, implementation, testing and the pilot phase. In that model the system entity is developed in phases and some modules are taken into use for the piloting already during the project. In the model different phases are iterated until the implementation has been accepted. The model is useful for getting user experiences during the piloting. Thus, the services might also fulfill the users' and the organization's needs. (Metropolia Wiki).

The third phase of the project consists of final testing, deployment and training. A more comprehensive piloting belongs to the third phase, too. After all phases a report has been made to describe the results and the progress in the project. (Metropolia Wiki).

3.4. Research method

Research process in general follows the pattern presented in Figure 3. As it seen from the Figure, the research problem is in center, and it dictates what kind of research method is used. Then, the empirical data is collected. After this, the research problem is solved completely, or partly. (Hirsjärvi & Hurme, 1980, p. 11.)

Figure 3. Research process in general



(Hirsjärvi & Hurme, 1980, p. 11)

In general, there is no general wisdom, what kind of methodology and method to use in the research. Same applies also to the method. For example Denzin & Lincoln (2005, p. 183) state that a method is practical when it can satisfactorily combine theory, research hypotheses and methodology.

In her article Qualitative Quality: Eight "Big-Tent" Criteria for Excellent Qualitative Research, Sarah J. Tracy defines eight key criteria of quality in qualitative research. Those key markers are listed as (a) worthy topic, (b) rich rigor, (c) sincerity, (d) credibility, (e) resonance, (f) significant contribution, (g) ethics, and (h) meaningful coherence. Tracy's eight-point conceptualization creates a useful pedagogical model and a common language of best qualitative practices. (Tracy, 2010, p. 838).

As Tracy states, comparing it to all social knowledge, values for quality are continually changing and located within local contexts and current conversations (Ibid.). Tracy's conceptualization pinpoints eight universal hallmarks for high quality qualitative methods across paradigms and at the same time differentiates these from general practices (Ibid.). The model is designed to provide a pedagogical tool, promote respect from power keepers who might misevaluate qualitative work, develop a general platform for unified voice for scholars, and encourage dialogue amongst qualitative methodologists. (Ibid., p. 839).

Worthy topics grow from societal or personal events and e.g. current political climates or contemporary controversies can inspire research (Ibid, p. 841). Worthy studies point out issues that shake the common-sense assumptions and practices and in cases where studies confirm existing assumptions, people tend to deny its worth even if they acknowledge its truth (Ibid, p.841).

A rich complexity of abundance is also typical for high-quality qualitative research. As Tracy points out, the researcher should show their diligence by making use of appropriate time, effort, care and throroughness (Ibid.). Especially the question about what amount of data is enough, is important in that context and it must be asked and answered in every research study. The amount of data also intersect closely with the level of analysis put into the study (Tracy, 2010, p. 841.). Thus, close data analyses can be rigorous even though the amount of 'raw' data is low.

Tracy connects the term sincerity with the concepts of authenticity and genuineness. Sincerity means that the research is honest and transparent about the researcher's biases and goals, and how they possibly affected the methods and traits of the research. Sincerity is in an elementary way connected with the self-reflexivity of the researcher (Ibid., p. 842). Self-reflexivity means that the researcher is honest about the strengths and shortcomings that might affect the research (Ibid.).

Credibility is connected with the trustworthiness, verisimilitude, and plausibility of the findings of the research (Ibid.). Whereas in quantitative research credibility means reliability, replicability, consistency, and accuracy, in qualitative research those criteria can only be partly met. Instead, qualitative credibility can be achieved through practices such as thick description, triangulation (or crystallization), multivocality and partiality.

In qualitative research, triangulation means that two or more sources of data, theoretical frameworks, types of data or researchers are benign to converging on the conclusion, then the conclusion is more credible (Denzin, 1978). Crystallization makes researchers to gather several types of data and make use of various methods, researchers and theoretical frameworks (Tracy, 2010, p. 844). In it, the aim is to provide the researchers with a more complex and in-depth understanding of the studied issue (Ibid.). Multivocality is closely linked to the idea of crystallization, and it includes multiple and varied voices in the qualitative report and analysis Ibid.).

With the term resonance Tracy refers to research's possibility to reverberate and affect an audience (Ibid.). In practice, resonance can be reached through aesthetic merit, evocative writing, formal generalizations, and transferability (ibid.). It can be said that high-quality qualitative reports must have impact (Ibid, p. 845).

Significant contribution refers to the ways in which the research contributes to the understanding of social life (Ibid., p. 846). In addition, theoretically significant research is "intellectually implicative for the scholarly community" (Ibid., p. 846). On the other hand, research is heuristically significant when it makes the reader curious and helps in inspiring new discoveries (Abbott, 2004). Tracy notes that heuristic research develops new concepts that can be further

questioned and explored later (Tracy, 2010, p. 846). Practically significant research sets the usefulness of the knowledge in focus (Ibid.). Methodologically significant research means that a research project contributes in new methodological findings (Ibid.).

Procedural ethics refers to ethical actions that are thought to be universally necessary by organizations and institutions (Ibid, p. 847). Situational ethics often center around the question about the means justifying the end and the term refers to ethical practices that emerge from a consideration of a context's specific circumstances (Ibid.). Relational ethics means ethical self-consciousness in which the researcher is aware of the research's consequences (Ibid.). On the other hand, exiting ethics are present in ethical considerations after the data collection phase and the questions on how the researchers leave the scene and share the results (Ibid.).

Meaningful coherence means that the research project achieve their stated purpose, accomplish what they are trying to be about, use methods and representation practices which follow the espoused theories and paradigms, and interconnect the reviewed literature with the research project's focus, methods and findings (Ibid, p. 848). According to it, the research project should live up to what the project focuses on and what it aims to be.

In this research, a qualitative approach is used for couple important reasons. The qualitative method gives researcher flexibility in research design, and it is suitable for this kind of research – this will be explained in detail in later in this chapter. Furthermore, researcher is more familiar from his previous studies with a qualitative approach.

Qualitative methods lack many of the statistical abilities, which quantitative methods have. This means that qualitative methods can be thought as an addition to quantitative methods in a way that they add a method to describe a human observation (Eskola & Suoranta, 1999, p. 32). Furthermore, qualitative method can be described more than an approach than set of methods (Morgan & Smircich, 1980, 491). Qualitative method provides a great amount of different methods to collect empirical data. This might be a result of the fact that there are many competing theories in many research fields, which use a qualitative method. (Hirsjärvi et al, 1995, 19).

In this thesis, a large publicly funded IS project is researched as a case study, holistic and systematic way of describing project work. Real implementation projects are not done in the laboratory, but in natural environment. Projects contain restrictions, which raises from budget, timetables, and customers and so on. There are different views in the project, which exists only in that project. A suitable method for this kind of research is case study.

In case study research, a single phenomenon or carefully narrowed entity is under research, by using miscellaneous and different kind of methods. In case study research, cases are researched merely through how and why type of questions. (Yin, 2009, pp. 8-9.)

In case study, it is not necessary to use only qualitative data. It can be easily thought that doing case study is using solely qualitative approach. Case study method and qualitative approach can be even seen as inter-changeably methods. This is not entirely true, because case study can be based on qualitative data, quantitative data or both. For example, quantitative method could be used sort of "filter", which reveal relationships in a case study data that are not obvious to the researcher. In addition, the quantitative approach may help the researcher not to focus "wrong" assumptions, which may be at first hand valid, if looking only qualitative data. Combining both methods could be useful: using qualitative method to understand phenomenon and then, with quantitative method, to find support for researcher's induction. (Eisenhardt, 1989, p. 538.)

Mintzberg (1979, p. 587) sees also synergies using quantitative (systematic data) and qualitative (anecdotal data): "For while systematic data create the foundation for our theories, it is the anecdotal data that en- able us to do the building. Theory building seems to require rich description, the richness that comes from anecdote. We uncover all kinds of relationships in our hard data, but it is only through the use of this soft data that we are able to explain them."

This kind of synergy cannot be directly used for this thesis' empirical data. It is only analyzed through qualitative method. However, the empirical data is collected based on quantitative framework, so the synergy in that sense is apparent.

Case study research consists of three stages: 1. define & design, 2. prepare, collect & analyze, and 3. analyze & conclude. At Stage 1, based on a theory (or development of theory), cases are

selected and design of data collection protocol is concluded. At stage 2, the actual case studies are conducted, and individual case reports are produced. At final stage, cross-conclusions are made, then possibly the theory is modified (or amplified), policy implications are developed and cross-case report is written. At stages one and two between case selection and actual conduction of the case study, there might be a feedback loop. This feedback loop is necessary for fine tuning the case selection and design of data collection. (Yin, 2003, p. 50.)

One can find three types of case studies: intensive, comparative and action research types. In intensive case study, the goal is to develop an intensive understanding of events and/or practices which happen to a person, group, organization or instance. This understanding is then applied to current theory or theory building. In comparative case study method, researcher tries to develop explanation based on a case or cases, and then replicates this to a new cases or cases, comparing the results. Finally, the action research method is researcher itself is part of the phenomenon he or she is observing. Then, researcher makes intervention and monitors, what kind of change is occurring. (Cunningham, 1997, pp. 402-406.)

Stake (1994, 237-238) on the hand describes case study differently. He classifies case study into three classes like Cunningham, but uses different names: intrinsic, instrumental and collective, and does not define action research method as a case study. Intrinsic case study resembles intensive case study, where the case itself is interesting, not necessarily its relation to outside world. In instrumental case study, the case itself is not in the center, it is an instrument how to improve the theory. Collective case study is very much the same as the comparative case study in Cunningham's definition.

In this thesis, a combination of intensive and instrumental case study method is used. This is because only one project is studied, so no comparative case study method is valid. On the other hand, using already defined theory and framework, this thesis try to find amplification, and added certainty of the theory, and this is described by Stake (1994, 237-238) as a property of instrumental case study. In addition, this is not a development project, which involves researcher itself as part of the project and developer, so action research method is not suitable.

In intensive case study method, it is expected that researcher is familiar of the real settings and variables, and then, try to match findings into the theory so that different explanations and interpretations will emerge. This is needed because actual research setting in the case cannot be controlled. This leads to situation, where researcher has to use previous evidence from different interpretations. (Cullingham, 1997, p. 403.)

In this thesis, the requirement for familiarity of real settings to be researched in the case comes from the fact the researcher has been closely tied with the over the case over the years. The researcher has over eight years' experience of the organization, including seven years of experience of issues that the thesis' case is all about.

When doing research as a case study, there is always certain amount of subjectivity that is meditates into researcher. This is because researcher has own experiences and even some prejudice against the research case at hand. This comes to apparent especially when the empirical data is collected, and the actual analysis is made. In case study it is typical that background theories and methods are combined and selected (Syrjälä et al., 1994, p. 13).

Actual empirical data collection was done using semi-structured interview. According to Gillham (2000, p. 65), semi-structured interviewing "(…) is the most important form of interviewing in case study research." This is because, when semi-structured interview is used by well-practiced interviewer, it seems very natural, and this naturalism makes semi-structured interview method a productive tool for research (Ibid., p. 65).

Pertti Alasuutari (2011) has listed different characteristics typical for theme interviews of good quality. The way in which the interviewer potentially affects the interviewee and the interview in itself, and thus the reliability and quality of data, should be estimated (Alasuutari, 2011, p. 142). That means that the interaction situation in itself is a potential source of erroneous information. It is also important for the researcher to use the potential moments and sources of additional information e.g. in situations where the interviewee tells something and at the same time gives an opportunity to ask additional questions on the same topic (ibid., 143).

An important aspect in this context is the possibility to analyze the interview situation in itself as a source of information (ibid., 143). E.g. the way in which the interviewee reacts to a question might tell much about the interaction structure the interviewed person makes use of (ibid.). It is also important to note that the interviewee usually tries to make sense what the researcher is intending to find out by asking the questions in an interview (ibid., p. 149). It is typical for the interviewees to apply the most usual situation that would be most possibly linked to a previously unknown situation (ibid., p. 150). An important thing to note is the fact that the interviewee also typically tries to make things sound better than what they actually are (ibid., p. 150). On the other hand, it could be thought that in some contexts also the opposite is possible, if the interviewee feels frustration about some things that could be improved.

3.5. Issues of reliability and validity

In qualitative research in general, there are three test of validity and one test of reliability, which are common for all qualitative research studies. These tests are construct validity, internal validity, external validity and reliability. In construct validity, the goal is to make sure, that the actual measurement is that what was expected in the research question or questions. In case of internal validity, the idea is to find causality between relationships in the data. An external validity is reached when research can be generalized. The research has reliability in order when it can be repeated based on certain protocol to reach same results. (Yin, 2009, pp. 40-41.)

In a case study research, construct validity is challenging to reach. However, there are measures what the researcher can take to increase internal validity. Internal validity can be increased by appropriately describing the environment, including factors affecting the study, and use multiple sources of evidence. (Yin, 2009, pp. 41-42),

This research's construct validity is increased by carefully describing the project under study. There is also comprehensive literature review of the project and project complexities presented in the study. Carefully description of the project and its environment helps to understand the relationship between the project and its environment. This is important because this creates

possibility form a picture how the environment affects the project. For example, when examining the project complexities, the project's environment may be major contributor the project complexity – not just the project itself. Without properly describing environment where project is in, it is impossible to say whether the complexities are from the project or from the environment.

Internal validity is problematic in a single case study, descriptive study. In fact, it is impossible (Ibid., p. 41). This is because internal validity means causality in the research data. When the reseach is descriptive, it criteria for causality is practically impossible to fulfill. In order the data to be causal, there has to be a research setting where researcher will try to find a causal relationship how the event x caused event y (Ibid., p. 42). There is also the problem with interference between the researcher and his or her persona and the actual research objective. This interference is impossible to avoid, it can only mitigated to some degree (Ibid., p. 42).

Internal validity is not a great concern for this study, because it is merely descriptive study by nature. Still, because interviews are used, it causes some interference to the data collection process between researcher (interviewer) and research objectives (interviewees). This interference is practically possible, because researcher is not very experienced. The experience is the key, because to be a good interviewer, you have to have quite a lot experience from interviewing (Hirsjärvi & Hurme, 1980, p. 65). One might think that every day interaction with people will properly train person to make good interviews, but this is a typical misunderstanding (Ibid., p. 65).

The mitigation of interference in this study is done with carefully preparing to the interview itself, and the background facts. Researcher will also look some guidance from literature. The fact that helps researcher in this project is that all the interviewees are colleagues, and employed by two institutions. This colleague status will probably ease interviewees' attitudes and increase motivation for a study. For example, the anxiety in interviewee (E. g., Hirsjärvi & Hurme, 1980, p. 119) can be diminished.

Last of the validity issues is an external validity. External validity of the research means the domain, where the research's results can be generalized. As an example, if the results for some study where gathered from one neighborhood, can this be repeated in another neighborhood (and

get the same results). This generalization is not necessary simple. For example, to be valid, it must be repeated and tested in other cases. This proves validity among many cases and helps to construct a theory. (Yin, 2009, pp. 41-42.)

In a single case study, the repetition logic is not applicable. Single case studies in general raise a critic about validity issues, including external validity. Problem with single case study is that it is just one case – how you can generalize this. This is true, when thinking same way as behind survey cases, where there is statistical power behind generalization. In a single case study, generalization is based on analytic thinking. This analytic method means that researcher try to link the findings in a single case to a theoretical framework. (Ibid., p. 43.)

Research presented in this thesis is based on a framework of complexity of projects. This is a basis theory for analytic generalization. In means of external validity, theory of complexity is used to link the findings in empirical part of the thesis. This generalization relies on the fact, that theory of the complexity is solid, and the findings in the case are correctly and carefully collected.

Finally, there is an issue about reliability. When certain research is classified as 'reliable', it is possible to repeat the results, if the research is conducted in exactly same way: using same research procedures and same empirical data. With this repetition, is possible to find errors and possible biased data. One must notice that this is not same as replicating the research, like meant in case of external validity. (Yin, 2009, p. 45.)

Common problem with reliability with case studies used to be that cases were not properly documented. This causes concern about reliability of the study, because there is no way to find out how the actual data collection was done. Moreover, without proper data collection protocol and case study database, it is very hard to convince examiners of the study about the reliability. (Ibid., p. 45.)

In this study, the reliability is one of the hardest things to actualize. This is because this is a single case study, happening only one time. This uniqueness in time is the problem in case of reliability, because in order to repeat the case, you will need exactly the same interviewees, same

setting, and same point in time of the project, for starters. In addition, other things in environment must be the same. This of course cannot be done, and it is always present with a single case studies.

Like stated before (Ibid., p. 45), the way to mitigate problems with reliability are data collection protocol and a case study database. In case of this research, data collection and case study protocol are based on literature, because the researcher itself has very little experience in case study method and data collection. A decent case study database, however, is available. Based on literature review, the project management, project complexities are well covered subject in the previous studies, and these serves as excellent case study database. This earlier research gives a solid footing to design and implement research. There is also at least few thousand qualitative research studies from other fields as well, which are documented. Although from different field, there are crucial similarities in case study design.

4. FINDINGS, ANALYSIS AND RESULTS

In this section of the thesis the interview results will be presented and analyzed. The interviewees' responses on the questions have been summarized under all four themes on project complexity.

4.1. Insights from the conducted interviews

The four factors and themes related to project complexity that are studied in this thesis are: structural organizational complexity, structural IT complexity, dynamic organizational complexity and dynamic IT complexity.

In Weidong Xia and Gwanhoo Lee's taxonomy, each dimension suggests two aspects of ISDP complexity. As noted earlier, the structural organizational aspect refers to the project elements in the organizational environment, e.g. project resources, project staffing, skill proficiency levels of project personnel, structural IT refers to the relationships among IT-related elements, e.g. software environments, variety of technology platforms, diversity of external vendors and contractors. The dynamic organizational aspect refers to the pattern and rate of change in ISDP

organizational environments, e.g. changes in user information needs, business processes and organizational structures and the project's effect on the organizational environment, and the dynamic IT refers to the pattern and rate of changes in ISDP's IT environment, e.g. changes in IT infrastructure, architecture and software development tools.

The interviewees objectives and points of views varied and the interviewees from TAMK and Metropolia had in general slightly different emphasis on the ways they had possibilities to affect the project. Also the position of the interviewee affected the points of view uttered during the discussion. The people with most possibilities to have an impact on the project and with the best knowledge of the technical implementation, tended to be the most positively related to the project, whereas persons with least knowledge of the technical basis were the most critical. However, most of them were quite satisfied with the project, but the complexity-related problems were linked to the biggest challenges they told about the project.

4.1.1. Structural organizational complexity

Structural organizational aspect of project complexity reflects the nature and strength of the relationships among project elements in the studied organizational environment. They affect the project complexity very much on its all levels and affects even all aspects of project performance: delivery time, cost, functionality and user satisfaction (Xia and Lee, p. 72).

The interviewees described the control over the project resources relatively limited as the permission for the project had been granted earlier and thus, they had to work inside the limitations created by the permission. The amount of personnel was also quite large, which made keeping contact quite complicated at times. Also some people were less committed or busy, which affected their ability to contribute to the project. The amount and quality of support during the project was relatively low according to the interviewees as they felt that the support was not very well present as a part of the project and the work is relatively independent on an individual level in the project's frame. Sometimes the possibilities to communicate with other was felt as quite limited. The amount of staffing was perceived as quite restricted. The knowledge and skills

of the project personnel was thought among the interviewees to be varied, but most of the respondents found them quite satisfactory.

How would you describe your control over the project resources?

An interviewee (project manager) responded: *When it comes to personnel resources, the situation was more challenging because the line organization became a part of the project. […] There were ca. 80 people in all and ca. 40 from Metropolia in all and that discussion was conducted over and over again during those three years. I had not that much impact on that, but I could ask if they wanted to participate and ask their managers' permissions about that as well.*

Another interviewee (specialist) emphasized some typical challenges for large organizations: *The control over the resources is very limited and problematic. The project organization is very wide with lots of human resources. Using personal resources is problematic, because people who have been directed to take part in the project. People have been quite lightly in the project. Many people have kept the traditions. It is not possible to affect how people take part in the project. They are obliged to take part in the meetings, but otherwise they are not that obliged to take part in the project – everything else is voluntary.*

A third interviewee (specialist) accentuated the user-oriented characteristics of the project: *The point of departure has been very user-oriented and all kinds of ideas have been collected, users have tested Peppi over 100 times during testing sessions and feedback has been collected using forms. I have used them a lot and have made initiatives, development proposals, correction proposals using forms. I have had a vantage point, because I have worked as an instructor for the staff and I have collected thoughts and there has been discussion even there. They are not my ideas, but I have made sure that they have been forwarded. It has been an important channel.*

A fourth interviewee (project manager) accentuated the aspects of the life cycle of the project: *I have good relationship with the owner of the process who is the vice principal and we are able to discuss about things. In the beginning, we did not know the manager level so that we could have chosen different people. During the project, we have learned to know people and we are able to*

require right people to right positions. There was a change in the organization as we merged, when this project started. […]

A fifth interviewee (information management chief) emphasized especially the investment-related and HR-related aspects of the project resources: *Money and work effort. I have built the budget with Metropolia. The definition project and the final plan based on that. Based on them and investment plan was made. Eduix Oy was chosen as the supplier. We had an agreement with Eduix even from before so that a price competition was not longer necessary and we could make the project start quickly. There were two of Finland's largest schools with a common goal, so the investment plan was accepted. The human resources was a bit more tricky.*

How many of the IT staff could be reserved for that was more tricky as there is a limited amount of staff. I have no programmers. The both survived with a minimum amount of staff, but it did not disturb, because the provider had the resources. The main stress in the project was on human resources and substance resources and how we make them work. At the beginning we realized that we would succeed only if we would take them to be a part of the work. We would not make a final definition, but with scrum or agile methods so that the users (mainly teachers) see what is about to evolve and can react to that, and only after that comes the follow-up work.

Teachers and the managers do not do anything if it not in the work plans. So we needed to reserve time. The vice principal […] understood that situation and decided that it was important to prioritize that when the resources are concerned. After that it started succeeding and we found the people for the work. Before this, in similar situations the system was defined, ordered and delivered by the IT management and it was taken into use by the users. But that did not work.

How would you describe the amount and quality of support during the project?

An interviewee (project manager) responded: *The control group gave good support on the project and the management was well committed to the project and that is not always so self-evident. Support was also sought in the line organization so that they felt that they got support*

for the changes. Inside the project, the support and resources were shared in the specialist groups and it was possible to be helped in different things.

Another interviewee (specialist) pointed out the fact that the meetings had a relatively 'descriptive' character instead of helping the staff to develop the ideas for the project and to make changes, as people mostly described how things are done instead of developing them: *I have not felt there has been that much support. I have worked very independently. There has been a project leader from Metropolia. The project manager and the project leaders are mostly responsible for the project. Even if it looks like there are many people in the project, there actually are not that many involved in it. In the meetings people mostly tell how things are done instead of developing them further.*

A third interviewee (specialist) responded: *I have done my work tasks very independently. The project has been virtually paper-free and we have kept online instruction sessions for different groups and the most important thoughts have been expressed in that context. The organization has been quite light, because people have counted on that it is a specialist organization where everybody is capable of asking for help if they need that. It has not been organized very heavily as meetings or things like that, but it is more like "ask if you need something". The other part in development has been in Tampere. This has worked surprisingly well with this kind of light management. Despite of that it has worked well and the project has been kept well in the schedule, which is astonishing. […] It has been notable that some parts have not been able to keep the schedules. I feel that I have got enough help for my part.*

A fourth interviewee (development manager) responded: *My responsibility is to ensure that the project managers will not become too exhausted while working and on the other hand, that they do their work. We have three higher project managers who take care of the projects and they work largely in a self-guided way. The main point in project management is that the resources will last and the clients will be somewhat satisfied. I have taken the role that I quite actively comment different things and I try to save the project managers by that. I am also with the projects' steering activity.*

A fifth interviewee (development manager) responded: *It is very varied. The resources are limited, and we form a large organization, which affect the personnel and the students. In that way the resources are limited and the work is "taken" from their normal work. There are usually quite many names on the lists, but the active work is for quite few people. That is the everlasting shortage. E.g. we are going to transfer all our performance digits and other information to a national Virta registry. It has been realized as a students' innovation project – the whole data transfer interface and the whole system that enables transferring them to the CSC server. It has been a very successful student project.*

A sixth interviewee (project manager) felt that Metropolia had been too dominant in the project, compared with TAMK, and there has been lack of communication between both universities: *There is too little communication and the other university of applied sciences has led it too much. They are always risks when systems are taken into use during different points of time and the different ways to act are not taken into consideration. We have had different points of views about testing. The provider has had too little information about the contents. It has been very painful project in that way.*

A seventh interviewee (information management chief) responded: *In the steering group there were three vice principals, even from Metropolia, and they took the project seriously, which made it easier to work. Everything that was performed, they were given reasons. When they were argued for, they started with the substantial part. There was an intention to use very concrete and usable real terms like course, period, curriculum. The technical part was in the background. They knew what we were doing.*

Has the amount of staffing been sufficient?

An interviewee (project manager) responded: *Yes and no. In different phases there was temporarily very much pressure on some people in addition to me. It is not possible to share all work, because only a certain person can do a certain work.*

Another interviewee (specialist) responded: *There has not been enough staffing in the project. In practice there have been three key people really involved in the project.*

A third interviewee (specialist) responded: *It would be better to ask the project manager Jaakko Rannila. There are always too few people. For my part during this final phase with all the user education sessions it has been problematic that the other chief instructor finished. For my part, I have been able to carry out the duties.*

A fourth interviewee (development manager) responded: *[…] There has been moderately staff. It will be important to specify the knowledge profiles in the future. It is possible to notice that there is need for another kind of know-how. It is impossible to inflate the organization too much. We cannot recruit people that much. We have tried to develop knowledge with the resources we have. If I could choose, I would recruit two full-time programmers right away.*

A fifth interviewee (project manager) responded: *There should have been more "correct" people to do the definitions. Everybody is very busy all the time.*

A sixth interviewee (information management chief) responded: *It is never. It must be measured correctly. If people are getting overwhelmed or tired, it is necessary to prioritize so that the core is done. We have a principle that overtime work is not done. There is a 20 hour limit for overtime work. Only during Easter some overtime work was done. The vacations were held normally. There shall not be overtime hours for teachers. We were quite successful, so that there will not be extra bill for that.*

How would you describe the knowledge and skills of the project personnel?

An interviewee (project manager) had a relatively good coverage on different aspects of the level of knowledge and skills of the project personnel: *It is a difficult question as there was a need for the core knowledge. However, the substance knowledge was good. The technological knowledge was mainly on the provider's side. A certain problem was the fact that some people changed their positions during the project. For example, a tehnology 'guru' had a long vacation for one*

year, which left a gap in the knowledge potential of the project organization, but that was partly compensated by hiring a new person to the team.

Another interviewee (specialist) responded: *I am very satisfied. We have found group of people with really good knowledge about their areas. The project manager is very skillful. In respondents' own position, the clients describe what they do and actually they have several ways to do things even in the same organization. To be able to combine all those, it requires lots of analysis to make the new system to satisfy everybody's needs in the organization. Understanding about how systems should work to satisfy everybody's needs is very challenging.*

A third interviewee (specialist) responded: *I respect Jaakko Rannila for the fact that the project started so that there was a good and thorough investigation about the starting point with shooting video material about how people do their work so that the needs were made clear. That needs lots of skills and patience. The base work was really well done. They had the patience to clarify it and to shoot the video material about the needs. When there was talk about IT related issues, I was not able to understand it. The project has been carried out well*.

A fourth interviewee (development manager) responded: *It is very varied in general in project. Content specialists we have more than 1000 people. The challenge in this large organization is the fact that we are so varied, even the way to deal with things is also varied. There is not a one single way to deal with things in Metropolia. The viewpoints are different. The resources are very varied. There can be "stars", but it depends on the motivation level, too. We are aspiring to develop our own staff's skills according to how it has been decided that 70% of learning takes place at work, 20% learning from others and 10% in additional education.*

A fifth interviewee (project manager) responded: *It could always be better, but we have survived. We have had Wiki, Lync, Skype to help the distance. The skills are a more important thing. The responsibilities could have been divided more.*

4.1.2. Structural IT complexity

The structural IT aspect of project complexity captures the complexity of the relationships among the very practical IT-related elements. In Peppi project, the amount of user units for the

project is 70 man-years, but some respondents noted that there were effectively fewer user units, because a part of the were working on an hour-based contract and thus, it was possible that there were fewer units in practice. The concept of an "user unit" was also interpreted in different ways depending on the respondent. The hierarchies and the structure of the project organization were perceived as quite complex and informing different groups and even the project team group members were perceived sometimes as challenging. The functionality of the project team was felt otherwise as being relatively good and it was easy to work together in the project. There are tens of software environments, and tens of technology platforms involved in the project. The interviewees felt as the project very important to make a new system that helps replacing the numerous old systems with a new system. The respondents also gave quite varies answers when the term "software environments" were concerned, as they emphasized the environments that the single respondent perceived as the most important ones. It was felt that the level of integration with the other systems is very deep. In the project, there is one contractor involved, a company called Eduix Oy.

How many user units are being used for the project?

An interviewee (project manager) responded: *There were approximately five to ten people in the personnel task force group and approximately 15 hours were scheduled for them per month which makes approximately 20 man days a year.*

At the specialist level of the organization, there was bit different view of the amount of the personnel. This is because the term "user unit" might be ambiguously understood. This can be seen from the following four quotes.

Another interviewee (specialist) responded: *Hundreds of people in all, approximately 80 people in the development team. It is challenging to keep it as a group. There is a long geographical distance. At the beginning, lots of travelling was necessary and starting to use the electronic meeting systems helped a lot. Lots of people, but making use of them [in the project] is ineffective.*

A third interviewee (specialist) responded*: A lot. This is so decentralized and we are in different units. I do not have any idea about this.*

A fourth interviewee (development manager) responded: . *Everybody. All teaching staff and the staff that is planning teaching are using it. In practice, all personnel are using it. And when the location reservation is concerned, everybody is using it. The results are being used by 16700 students.*

A fifth interviewee (project manager) responded: *There have been a couple of people (3to 4) if they are defined as full time workers. Several tens of teachers and managers are doing this. In information management ca. 10 people are involved in this. Everybody who are responsible for the cluster are entitled to work in this.*

How would you describe the functionality of the project team?

An interviewee (project manager) responded: *The control group was the highest in the hierarchy, the project group was under that, and the specialist groups were under that and there were divided to different substances (teaching planning, annual planning., timetable planning, teacher's services, reporting-related specialist workgroup). The definitions were created by the specialist groups and they did the iteration in the modules. The specialist groups' themes were brought to the project group. Usually it was about exchanging information, because there were so many people involved in the project. Spreading information to all was challenging because of the size of the group. Some of the people were very involved and some others were less involved. After that was some testing done. It could have been more efficient and more work-shop like meetings instead of spreading information.*

Another interviewee (specialist) responded: *I cannot reply actually. There are different groups and I have been in the project group. Without the excellent project manager it would have been very different. It is a good example on how with a project manager it is possibly to compensate*

challenges and problems. There has not been that good cohesion in the project group. There has been mostly declarative, not analytic discussion about things.

A third interviewee (specialist) found that spreading informing between the project members was relatively challenging: *At first, I took time for me to understand who were with in the Peppi project, because I became part of the project later. Perhaps Jaakko was in the project, was even he? What are the official organizations that can be found on the first page of the project, but that is not a functional organization. It was quite hard to grasp, whom I can ask about a certain thing or area. I have tried to help that because I have been responsible for the communications.*

A fourth interviewee (development manager) responded: *It has worked better. The project group is kept quite limited and it has been a conscious decision, but there are sub-projects like annual planning, teaching planning, resource planning. It works in a certain way. In a project with two large organizations there is always the challenge how it is ensured that the both parts are active. It works, but it needs lots of work. The project manager must be very strict and insist. Rannila, the project manager, must have command on everybody. We have had so long time co-operation with TAMK so that we know each other. If we think about Peppi, almost 2000 people from the personnel uses Peppi and around 25000 students makes use of those services provided by Peppi.*

A fifth interviewee (project manager) emphasized the differences between Metropolia and TAMK when the feeling of influence was concerned: *It works well here in TAMK, when I understood that we need main responsibility even here. When they went further, they forgot about us. We should have more Wiki recording and information there. If the group lead has changed, it has weakened this thing. In one group, the first one did not take the responsibility, the other one was on a too high level and did nothing there and then it came to us and then it changed from the beginning of this year. Every time it has changed to the better, so now it's the best one.*

How many software environments were involved in the project?

It was notable that interviewees understood the definition of the term ‘software environments’ in different ways. An interviewee (project manager) responded: *During the development phase, the definition phase, and the implementation phase there was a common demo environment with the newest versions of the system. It was common for TAMK and Metropolia so that it was running in the provider’s server halls and Metropolia and TAMK’s data was run on it and the project group’s and the specialist group’s members were able to sign in to the system. After that, the data was presented for the control group for decisions about the environment: was one environment enough or would the service run in a cloud service environment or in own server halls. The decision was made to use the own server halls and thus, for Metropolia and TAMK a staging environment, an education environment and a production environment. The demo environment is still there as well as another demo environment for other interested schools. The data is clustered so that it is run on several servers.*

Another interviewee (specialist) responded: *What is not seen by the users, one of the most important changes is the architectural change. They started thinking in early 2000’s about what to do – a “monolithic” system or several minor systems. Either way would have been potentially problematic: a “monolith” would be never ready and several minor systems would not be compatible with each other. In 2008 the systems were not compatible with each other. Then there were tens of systems. In the architecture it is essential to make those tens of systems to be compatible with each other. In minor systems they would be having problems with synchronization and copying.*

A third interviewee (specialist) responded: *Project’s information is in a wiki and we have been in contact using email and Lync. People expect that you will do will well with different platforms. […] We all have not been obliged to be so familiar with them.*

A fourth interviewee (development manager) responded: *There is the database and the service bus. The people from TAMK are asking what the version number of Peppi is. It is based on so many little pieces that if some of them are updated, it does not affect all of them. I cannot answer. Several.*

A fifth interviewee (project manager) responded: *There are tens of databases in this and there are two testing platforms and applications, the one is technical testing and the other is contents testing. And we have the education environments. Out IT team has been learning the service mixes of the environments. The use must be decent because we have 800 people staff who make use of it, and the information is soon used by 10000 students so it must work well. So it has been taken care of from the beginning.*

How many technology platforms were involved in the project?

An interviewee (project manager) responded: *Open source components were used, life ray, apache service mix for running services, services were Java-based and the data base environment was mySQL-based, but it is independent of database so that it could be changed later.*

Another interviewee (specialist) responded: *There have been tens of them. There have been lots of different systems and they have tried to integrate them*.

How would you describe the system's level of integration with other systems?

An interviewee (project manager) responded: *In the beginning of the project there was a decision to carry out the project as a service-based project, using the SOA methodology. There was an aim to build the SOA environment so that there was a possibility to integrate it to legacy, or third party systems. In Peppi, all services are behind service interfaces. Ie. all services that can be used in the user interface, they also can be used through program interfaces. Because of the, Peppi's integration possibilities with other systems are very good, because it contains several web service interfaces that can be made use of anywhere.*

They have been installed on servicemix ESP product that is an Enterprise service bus that is an integration platform that has possibilities using Apache Camel to make message queue type

integrations using different protocols to the third party systems. Integrations have been carried out to different systems so far, e.g. the student's guide, mobile services, the schedule creator, the hall's touch pad information screens, user administration, HR, and Life Ray, Tuubi Intranet, Winha. There are good possibilities to integrate different systems and the point was to make integrations easier.

Another interviewee (specialist) responded: *They are in the deployment phase. It is not only about integrating systems. […] The system is used for standardize the ways to work. […] In this case it is necessary to find under that "we do it in this way" talk, what divides these or are they talking about the same things, but they are just talking in a different way. In that situation, integration is not only about integrating the system's inner architecture, but also about the process, practices' and the system's integration together. It is hardest to hear what people really mean.*

A third interviewee (specialist) responded: *The result has been excellent compared with the starting point. Peppi can find information very well.*

A fourth interviewee (development manager) responded: *Integration is very deep. The technology enables integration with anything that has been produces without technology-dependence in a relatively reasonable way. This has been produced with Java, and Peppi does not have any licenced product in in. The service bus solution makes it possible for any technology that follows standards, the WS (VS?) services is able to communicate with Peppi. The technology independence has been an important thing. We have lots of systems that are very closed systems, but we have been able to integrate them as well as Exchange Outlook to the calendars. Microsoft has widened the support to different systems. Peppi is also database-independent. Integration is quite deep between user management and Winha Pro.*

A fifth interviewee (project manager) responded: *There is a problem with the student administration system's transfer. The transfer does not correspond to our needs and we are in a hurry to make it work. The realizations and the curriculum are not transferred yet. We do not accept the transfer in the same way as Metropolia has accepted it. The system would need an interface to make visible information for this system and the teachers from the student*

information system. We have asked that for over one year. There are not online transfers from the HR system.

How many contractors and vendors are involved in the project?

An interviewee (project manager) responded: *The project was carried out in co-operation with Tampere University of Applied Sciences and TAMK has paid the part according to the FTE figure. The portions are approximately 60% for Metropolia and 40% for TAMK. The requirements were listed in co-operation with TAMK, and thus, also the both parts' points of view have been taken into account. The requirements have been dependent on the area of education instead of being primarily dependent on Metropolia or TAMK. The programming was carried out by Eduix Oy that has created the system and has been programming according to the requirements. There have been three agents in all in this project in the beginning. It is possible that there might be more agents later.*

Another interviewee (specialist) responded: *Two central agents: the student and study system's vendor (supplier) and the present system's vendor and a couple of smaller vendors – that makes 4-5 vendors in all.*

A third interviewee (specialist) responded: *I do not know anything else than Eduix.*

A fourth interviewee (development manager) responded: *One. Eduix.*

A fifth interviewee (project manager) responded: *Eduix and Metropolia, even Basware.*

4.1.3. Dynamic organizational complexity

The dynamic organizational aspect of project complexity captures the pattern and rate of change in ISDP organizational environments and also the dynamic essence of the project's impact on the organizational environment. It is also correlated with the cost aspect, when the project performance is concerned (Xia and Lee, p. 72). According to the interviewees, the project has caused changes in business processes when the organization structures are concerned. There

have already been changes during the project. The organization structures have been changed, but on the other hand, the interviewees differed when the business processes in general are concerned: some respondents thought they have changed relatively much and the others thought that the changes have been quite limited. When the changes in users' information need are concerned, there will be new needs as they start using the system. They have chosen the middle-of-the-road between centralized or de-centralized ways to do things. When the changes in business processes is concerned, the original ideals of openness have stayed, but other minor changes have been done. When the impact on organizational structure is concerned, the organization in itself changes constantly – however it has had a minor impact on e.g. how people user their time, compared with the earlier situation.

Has the project caused changes in business processes?

The interviewees agreed on the fact that the project has affected and changed the business processes – only the scope and the different aspects of it vary depending on the respondent. An interviewee (project manager) responded: *Some changes were made during the processes. Some of the processes were built according to the previous systems' functionalities. If the previous system did not make it possible to carry out something in a more simple way, we have been able to simplify even the process thanks to the system changes. There was a notion already at the beginning of the project that changing processes might be quite difficult and on the other hand there was no point in changing a process without an enquiry from the parties. There was no pressure for changing the processed, but if there was a need, the process was changed at the same time.*

Another interviewee (specialist) responded: *The business process has been directed by the system and also the system developers. It is easier in that way, but it feels like it is not fair. It is necessary to be diplomatic between the two parts. Yes, it has changed things and I think it is good: we need to develop and change the processes.*

A third interviewee (specialist) responded: *It will change and already has changed partly. It will change the curriculum work. The system has directed what people are able to do, which is very reverse. The teaching plans can be thought of in a very different way.*

A fourth interviewee (development manager) responded: *Yes, in some degree. It has not changed the teaching planning and annual planning processes, but e.g. the timetable planning process has been changed. It has been built so that it supports different ways to plan timetables as well as possible. When it comes to all its functionalities, it does not measure with Untis. For years we have tried to change Untis with its provider to transfer result data in and out of it. They are not interested in that in Austria. They are doing the product there and that's it. All its functionalities are not being used, e.g. optimization, which is one of its most important qualities.*

A fifth interviewee (project manager) responded: *Yes. It finishes old practices. The teachers' work changes as there are new tasks for the teachers. The managers' work changes. The reporting part is not yet ready and it will be the manager's tool. Very many changes will emerge. Before this, the teacher did not accept the realization. Now the teacher will do the implementations. We are getting the studies guide and the schedule creator.*

Have there been any changes in the users' information needs?

An interviewee (project manager) responded: *During the project there was response about what kind of information should be provided by the system received by the users. […] It was possible to notice that it is impossible to keep all the needed information in the Peppi system. Instead of that, the information is being created in the HR systems, some of them are being created in the credit registry Winha. For example, during the annual planning process, information from the study period feedback, personnel's vacations, personnel's absences, salary-related issues, possible economic planning, information from STTS process, and information from budget planning, would be needed to carry out the annual planning in a quick and effective way.*

The amount of information is very large and that is a challenge from the user's interface design point of view as well as regarding the fact that everybody do not need all that information. The longer the process progressed, the more requests (e.g. the need for certain types of reports) from the users were received as the users started to use the system and during the next iteration round there were new requests and ideas received. During the life span of the product, there surely will be more requests to come.

Another interviewee (specialist) responded: *At the same time they are developing practices and processes and they also need to intermediate the changes. It feels often unfair with the resources, when they are developing the system, the processes and the practices.*

A third interviewee (specialist) responded: *During this phase when people are starting to use it, they have been surprised to find so many different things in the same system. The users will have ideas, but the ideas will emerge while they are using the system. There is partly some incompleteness there, e.g. how personal user information is shown. That needs discussion with the HR unit. After people have used it for a while, they start thinking if they could have even more features in it. […].*

[…] has led the timetable process harmonization workgroup, where it has been searched how to do things – in centralized or in de-centralized ways. We are trying to support everything and we have chosen the middle of the road. It has been built to support the process that the specialists have found to be the right one. (Transition from Untis to Peppi is problematic in that way that the provider has not made a picture of the database and it must be transferred manually to the new system.)

A fourth interviewee (project manager) responded: *This project has not changed the direction.*

Have there been changes in the business processes during the project?

An interviewee (project manager) responded: *Yes, there have been changes in the business processes, e.g. they have given up certain features that are not typical concepts in Finland […].*

Also changes have been made regarding the way the costs have been divided between the involved parts and e.g. some internal invoicing with some multipliers. Some of those were brought to the control group, because they did not seem to be rational or the control group was unaware of them so that the vice principal was informed about them. in the basic practices, i.e. how the curriculum was created, how the actualization supplies, how the timetables are created, were not affected that much.

There have been differing opinions about how the schedule planning should be actualized – should it be centralized or decentralized or could there be some common practices related to it. The schedules differ really much depending on the field of education. Instead the teaching planning and annual planning are quite equal independent of the field of education.

Another interviewee (specialist) responded: *People are astonished how it looks like their work, and it feels like it is logical.*

A third interviewee (project manager) responded: *They have been in the original definitions so that these have not changed them. Openness, everything is in the same place and the information is visible from the same place have been the basic themes.*

Has the project had any impact on the organizational structure?

An interviewee (project manager) responded: *Yes, on some degree. In the beginning of the project they wanted to make a difference between the official education plan division by the Ministry of Education and the Statistics Finland Bureau from the school's internal organizational hierarchy that has been built on the education plan structure originated by the Ministry and the Statistics Finland Bureau. The curriculum and the organizational unit have been mixed earlier as concepts in the systems and there have been challenges to define what an educational program and an organizational unit actually mean.*

In this system there was built a service in which it is possible to model the organizational hierarchy fully […]. Thus, the hierarchies can be separate, which makes it possible to make

adaptations to them if the organization decides to make changes in the organizational hierarchy, it does not affect the educational branch hierarchy. Approximately 1 to 1,5 years ago the cluster managers were sent questions about the fact that a certain kind of organizational hierarchy was to come with the Peppi system and it was created according to HR and with HR the organizational hierarchy was checked and many shortcomings were found in it from the time of unification. The hierarchy was created according to the cost center structure.

In that phase, the HR system and the hierarchy of the organization units to be created in the HR system as well as definitions of the roles of the employed in the organizational units was checked with co-operation of the cluster managers. Thus, the organization hierarchy was cleaned during the process and that was brought to the new Peppi system. After that, it is possible to make inquiries to both hierarchies, e.g. which students belong to the IT education program (students belong to the study program hierarchies) and on the other hand who of the personnel belongs to the IT education in Helsinki (organizational hierarchy, master data created by the HR system information), but that is asked from different data bases. Thus, it is possible to make an inquiry about IT education students in Helsinki.

Another interviewee (specialist) responded: *It is not necessary to change the organizational structure, but the system needs to supply the organization that already exists. There are several organizations inside organizations. Inside the education organization there is also HR organization. The outer clients look at us through another (outer) organization. In one organization, there are three organizational structures, which make it very hard to grasp how the system should be work to satisfy all different parts' needs. From one direction it should look like certain and from another point of view it should look different. It is quite ameba-like in that way.*

A third interviewee (specialist) responded: *The organization feels like it is moving all the time. I cannot say if it affects the structure. There has been a fear that schedule planning could not be done in a centralized way, but in an easier way. It is not a specialist work anymore, and it is not necessary enter several times same information to different systems anymore.*

A fourth interviewee (development manager) responded: *In that way that the timetable planner in Leppävaara has quit the job. The philosophy behind Peppi has been that we will not be the only users of it. Peppi has not been built to support only a certain type of organization or a certain way of thinking or a certain way of structure in any regards. The impact is that it reduces work and thus, it affects how you use your time. However, it does not reduce the need of staff.*

A fifth interviewee (project manager) responded: *There are changes in the organizations even otherwise so that this project feels like it is more stable than everything else. The change has been to that direction otherwise as well.*

4.1.4. Dynamic IT complexity

The dynamic IT aspect of project complexity measures the pattern and the rate of changes in ISDP's IT environment and the very practical aspects in it, such as architecture and software development tools. The dynamic IT aspect has correlation with the functionality aspect in project performance (Xia and Lee, p. 72). The interviewees agree on the fact that there have been relatively rapid changes in both IT infrastructure and IT architecture. The software development tools have got newer upgraded versions, but otherwise the opinions differed quite a lot, probably because their concepts of rapidness of change and points of view differed from each other.

Have there been relatively rapid changes in IT infrastructure?

The interviewees agree on the fact that there have been rapid changes in IT infrastructure related to the Peppi project. An interviewee (project manager) responded: *Yes, the architecture was changed to a service-based system and it has been the first service-based system in Metropolia and in TAMK and probably in all the university sector when the administrative systems are concerned. SOA systems have not been used that much in this sector, which made people to design and think in a different way to gain benefits from the service-oriented systems and to gain the benefits that are listed for SOA: multipurposefulness, granularity, and the loose connections between the services and the fact that standard interfaces are being made use of. I cannot say, if the change actually was rapid. It took place during three years and thus it was not actually that*

rapid. The technologies were not changed during the project from what was decided earlier. Rapid changes during the project were not made.

Another interviewee (specialist) responded: *In a very notable way. They have moved to a SOA-based architecture from several systems. It has been a very remarkable change. He hopes it is possible to make it visible to the user's direction so that they can quickly change the services that the users need and to compose them in completely new ways. There are two central goals: building the service-based architecture and to be able to compose several functional entities for the users. We have several groups of external users and two groups of internal users.*

A third interviewee (specialist) responded: *I think it has changed a lot.*

A fourth interviewee (development manager) responded: *Yes. The IT infrastructure with service oriented architecture has been built. So far, the different systems had connections to the database. With Peppi, many of them were dropped away, but we use the same service, when we list teachers when we are doing schedules. We have narrowed the point-to-point integrations. We will open a part of Peppi's services. We will have an open interface that can be made use of in student projects. If we do apps, we should do three of them. They could be e.g. mobile services that work reasonably in html and thus, a mobile browser is enough. This is the principle of the open data. The aim is that there would be a national service where you can see all your records, but that is a dream quite far away now.*

A fifth interviewee (project manager) responded: *To be able for both schools to build own technical environment, it has required studying thing, buying hardware and understanding that there are over 10 000 people using the system. In the old systems there have been problems with the slowness. At the same time we have complete changes with our Intranet built with Life Ray.*

Have there been relatively rapid changes in IT architecture?

An interviewee (project manager) responded: *IT architecture was completely changed, but it was not changed during the project. There was a decision to carry out as planned.*

Have there been relatively rapid changes in software development tools?

An interviewee (project manager) responded: *Yes, especially during these three years. The integration platform Apache Service mix has progressed several new versions from the time the decision was made. When the decision was made a new version of Service mix was launched and it supported the technology that was used (OSGE standard). There has been an idea that the visual interface layer can be changed more often than the service layer and between them there is a link, but that link is the service interface […] by which the user interface communicates with the service. Life Ray platform was updated several times during the project. Even the browsers have been updated several times, and thus, changes must have been done during the project.*

Another interviewee (specialist) responded: *Fortunately, there have not been remarkable changes during the project. The architecture solutions have been reasonable and because of that it has not been necessary to change them during the project, because that would have been a disaster. The technology choices of the previous action guidance system (toiminnanohjausjärjestelmä) were not that reasonable from the current perspective. When it is time to decide, it is important to make decisions. It looks better now, but it is impossible to know if it will do it in five years. The progression is so quick that it is hard to say.*

A third interviewee (development manager) responded: *Not specifically. The same tools were used. With this project, we have started to use more performance-related tools, so that we can notice how the new features affect the performance. We have thought more of them. A lot of new things have come to develop the change management.*

A fourth interviewee (project manager) responded: *For the application developers, they have built using something for 1,5 years and now with something else. The problems are the same as with the previous system, there are new blocks they are done using new techniques. There are updates but they are not done everywhere. Very silly traits. It feels like the most qualities are coming. E.g. getting a program that works with all the most used browsers is something we have*

asked for over one year. It has not worked with IE. They have said it will work when it is ready. The developers should have something more than an Apple Mac.

4.1.5. Additional notes on project complexity

An open question was left at the end of the interview to make it possible for the interviewee to express additional thoughts about the theme and thoughts that have appeared during the interview. There was a notion that the more agents there are, the more complex a project will be. Also many seemingly paradoxical notions were made. Even if it is important to have a large scale of testing, handling that much feedback can be very challenging. It is also important to note that while the testing was done during the iteration phase, the feedback might have been different from what might have helped most. In a specialist organization, there are also lots of differing opinions about how things should be done. The amount of organizations is very large, which makes a project also more challenging to succeed.

Do you have anything to add to your earlier answers or the themes in general?

An interviewee (project manager) responded: *The project was carried out using an iterative development method and all education branches were taken into account so that their viewpoints were heard widely. The amount of people (ca. 80) was large and that made it quite challenging, as e.g. exchanging information with so many people is very challenging, when informing users about how the project is evolving is concerned. […] There was feedback received about the fact that there was not enough information delivered. […]*

Some features were discussed about during the project, if certain features were needed at all, partly or fully. Some delays existed because there was done some research during the project about what is needed. The iterative method with the ideal that as many interested end users as possible would be able to test the system during the development stage, was used. Some of them expected the system would be almost ready, but instead it was just in production phase, and they

could not get that kind of feedback they wanted (e.g. what is needed and what could be done better).

Over 300 different people tested it while it was in production phase and approximately 1500 feedbacks were received. Handling that high amount of feedback also takes time. Changes in browsers, e.g. how they support Java script, has affected the project as well, as they want it to make work in different browsers.

Another interviewee (specialist) responded: *The choices of technology are done in "darkness". There are different opinions about how to do things in a specialist organization. There are different "clients": students, teachers and managers and that makes it hard to manage. There are even several organizations instead of one organization. It feels like it is a bigger miracle to succeed instead of failing. It is enough that a minor thing fails to make the whole project fail. It is almost impossible think that one could make a system completely ready and then give it to the customers for them to start using it. That is an impossible thought.*

It would be even nice if the developers read the definition work created by the specialists. […] If there is too much of that information, it is impossible to handle it in the development. There is a strange "gap" in it, when there is enough of information. Perhaps the agile software development systems give some kind of answer to it, but from the contractor's perspective the agile development methods a more of a swearword, because they enable the developer's side to cheat. From the contractor's point of view, the testing is moved to the customer. That is painful, because it is time-consuming. The developers are not prepared to a situation where the customer has not tested it. We do not have resources to test it how it should work. […] It is necessary to survive.

A third interviewee (specialist) responded: *I cannot say very quickly about the whole idea, but I am very satisfied with the fact that people have noticed that the structures in education and IT management have not been functional. People feel like that is a relief. People get the help they have thought they would need. The change that has been needed, has been carried out.*

A fourth interviewee (development manager) responded: *The more agents there are, the more complex things become. That is the reason why many national projects stop at some point. Perhaps this way we have done this and we will not be alone in this. The model for managing complexity has been derived from America. There is Qual Foundation in America. Qual is a foundation supervised by universities and research organizations. They do a qual product about universities' student management, locale management, research management, financial management, and human resources management services. Because it is a big country, they have solved the complexitity-related problems in a reasonable way. For a million dollars you can say your opinion, who does not pay, cannot say anything. […].*

A fifth interviewee (project manager) responded: *It is risky with the updates. When there are reparations, they need to be checked from several points of view and it is quite hard. The users need to test if the program works. The developers does not test them. E.g. the group information was not visible and it is fixed now partly. But there is still one part missing. The user interface part (and developing it) is very different sand separate from what is underneath it (and what has been done there). It feels like there are challenges.*

5. CONCLUSIONS

This concluding section summarizes the research followed by main findings. The aim of this thesis was to find out the factors that contribute project complexity of public IT project. To address that question, this case study was done using interviews among the project personnel with different kinds of responsibilities in the project. Before the case study was conducted, literature was reviewed with concentration on theoretical framework of project complexities, earlier studies on project complexities and their key findings.

5.1. Research summary

In the literature review, the concepts of a project, project management and project complexity were introduced to provide a picture of the issues related to IS project complexities. Project management can be seen as a part of project complexity and e.g. a degree of complexity in the project has a direct impact how to plan, control and co-ordinate project requirements. As we noted earlier, poorly managed project will add complexity to simple project, and with good project management, it is possible to reduce complexity in project.

The project complexity can be defined through terms of differentiation and interdependency. Both of these can be defined in terms of organizational complexity and technological complexity. In the organization complexity dimension, differentiation means how many hierarchical levels, number of organizational units and divisions of tasks there are in the project. On the other hand. interdependency in organizational complexity means how high is the degree of interdependencies in these organizational units. In technological complexity, differentiation means how many different tasks, and how diverse are project's inputs and outputs, for example. Interdependency complexity in this technological dimension means interdependencies between these tasks and technologies used in the project. In a complex project, there are many varying interrelated parts.

In addition, new technology might also be adding further complexity to project. For example, taking a new management system into use at the same time with a new project can be very risky, and increase complexity, because this new management system adds more variables to manage in addition to project management itself. Uncertainty in goals is also typical for IS projects. This uncertainty rises from the fact that especially in IS projects, the user's requirements are uncertain, they might be hard to specify or are in flux, e.g. after the first version of the software. Complexity increases when the requirements are not kept, and feedback-loops cause constant changes. How much these actually increase complexity, is hard to measure by, for example, quantitative methods.

Xia and Lee's taxonomy on ISDP complexity was used as the main framework for analyzing the conducted interviews. According to Xia and Lee, ISDP managers can think about the project complexity by analyzing the organizational and the technological aspects of ISDP complexities in terms of structural complexity among the project components and the dynamic characteristics that result from the potential changes that may occur during the project. The taxonomy consists of four components that can describe project complexities: Structural organizational, Structural IT, Dynamic organizational, and Dynamic IT.

The research method is qualitative and interpretive. The empirical part of the study was done using interviews among the project personnel with different kind of responsibilities in the project. The researcher had no control of the events in the selected organization so that the project was a contemporary phenomenon in a real-life context. This research is a case study based on a single case. Although multiple case study in several of similar projects could have provided more coverage, that was not practical in this case as similar kind of projects were hard to find in Finland in a given timeframe to this study. In the Peppi project, during the interviews, we were in the deployment and training phase of the project.

5.2. Main findings

This study gave an insight on the aspect of project complexity in a public sector project and it also shows the challenges related to the size of the organization and the hierarchies inside the main organization, as well as the fact that two different universities of applied sciences are co-operating in the same project. Communicating with others, informing about changes, collecting information and understanding the organizational "culture" of different organizations and sub-organizations increase the project's complexity in an immense way.

When the structural organizational aspect of project complexity is concerned, the interviewees described the control over the project resources relatively limited. The amount of personnel was also large, which made keeping contact quite complicated at times. The structural IT aspect of project complexity captures the complexity of the relationships amount the very practical IT-related elements. The hierarchies and the structure of the project organization were perceived as quite complex and informing different groups and even the project team group members were perceived sometimes as challenging. The functionality of the project team was felt otherwise as being relatively good and it was easy to work together in the project. The interviewees felt as the project very important to make a new system that helps replacing the numerous old systems with a new system. It was felt that the level of integration with the other systems is very deep.

The dynamic organizational aspect of project complexity captures the pattern and the rate of change in ISDP organizational environments, and the dynamic essence of the project's impact on the organizational environment. According to the interviewees, the project has caused changes in business processes when the organization structures are concerned. The organization structures have been changed, but on the other hand, the interviewees differed when the business processes in general are concerned: some respondents thought they have changed relatively much and the others thought that the changes have been quite limited.

When the changes in users' information need are concerned, there will be new needs as they start using the system. When the changes in business processes are concerned, the original ideals of openness have stayed, but other minor changes have been done. When the impact on

organizational structure is concerned, the organization in itself changes constantly – however it has had a minor impact on e.g. how people user their time, compared with the earlier situation.

The dynamic IT aspect of project complexity measures the pattern and the rate of changes in ISDP's IT environment and the very practical aspects in it, such as architecture and software development tools. The interviewees agree on the fact that there have been relatively rapid changes in both IT infrastructure and IT architecture.

There was a notion that the more agents there are, the more complex a project will be. Also many seemingly paradoxical notions were made. Even if it is important to have a large scale of testing, handling that much feedback can be very challenging. It is also important to note that while the testing was done during the iteration phase, the feedback might have been different from what might have helped most. In a specialist organization, there also are lot of differing opinions about how things should be done. The amount of organizations taking part in the Peppi project is very large, which makes a project also more challenging to succeed.

5.3. Theoretical contribution

Although, the complexity of project has been studied quite vastly, there are still some gaps in the academic research on this subject. As a theoretical contribution, this study is made so that there are two different, public funding based organizations responsible of the project. Based on the framework provided by Xia & Gwanhoo (2004), complexity is a typical trait for projects in different types of organizations. According to author's knowledge of the subject, these kinds of multi-organizational studies about complexity are more rare. Moreover, research about complexity where there are two organizations, in which the other organization is in a minor role, is harder to find.

This study extends Xia's and Gwanhoo's (2004) framework to be applicable also to situations where there are two different organizations working for the same project. Same kinds of complexities can be found inside these organizations affecting both of them as with projects working solely on one organization per project.

There is also an aspect of public project versus private funded project. There are numerous examples of IS projects that did not keep their project timetable and exceeded greatly their budgets. Can there be found some complexity issues that are typical for public projects, which do not exist at the same scale elsewhere? This study did not find any evidence for the assumption that public projects have different complexity issues than 'common' IT projects, in which the framework was tested.

5.4. Managerial implications

As a managerial point of view, this study gives a solid understanding about complexities and their relations in IS project. The framework used in the study is tested in over 500 IS projects, and this study further extends its usability for the projects where there are two responsible organizations working on a single IS project.

Results of the study are easy to implement into practice. When designing an IS project, manager responsible of the project could use the results as a risk analyzing tool of different complexities in an IS project. This is particularly important when it is known that failure in risk management may put the whole project in risk. In this study, there is also thorough interpretation of the nuances inside the results. This helps IS project managers to get more depth in the understanding of complexity issues that they will face during the project.

5.5. Limitation of the Study and Future Research

This study is a single case study made in two organizations with qualitative interviews. This empirical data consists seven interviews. This is quite small amount of data, so this should be taken into account when interpreting the results. Although TAMK was in important role of the overall success of Peppi project, there were only two interviewees' from TAMK. This may cause some skew to the results.

It would have been a great add on to the results, if there were also of the software creator's point of view in the empirical data. That could not be arranged, although the researcher tried to arrange many times an interview with the Peppi software provider.

Issues of validity and reliability are some of the hardest questions for a single case study. In the case of validity, this case study must rely on analytic thinking of the researcher – simply because repetition of the study is not possible. This means in practice that the researcher itself is using his analytic thinking, not for example with statistical methods. Therefore the researcher does the generalization of the results. Although researcher in this thesis has been involved with Peppi for several years, this is his first study with project complexity framework. This leads to a problem with the experience as a researcher, at least at some level.

In case of reliability, one should be able to repeat the research exactly in the same way. In this kind of single case study, which happens in one point and time, this is obviously impossible. If it could be done, this repetition process would be useful, because one would find errors and possible biases in the data in a better way.

An interesting topic for future research would be a follow-up of this study after the new system has been taken into use, and it would be interesting to analyze the new data with the knowledge of the real project performance measures of this project. It would also be interesting to do a comparative study of two large public sector IT projects of this scale.

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Interviews

Osmo Troberg, specialist 2.5.2013

Mika Lavikainen, project manager 14.5.2013

Jaakko Rannila, project manager 14.5.2013

Eija Kumanto TAMK 17.5.2013

Tuomas Orama, development manager 22.5.2013

Päivi Tenhunen-Marttala, specialist 23.5.2013

Matti Lehikoinen, TAMK information management chief 30.5.2013

APPENDICES

(These questions are based on a framework introduced by Xia, W. &. Gwanhoo, L. (2004) – see references)

Please introduce yourself, your background and your position in the project. I would like you to describe your experiences with IT projects.

Theme 1. Structural organizational complexity

- How would you describe your control over the project resources?
- How would you describe the amount and quality of support during the project?
- Has the amount of staffing been sufficient?
- How would you describe the knowledge and skills of the project personnel?

Theme 2. Structural IT complexity

- How many user units are being used for the project?
- How would you describe the functionality of the project team?
- How many software environments were involved in the project?
- How many technology platforms were involved in the project?
- How would you describe the system's level of integration with other systems?
- How many contractors and vendors are involved in the project?

Theme 3. Dynamic organizational complexity

- Has the project caused changes in business processes?
- Have there been any changes in the users' information needs?
- Have there been changes in the business processes during the project?
- Has the project had any impact on the organizational structure?

Theme 4. Dynamic IT complexity

- Have there been relatively rapid changes in IT infrastructure?
- Have there been relatively rapid changes in IT architecture?
- Have there been relatively rapid changes in software development tools?

Do you have anything to add to your earlier answers or the themes in general?