UNIVERSITY OF TARTU

Institute of Computer Science

Conversion Master in IT Curriculum

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Case study: Business analysis in ERP implementation/customization projects

Master's Thesis (15 ECTS)

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Juhtumiuuring: Ärianalüüs ERP juurutamise/kohandamise projektides.

Lühikokkuvõte:

Käesoleva magistritöö eesmärk on uurida ärianalüüsi osakaalu, tegevusi ja mõju ERP valmislahenduse juurutamisel ja kohandamisel. Töös uuritakse äraanalüüsi osakaalu erinevate juurutusmeetodite puhul ning äraanalüüsi mõju projekti tulemusele. Teoreetilises osas antakse ülevaade ärianalüüsist ning ERP-st üldiselt. Empiirilsies osas kirjeldadatakse ning analüüsitakse andmekomplekti ja leitakse vastused uurimuse eesmärgiks seatud küsimustele.

Võtmesõnad: ärianalüüs, ERP, COTS

CERCS: P170 Arvutiteadus, arvutusmeetodid, süsteemid, juhtimine

Case study: Business Analysis in ERP implementation/customization projects

Abstract:

Thesis aim is to study the ratio, activites and effect of business analysis to COTS ERP implementation and customization. Reseach has been made to compare business analysis core activities ratios in different implementation methods and business analysis effect on project outcome. In theoretical part overview of business analysis and ERP in general is provided. In reseach part used case study is planned, dataset is prepared and answers to research questions are provided.

Keywords: Business Analysis, ERP, COTS

CERCS: P175 Computer science, numerical analysis, systems, control

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Glossary

BABOK Guide - the globally recognized standard for the practice of business analysis.
Business Analysis - (also BA and ANA) set of activities performed in order to gain in knowledge of problem and engineer suitable solution
Business process – process, that is developed or implemented by organization to meet one or more business goals or softgoals.
Client/customer – owner and user of implemented solution.
Consultation- in this paper term is used as ERP specific consultation of customer. All business line or business process specific consultation is extracted as part of business analysis.
Company- organization, that case study is based on. All other organizations are referred to as organization or client/customer.
COTS- Commercially-off-the-shelf software, that is available in packages, that can be used without modification.
Development – in paper development work is referred as any modification or extension of vendor provided ERP code.
ERP- system for integrating and managing core business processes
Implementation- customization, modification or extension of new COTS ERP software or COTS ERP element.
NAV – ERP solution, part of Microsoft Dynamics product family.
Project- in this paper new implementation, business process change, platform upgrade and support or maintenance is referred to as project, that cover variety of activities which aim to maintaining or customizing ERP. Each distinct set of tasks, that exceed 60 hours of work is considered separate project.
R – programming language for computational statistics
Requirement- functional set of identified need, document or activities. In this paper requirement is used to refer as complete set of actions to meet business need. Each requirement can consist of several individual requirements that could reference to one or more additional requirements.
Task – set of similar actions performed for solving an issue. Each type of work in same issue is considered

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1. Introduction

More and more we see solutions ready for implementation, which should require less effort on implementation, since full solution is already available and ready to be used as is. These solutions are generally referred to as COTS (commercially-off-the-shelf), a term based on Federal Acquisition Regulation's definition [1]. Implementation of COTS system requires way less effort compared to new developed system, however there are some limitations that are to be addressed during implementation. The best example of challenging COTS implementation is ERP (enterprise resource planning), since products are developed to meet as wide range of clients as possible and best of breed [2] systems have wide range of possible utilization areas, that need to be configured or modified to meet organization's needs. COTS ERP itself does not give any competitive advantage to organization, the key is to understand possibilities behind system, which would allow organization to meet optimal processes and create suitable solution [3]. In COTS ERP implementation majority of requirement and background analysis activities performed can be considered as business analysis.

Business analysis is set of rules and activities that differ on solution requirements mainly on aspect, that overall solution requirement engineering focuses on „how" and business analysis focuses on „why" and „what" [4]. During COTS implementation it can be difficult to determine, what part of analysis is to be considered solution oriented (since software itself is already created and deployed) and what can be considered business analysis during implementation. In this paper it is considered, that all analysis activities, that are not directly related to bugs or specification, configuration and deployment of standard product can be considered business analysis.

Business analysis can be controversial topic on COTS implementation. It is common that COTS products are marketed as universal toolboxes and during the sales cycle it is often disregarded, that most important part is to not implement software, but to gain expected benefits from it [5]. Usually ERP software alone does not contribute to business in any significant way. Without proper implementation the result could lead to a worse situation than before [6]. Unless the implemented system is already tailored to meet the needs of the business line, the implementation service provider should have deeper insight of business field processes to avoid unnecessary developments [7].

COTS ERP can be implemented in different forms and with different methodologies, however it is important, that expectations of the client are managed and met [8]. Usually the implementation already begins with business requirement analysis in order to calculate the estimated time and cost of the project. After that all requirements are gathered and compared against COTS ERP possibilities [3]. This will be followed by development, testing and finally deployment to production environment. Business analysis should be done in the earliest stages of implementation, since the prototype that is created during the business analysis phase can be changed in a matter of hours [9] whereas the same level of developments in later stage of implementation will require times more effort and will lead to increase in number of people involved and thereby to loss in motivation and even further delay [10].

Due to the fact, that ERP is implemented to be used by people, who rarely know what the actual benefits could be [11], business analysis has a key role in proper implementation due. As a part of business analysis, activity process modelling documentation or design documents are created. This may seem like a waste of time to the client, however lack of documentation can easily lead to a huge loss of resources in case key personnel changes during the solution's life-cycle [12]. This is often the point where interests of parties collide, since detailed analysis is time consuming and usually the client takes it for granted, that everyone knows their business in detail and can start developing immediately. However there are several reasons why insufficient analysis can and will lead to misunderstandings between parties, which in worst case could lead to cancellation of implementation and loss of time on both sides. [7]

The research objective of this paper is to determine, what impact business analysis has on implementation and customization of COTS ERP solutions. To reach the overall conclusion, two sets of research questions are used. The first set of research questions concentrates on measurable outcomes of project by comparing business analysis with quality, satisfaction and delay. The second set of research questions is focused on exploratory search for reasons or differences in actions performed and practices conducted in projects. Target is to find if business analysis matters in COTS ERP system implementation and to determine if the business analysis work required for successful COTS ERP implementation can be identified. Another aim is to find possible relations and dependencies between business analysis and result in ERP implementation and customization projects. This thesis is looking at business analysis work performed after the software has been chosen and

implementation partner has been selected. Activities compared in this paper are performed after initial business analysis and the stakeholder's decision for a change.

Conclusions will give an overview of the process and probable results in different implementation methods and the overall quality of implementation. The work could be used as a framework to implementation companies to assess their business data and to assess business analysis part of implementation for ERP implementation projects. The results of this thesis are not to be considered as overall benchmark to predict the optimal level of business analysis in the process, however it is possible to use same methodology and steps to analyse other similar data sets using same steps to get an overview of other similar company's processes and correlations.

Quantitative/exploratory research methodology will be used to answer research questions because all implementation projects have some variance and extreme cases can be excluded from quantitative analysis. Data was gathered from various sources, tested, cleaned and categorized to get an overview of correlations and processes, which are present in ERP implementation in relation to business analysis activities.

Thesis is divided to chapters. Second chapter gives short overview about background of business analysis, implementation methodologies and ERP. Third chapter focuses on case study description. Fourth chapter consists of findings in relation to research questions from the analysis and additional analysis based on findings and is followed by chapter of the previous works that are related to area. Final chapter concludes findings in the thesis.

2. Background

This chapter includes general overview of business analysis, its activities relevant to thesis and COTS ERP. Aim of chapter is to provide background information that allows to get insight of case study itself and gain brief knowledge in the general area.

2.1 Business Analysis

Based on BABOK it is set of rules and techniques to establish bottom line of business. Usually business analysis has determined set of rules and activities to what business analyst should focus during analysis. Main focus is on business background, requirements gathering, requirement engineering, elicitation, stakeholder definition and other. [13]

Business analysis is a complex set of activities, which is used throughout the business change process. The main goal of business analysis is to get a general overview of not only the visible problems but also the underlying causes that should be addressed in order to meet the expected result and to assure that decisions are made by calculating the best possibilities and all requirements. [4].

BABOK [13] recognises 6 major knowledge areas that are essential in order to avoid failure on analysis. Their relations and links can be seen on **Figure 1.** :

Figure 1. Relationship between knowledge areas of business analyst [13].

Each knowledge area consists of several activities and possible techniques, which can be used. Business analyst has a large tool set that can lead to comprehension of bigger picture, than the people involved in the processes on daily basis. It has been stated that a good business analyst has over 99 techniques to choose from and that can be combined. [4] Considering that Business analysis itself is well studied and explored area only activities used in COTS ERP implementation are explained.

Business analysis planning and monitoring

Planning consists activities performed by analyst before starting next phase [13]. It includes all tasks, which are described as initial evaluation, proposed timetable, proposed go-live plan etc. Defining stakeholders is also considered part of planning together with communication channels and information change routine. Planning and monitoring is important part of implementation, since it covers most red flag actions [14], which may occur in implementation phase. It is key element that prepares all following activities and simplifying this activity will most likely lead to miscommunication and failure to meet expected results.

Elicitation

Elicitation in general is major component of gathering and verifying data [4], therefore the activities can be divided to 4 separate subgroups.

First separately viewed set is research and information gathering. This set includes all activities that are performed by analyst without client's active involvement. This includes background information gathering on client's documents and data, consultation with other analysts/consultants/developers in order to get possible approaches from other clients/solutions etc. [4]

Second block of activities is collaboration. This is a set that includes all meetings and information exchange between BA and organization representative as well as other people that are involved with the project. [13] Collaboration is separate important tool that in this paper is separated from both planning and workshops. Collaboration rules are usually defined during planning activities and are used to keep track on overall process.

Third part of obtaining knowledge are workshops with client stakeholders [13]. This practice can be conducted in various ways and each analyst has probably his or her own

methods developed to get maximum information during workshops. During workshop business analyst can be present as observer, performer, or conductor, depending on purpose of workshop, however it allows to assure, that all participants are in the same informational field. [4]

Fourth block of activities is prototyping [13]. Prototyping allows for business analyst to express solution in visual manner that can be more relatable for client. It is common, that business analyst uses slightly modified version of already created prototypes from previous similar implementation to provide high level visual overview of offered solution [9]. In case there are some issues, which need to addressed or requirements, that are not aligned, prototype will point out all possible conflicts.

Requirements life-cycle management

Requirements life-cycle management is set of activities that are related to knowledge of complete system [15]. This set is defined based on knowledge sharing and contains all tasks that require analyst to have insight on solution and organization as well as maintaining clear view on new requirements after software has entered in maintenance phase.

Requirements analysis and design definition

During COTS ERP implementation main difference in requirement elicitation and design is level of detail, since business process modifications are described in design document. In business analysis requirements and design will continue to operate in loop (each requirement refines design and design refines set of requirements) until all issues are resolved. Therefore requirements analysis and design definition activities can be divided to two separate groups.

Requirement analysis is set of activities that target identifying and documenting requirements from business or from solution [13]. This is based on general analysis and preparation for and documentation of workshops. General outcome of requirement engineering on ERP implementation is functional requirement document that describes required parts of process in general, giving answer to overall question: “What functions have to be available?”

Design definition includes all information that follows requirement analysis and refines it further [13]. Final documentation titled or referred as enterprise design document are

included to design activity and it generally answers to question “How the functions and processes are covered in solution?”

Solution evaluation

Solution evaluation is set of tasks performed in order to test performance of solution against organization’s processes and requirements [13]. This includes preparation of test data gathering and assessing all possible and probable exceptions in processes and data-sets. Testing as activity is not generally considered as part of business analyst role, therefore all testing, that is performed by anyone but solution designer is considered developers test or consultation work. This set also contains finalized solutions performance evaluation during life-cycle.

Strategic analysis

Strategic analysis is set of activities, which are performed in order to get insight of customization impact on strategic initiative or long term perspective [13]. It can include business process changes in order to minimize financial impact on project cost or prioritization of requirements/developments. Strategic analysis is done not only in regard to single project, but is often tool for creating list of related projects.

Business analyst role itself can be covered by customer, by implementing partner/vendor or by independent business analyst regardless of other roles during implementation. [4]

Major responsibilities of business analyst during software implementation and overall life-cycle can be presented as seen in **Figure 2**.

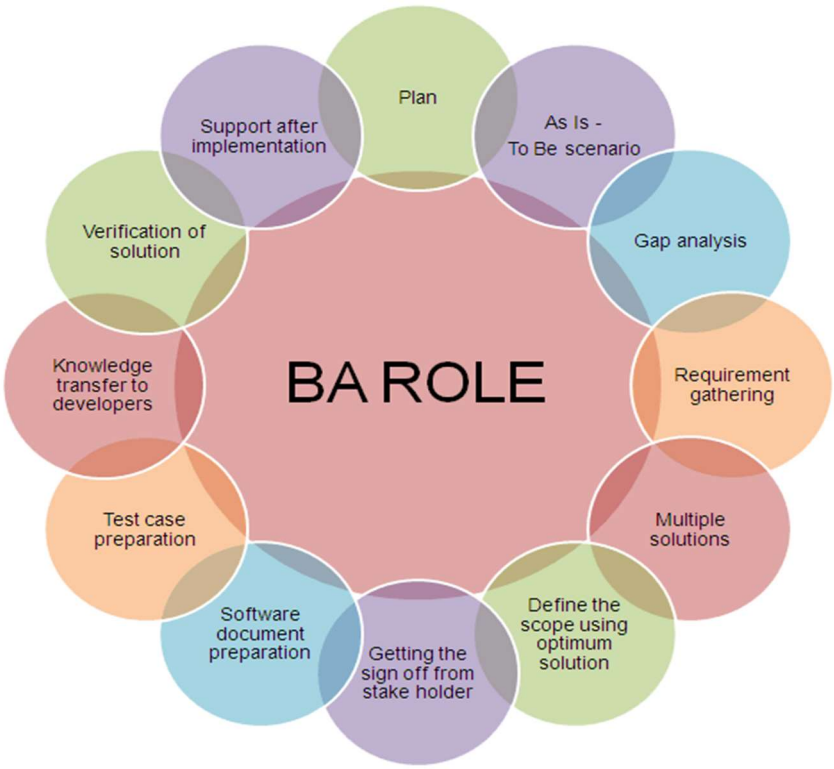


Figure 2. Business Analyst roles in implementation [15]

Often business analysis activities are considered to be a separate part from the ERP implementation project or it assumed, that ERP implementation will automatically solve all problems in instant. However there are some rules as to what business analysis is and is not in implementation project. Business analyst does not require specific knowledge of any distinct system or be limited with technology. The broader view allows business analyst to concentrate on business requirements and elicitate stakeholders needs instead of limiting analysis to possibilities or best practice in solution [4].

It is stated in several works [4; 15; 16], that business analyst's work is not implementation of a solution. Although the person performing business analysis may be also be in a role of developer, project manager or tester and therefore cover several roles in the project, the business analyst role does not include implementation, testing or blindly writing down requirements without root cause analysis [16].

2.2 Enterprise resource planning (ERP) overview

ERP is essentially a resource planning system that allows core business actions to be tied together in a single infosystem. ERP is commonly referenced as a system, which has the

capability of cross references through system using data from single point of entry and allowing full traceability of entered data from any part of system. Usually it covers key areas of business processes.

As ERP is becoming more and more standard to any industry it rises several challenges to organization. Most of these challenges are based on ERP conceptual design. ERP is generally a single infosystem, that is set up on common database and has quite strict set of rules compared to systems, that have decentralized database without single point of data entry. ERP is usually major step towards organization's digitalization since it will cover most if not all companies' business processes and therefore requires much larger degree of precision in all part of business processes and clear vision, how organization's resources are monitored and handled. Based on economical definition business/organization main resources are: Land, labour and capital (both monetary and machinery). As addition to that there may be other types of secondary resources, such as energy, management and time. [17]

It is considered, that each system, that has overall insight in organization's primary resources and can be used to manage them could be considered ERP even if it does not have all functions of modern ERP as described in **Figure 3** [18].

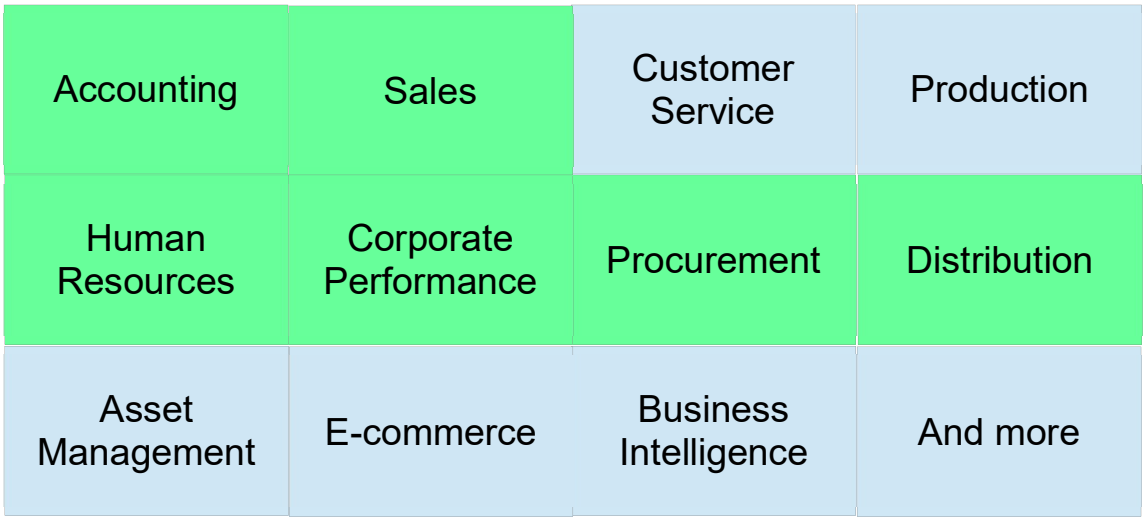


Figure 3. Overview of ERP II modules [18]

It is often difficult to comprehend for employees why it is difficult to maintain processes that have been in place for long time. From previous works it is possible to conclude, that most users view ERP as tool for financial management, centralization and killer of creativity. [33] Since ERP relies only on data entered, it is crucial, that entered data will be

correct and any incorrect data insertion will lead to error messages or in highly automated systems maybe even to stopping of production.

With availability of thousands different sized ERP systems it is difficult to choose the right product to get best possible result. Since implementation of ERP is generally one of the biggest change an organization can make [19], it is clear, that this decision should not be made in a rush and without proper preparation. [7]

All businesses are in some degree different, so in order to maximize ERP positive impact on organization's performance it requires some degree of customization to be accepted throughout organization. Changes can be made to processes (as part of business process re-engineering), software (as modification, extension or configuration) or additional software component added to core ERP. With technology changes it is common, that organization wants to use latest technology in order to keep investment value for as long as possible. Business analysis aim is to assure, that resources are spent on right amount to right place. If organization has strategic goal for increasing profit, while automating document flow, it is essential, that instead of making changes to user interfaces, more time should be spent on elicitation of e-documents handling [7].

It is assumed, that in core COTS ERP systems work by definition alike and most companies have similar issues regardless of ERP chosen [20]. In different implementation strategies and software the activities list will remain similar, only difference could be on customization method and performer of works. Most important part is to perform business analysis to assure, that budget would meet all requirements and critical success factors [6]. The goal of ERP implementation should not be implementation itself, but meeting required results.

In case ERP requirements document is written in business analysis stage beforehand in solution neutral [21] the actual implementation of solution must refine all desired requirements with more specific level of degree. Most ERP-s have similar function and layout, but there are several possible ways to implement it.

ERP can be implemented as single system covering all processes. This is usually most risky and time-consuming way of implementation. Basically it requires very strong knowledge of organization's future in oncoming years and since this approach requires huge amount

of work it is essential, that all business processes are thoroughly analysed since cost and effort on implementation is so significant, that it will be unchanged for years.

Other possible way is to centre the financials to one system and link it with other systems that are dedicated to certain field of business such as retailer's POS, real-estate management and personnel management or similar. These solutions can be stand-alone specialized systems or could be based on some existing COTS system. This approach can save lot of time and money provided that selected systems are generically interfaceable and cover one or more company's demands in process management. This type of solution allows for organization to manage several software systems implementation simultaneously, allowing therefore faster and stronger digital transformation of organization.

Downside on this approach is that complete infosystem can only be completed if there is strong business analyst present and requirements are engineered covering all systems. In case of one component or requirement changes, it could immediately change some requirements in interconnected systems. This approach must allow for BA to change some business processes, when necessary to elicit possible conflicts since as addition to already fixed needs of COTS ERP specialized software provider has added other limitations in system.

For the future "postmodernERP" approach is considered, that was presented by Gartner first time in 2013. It is based on contemporary idea of logical evolution of MRP and ERP. Based on ideas behind 'old ERP' and 'modern ERP'. As depicted in figure 4 Gartner proposed, that new approach will again combine best of breed solutions with use of modern interfacing technologies.

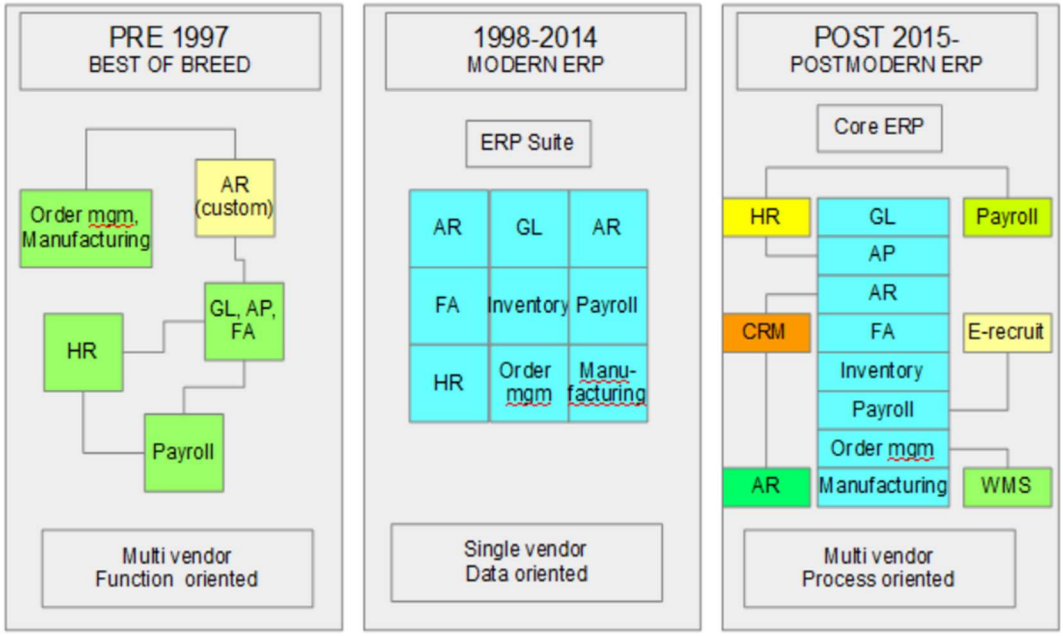


Figure 4. ERP evolution, based on Gartner [22]

Best of breed was based on large ERP systems that were tailored to specific needs. The implementation generally was large and costly project. In most complex cases [23] time for implementation was so long, that by the time implementation finished, the solution would have been already outdated and upgrade had to be started.

Modern ERP was introduced as solution, which used latest technical platform and could be updated much faster, since all integrations between modules were made inside solution itself. However- main issue still remained- it is impossible to update only part of ERP, so in case requirements changed, there was need to create another customization project to address specific issue. It was usual, that due to partial implementation of requirements and long life cycle, companies could not upgrade systems or after platform upgrade cannot use all features of system, since functionality has already been re-implemented to solution in different way.

Idea behind ’postmodern ERP’ is that ERP consists of separate small products, that are interlinked via interfaces. This approach allows all necessary customization to be created via interfaced document processing logic. It also allows all systems to be upgraded or changed without serious effect on other systems (for example POS can be changed without any impact to web shop or accounts receivable).
This allows organization to tailor their own best of breed ERP without being tied to any distinct service provider or any specific platform. It also allows to combine client server on

premises services with software as a service, function as a service and any number of cloud servers. It also makes it easy to create necessary customizations as separate solution on any side of interfaced system.

With rise of postmodernERP approach and agile methodology there is risk, that promise of fast and implementation is not related to real process and investment results in ERP software.

2.3 Implementation methodologies

There are several different implementation methodologies for software development. However since COTS software has own limitations, it can be implemented only by selected variety of methods. In dataset that thesis is based on three described methods are used. In some projects the methods are scrambled during process. Generally lack of selected method will most likely lead to situation, where project has no measurable goals and remaining workload cannot be assessed in sufficient detail.

Waterfall

Most widely used historical method is Waterfall[24]. It consists of cascading style tasks that are taken on one after another as pictured in **Figure 5**. Positive impact is clarity of scope and clear definition of goals. Negative side is time and issue, that it is not possible to make easy adjustments to previous step. In big projects each iteration could render previous version or even itself obsolete due to changes in requirements. Waterfall is well established method in implementations, where scope is well defined and budget has to be kept. It is also easiest form of implementation, since result is visible and measurable.

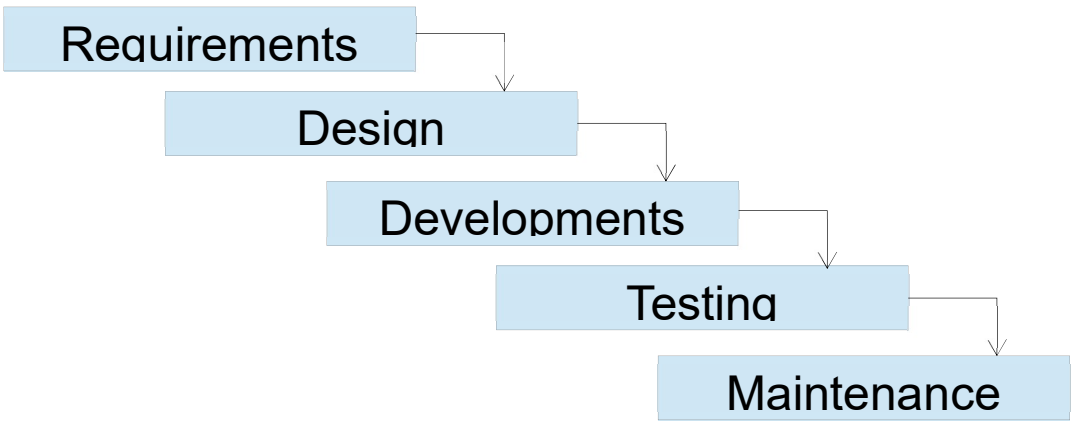


Figure 5. Waterfall style implementation

V-Model

Second widely used method is called V-model. In this tasks are performed in stand-alone blocks as shown in **Figure 6** allowing for solution's requirements to be validated before actual system is completed [25]. Positive side is, that it allows quite clear scope, while still making it possible to change some aspects in previous stage. Methodology however has major negative side, what is, that any next step could change previous iteration and documentation must be constantly updated throughout project. Author believes, that during V-model projects quality and quantity of business analysis has biggest impact, since both other described implementation methods have already agreed solution in place, while processes agreed under V-Model can easily change in next steps or previous of project.

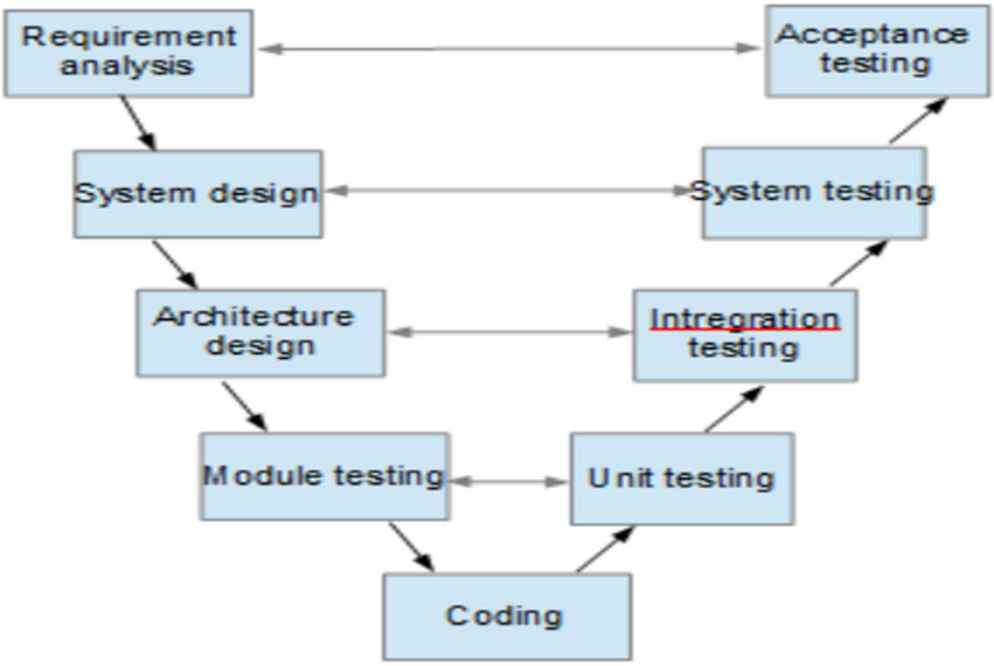


Figure 6. V-model style implementation

Agile methodologies

In this thesis all agile methods such as Iterative,[1] Scrum[2] and RAD[3] are viewed as one method, because the nature of ERP requires some components and approaches from each method to be combined. Tasks are however agreed on in short time sprints for one or more requirements. Overall view of ERP implementation in agile methodology is depicted in **Figure 7**.

Positive impact in this approach is that as long as there is no fixed goal, it is possible to reprioritize requirements and thereby make solution simpler or make changes to previous code in each iteration [26]. Negative side is that in case requirements are not designed with sufficient analysis, some COTS solution elements could become unusable. In case of ERP implementation if customizations are done one by one without fixed scope, all modifications have be recoded in detail since any change in solution leads to significant change in COTS standard functions.

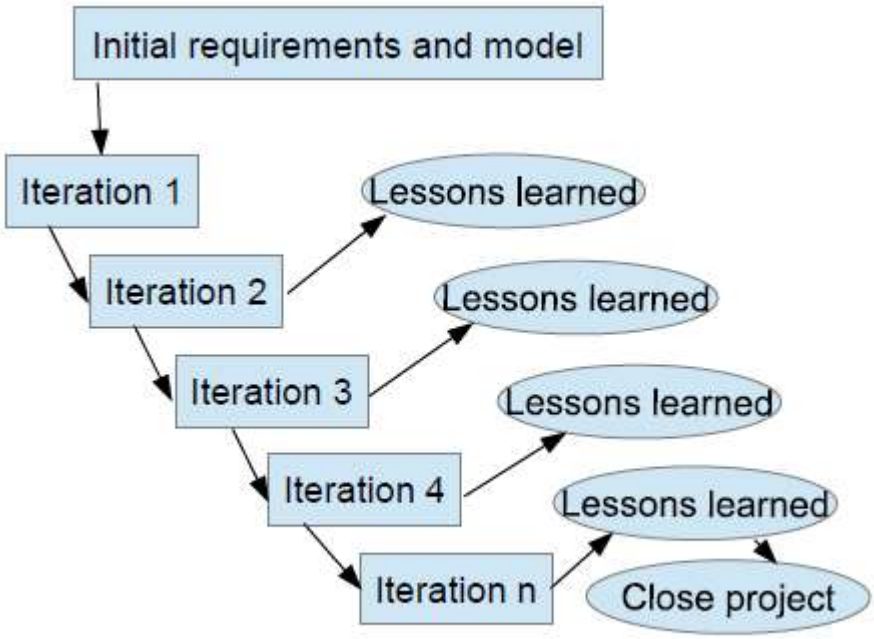


Figure 7. Agile implementation process.

[1]https://airbrake.io/blog/sdlc/iterative-model

[2]https://airbrake.io/blog/sdlc/scrum-what-is-it-and-how-do-you-use-it

[3]https://airbrake.io/blog/sdlc/rapid-application-development

Selection of methodology for implementation is done based on needs of organization, scope definition of works and limitations of time and cost. In case there is tight budget, it would be useful to implement less customization and focus more on business process change and use agile methods to get as much done with standard COTS functionality. In other cases the unique business proposal depends strongly on process that is not available in COTS ERP, so using waterfall is most likely to be chosen in order to create solution that would fit process.

Business analysis part in implementation method selection is to assess expected requirements and evaluate what part of business processes must remain as they have always been and therefore require larger amount of customization and what amount of overall process can be changed to avoid implementation of features or even a complete solution, that does not attribute to final goal in any means.

3. Case study

In this chapter, the case study used to address the research objective business analysis role on COTS implementation is specified together with description of work done. First selection of case study methodology to empirical research selection for thesis is explained. In second part case study design and plan is described together with research questions and motivation. In third part case setting is described, giving overview of data background. In final subsection performed analysis is described.

3.1 Case study methodology

In general empirical studies are becoming more common in software engineering [27; 28] as they provide overview that is more focused on people, than on technical outcome. There are several empirical research methodologies that serve different purposes of research. Based on Robson's (2002) classification Runeson distinguishes between four types of purposes for research and their respective report form [27]:

- Exploratory (Case study) — Aim is to get detailed info of what is happening, seek new insights or generating ideas and hypotheses for new researches;
- Descriptive (Survey) — aims at portraying of situation or phenomenon;
- Explanatory (Experiment) — Aim is an explanation of a situation or a problem, usually, but not always in the form of a causal relationship;
- Improving (Action Research) — trying to improve aspect of the studied phenomenon.

Runeson [27] also states, that case study will never provide conclusions with statistical significance, however different kinds of evidence, figures, statements, documents, are linked together to support a strong and relevant conclusion.

According to Yin case study is most flexible method for concluding empirical data, and despite of its general design of having generally holistic and quantitative view it has several possibilities for extending it to use of other empirical study methods as well. Case study itself can be holistic and have single case per case study or embedded what means that it consists of several cases that are put in same context. [29 via 27]

Since data gathered and modified is gathered from single company using mainly single ERP solution the embedded case study method was chosen. Despite of quantitative measures used, main data classifications are based on qualitative description. Nature of case study is however mostly quantitative in order to avoid assumptions, that are based on general ideas in software development field or cognitive knowledge in COTS implementation. Usage of case study allows for deeper mining into data and explore different aspects for future works in field.

3.2 Case study design

This chapter briefly describes the setting on which the case study was created. It provides overview of where, how and what data was gathered and how analysis and data modification was performed.

3.2.1 Research Questions

Thesis is aimed to explore performed business analysis activities impact on project outcome. There are numerous aspects in COTS ERP implementation, which could be measured, however requirement management, project management and development quality is not very different from other types of systems development. Research questions are raised in order to get better understanding of their relations with other types of works to determine pattern of to answer most important question, if it matters in precision, quality and partnership.

Research Question 1: Does business analysis affect customer satisfaction?

For service provider, customer satisfaction is most important part on implementation because each satisfied customer is likely to give testimonial that can be used to find new clients. Customer satisfaction can be traced to several aspects from cost of project to personal likings. However, since business analysis is a key to understand organizational requirements and needs, more time spent on business analysis could contribute to higher satisfaction of customer.

It is common belief, that customer satisfaction is based in several factors between companies, such as history of cooperation, chemistry between people involved, promises kept and individual projects or activities have only minor effect on general satisfaction. This

raises question, if there is any impact on satisfaction of business analysis conducted during ERP project. In case there is, it would be possible to search for pattern, which can be used to boost customer satisfaction. In case there patterns in business analysis activities, that can be identified to prevent satisfaction drop.

Hypothesis 0 is defined that business analysis has no effect on customer satisfaction.

Hypothesis 1 is set that more business analysis is performed, the more satisfied with service provider customer would be.

Research Question 2: Does business analysis affect the quality of the project after it has been implemented?

There are lots of activities involved in implementation projects. It is often assumed, that good analysis is the key to high quality result. This is exceptionally important in COTS environment, where some processes are fixed and future change in them would lead to complete reimplementation of process and related processes. Quality is measured by counting tasks that have been re-done during implementation or in 6 months warranty period after implementation has completed.

Hypothesis 0 is defined that business analysis has no effect on amount of work that needs to be redone during or after implementation.

Hypothesis 1 is set that higher amount of business analysis leads to better solution with less errors during customizations.

Additional research can be done to test if there is possibility to determine the level of business analysis conducted, that will minimize hidden errors in completed implementation. For this purpose it would be good to use also prediction system created by Rosa et al [30] and Janssens [23] approach for assessing complexity of ERP implementation. However this is beyond of case study's scope.

Research Question 3: Does Business Analysis affect the time of the delivery of the project (delay)?

The delivery delay is one on most important issues when implementing a software solution that has impact on organisation. Delay can be caused by many factors and may be calculated

as best way to minimize risks from both sides. However since delay and changes in initial project plan have huge impact on both the customer and service provider [20] the smaller changes in project plan are in all involved parties best interest. Project can be held in time and in budget by refining the requirements and scope, it is possible to assume, that well conducted and proportioned business analysis, that has major role of refinement and solution has impact on delay.

Hypothesis 0 is set as amount of time business analysis activities performed has little or no effect on delay in implementation project.

Hypothesis 1 is, that amount of time business analysis done has impact on overall project duration.

Hypothesis 2 is, that Business Analysis has proportional effect on delay of final delivery of project.

Research Question 4: What is the ratio of business analysis to other main activities?

All activities have certain role in customizable ERP solution project. Question focuses on correlation between business analysis activities and outcome during ERP implementation and customization. Since business analysis main goal is to determine, what are the needs of customer, it is probable that more time is spent on business analysis, the more precise solution for customer need is created.

It is clear, that not all activities are related to business analysis, however the need for customization is often resulted in elicitation skills of business analyst. Question is aimed to answer if there are ways to determine at what is current ratio the business analysis to other works and what could be best optimal ratio between tasks in implementation of ERP.

Research Question 5: How is business analysis conducted in different software development methods?

There are several methods for implementing a software. Since technical and economic environment changes, organizations differ also their expectations to implementation styles and process management. If company has methodology, that will not meet customers expectation then the result of project would not meet quality standards. All development methods are created for developing software and will therefore have some modifications, if

used in COTS software. However since they are already used, it would be good to know how the processes differ from each other and in what stage and amount should business analysis be included, to get best results. This analysis will concentrate on differences in processes, in order to avoid complications that could rise if different approaches are used within implementation method.

Research Question 6: What types of business analysis activities are conducted?
Since there are number of different analysis activities in bag of business analyst, all of them have good sides in certain parts of processes.

In COTS ERP implementation there are some methods that are more productive than others and it is possible, that methods and activities differ in different implementation methods. Analysing activities in relevance to results and comparing implementation as complete case it would become clear, what are the most used methods, that produce results and what will not add much to result. After activities are categorized it is possible to create best practices for certain activities and create in house training program to keep consistency and get best results.

3.2.2 Case study setting

Dataset used in thesis is from company with over 20 years of experience in field of ERP implementation and customization. BCS Itera is ERP Consultation Company that was established in 2000 and has currently around 60 employees. Company is official Microsoft NAV and LSRetail localization partner. The strategy of company is to deliver changes and innovation with new business process insight to achieve maximum effect on ERP implementation. Company has performed around 350 new implementations and is supporting about 350 enterprises with altogether over 4000 Microsoft Dynamics NAV users all over the Europe. Company's expertise in ERP solutions based on the Microsoft Dynamics NAV can largely be divided into wholesale and retail, business services, utilities, and manufacturing areas. [31]

Company has developed implementation methodology that is based on Microsoft SureStep, what in essence is modified version of waterfall. However throughout times methodology is changed to meet customers' demands and therefore it is possible to compare differences in methodology as well.

Microsoft Dynamics NAV is easily adaptable ERP solution that helps small and medium-sized businesses automate and connect their sales, purchasing, operations, accounting, and inventory management [32]. As all ERP-s it covers basic modules described under ERP2 requirements. NAV itself is highly customizable allowing configuration, modification and extension of existing functions. Microsoft has created has large network of NAV partners and therefore NAV has several ISV modules [33], that can be easily implemented as part of COTS ERP reducing overall speed and cost of implementation even more. NAV overall covers majority of requirements, that small and middle sized companies could require, such as multi-language and multi-currency capabilities. In 2018 Dynamics NAV was relaunched by Microsoft as Business Central that aims via possibility to Microsoft Azure cloud and web services usage to postmodernERP solution market, while still attaining possibility for high level of customizations. [32]

3.2.3 Data collection and preparation

Since case study is by design built as quantitative analysis, instead of qualitative, data collection is done only once from data sources. For triangulation purposes data was gathered from different sources, not only from single system. Current work is mostly based on records from helpdesk system that is used to record each task performed in accuracy of 30 minutes.

Chosen set covers of all works recorded from February 2009 to February 2019. Reason for time limitation is the size of listed works and inconsistencies in data recording before 2009.

Main dataset used for analysis in this work is extracted from work management system and modified to get systematic view for most important variables in process. Work management system is web based application that is used to track task completion and workload. Since all works performed are entered to system it provides good overview of all activities. Detailed overview of data structure is provided in **Appendix 1**.

Second dataset is extracted from ERP and consists of task number, time worked, task number, time invoiced and price. Second dataset is used mainly for triangulation purposes to test first data set observations accuracy. Detailed overview of data structure is provided on **Appendix 1**.

Third dataset is extracted from ERP and contains projects with estimated start and end date, price and other general attributes.

Additionally customer satisfaction dataset is extracted. It provides numerical and textual overview of customer satisfaction. Questionnaire is used since 2015 and is sent out to all companies that have had ongoing project during previous period. In this paper actual response rate is calculated based on performed works from work data in comparison with responses. Questions asked are:

- „Would you recommend company to others“;
- „How would you rate your experience“.

Both questions have free form text box for commenting. Customer survey is joined with customer and project dataset in order to determine, what type of works were performed prior to survey. All customer surveys have date stamp. Detailed overview of satisfaction data set is provided in **Appendix 1**.

Extracted data consists of 1247 separate projects, covering 226 clients and 233 531 usable lines of tasks with 440 responses to satisfaction query, which allows to conclude, that there is enough data to answer research questions.

Since data was extracted from different systems, first task performed was decomposition of datasets and creation of ERD model. Since data analysis was to be performed in R using data frames, the recurring values from original data were eliminated using separate sets. Since used data is gathered from different original sources the key values had to be structured to eliminate possible replicas. Database type approach was used to achieve that. In order to get best overview of existing data and significance in complete set data diagram was created to get complete overview of usable data and to evaluate all possible analysis possibilities. Relations between extracted datasets are described in **Figure 8**.

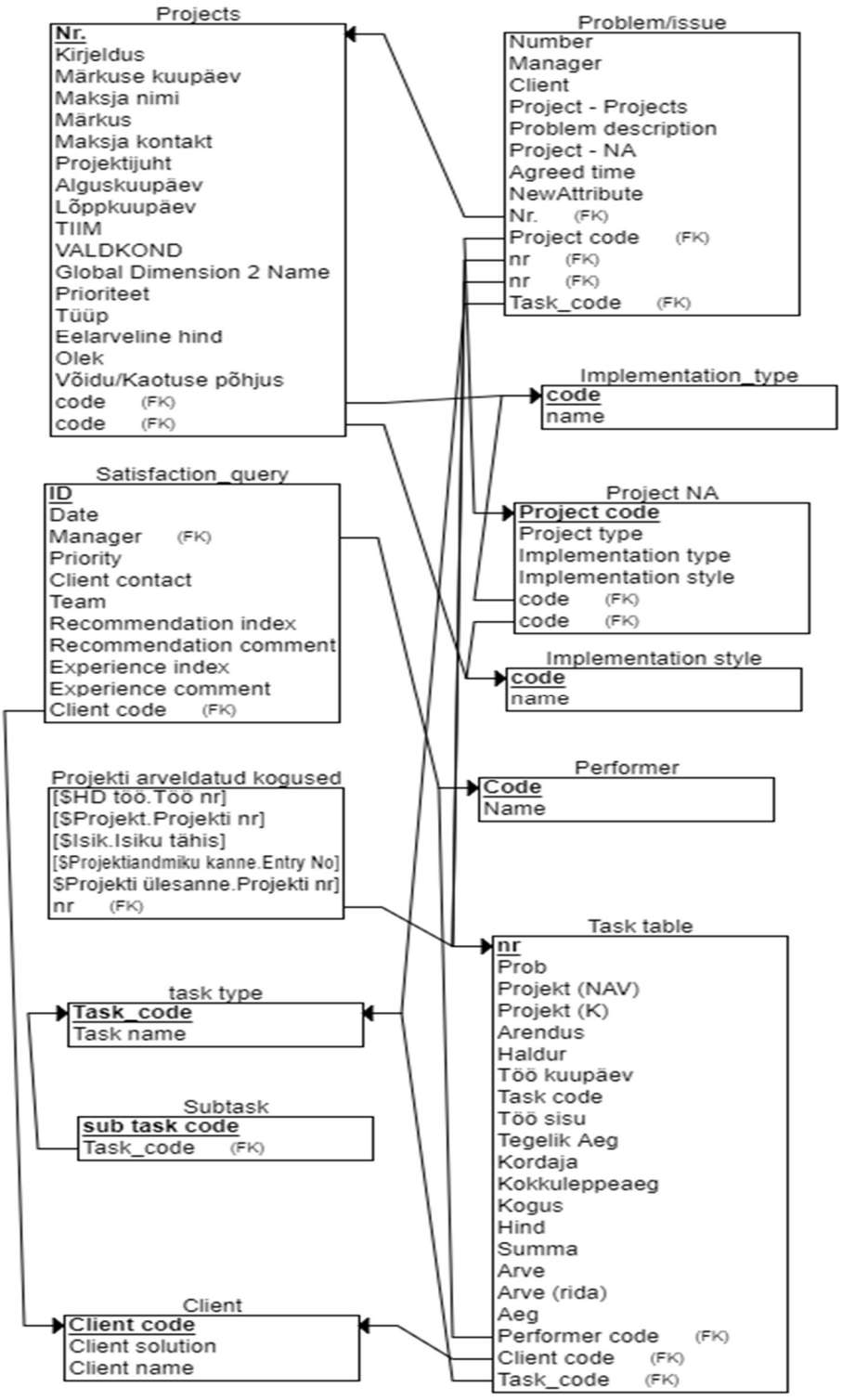


Figure 8. ERD overview of extracted data

In order to eliminate possible bias and generalize possible error rate as well as to observe all possible aspects in implementation, data analysis is performed in complete set. Gathered and initially prepared data is combined in separate sets.

To assure, that all conclusions are handled neutrally all data is anonymised to prevent any observation to be linked back to actual works. To minimize personalization of data and therefore assumptions by author personnel and clients was re-coded after task data preparation. All uniquely identifiable codes were exported from data frame to excel and recoded to numeric values in random order. After randomization and anonymization all data in original imported dataset was overwritten with use of R standard functions. Anonymization will allow to check various personal performance impact on processes without any tie to actual persons. However aim of current paper is not capabilities study, therefore no relation to personal experience and performance was analysed.

For anonymization simple R subsetting was used. Since data is extracted from several systems initial coding was created based on all unique description values from each dataset. All values were extracted from different datasets as list and combined in alphabetical order. Result is unique code that is used on all datasets and is also used to filter out datasets for testing.

Client code is created for solution that in this paper is defined as implemented ERP system that has one or more implementation or support projects. Structural overview is depicted in **Figure 9**. Cleared dataset has client solution code as common denominator that represents ERP solution throughout overall life-cycle. Under each project is one or more requirement in implementation cycle or issue in support project. Issues are usually created in same level as requirement. Each requirement consists of different tasks performed. In dataset each type of activity is considered different task as defined in glossary.

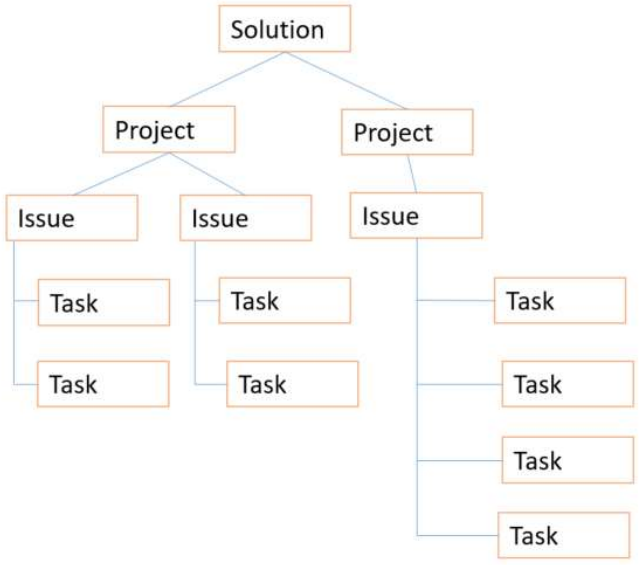


Figure 9. Solution dependency

For testing processes against actual processes in methodology, business analysis part was extracted from official methodology. General graphical overview of issue or implementation analysis process in COTS ERP is depicted on figure 10 and will be used as ground point for analysing real world usage of actions based on collected data.

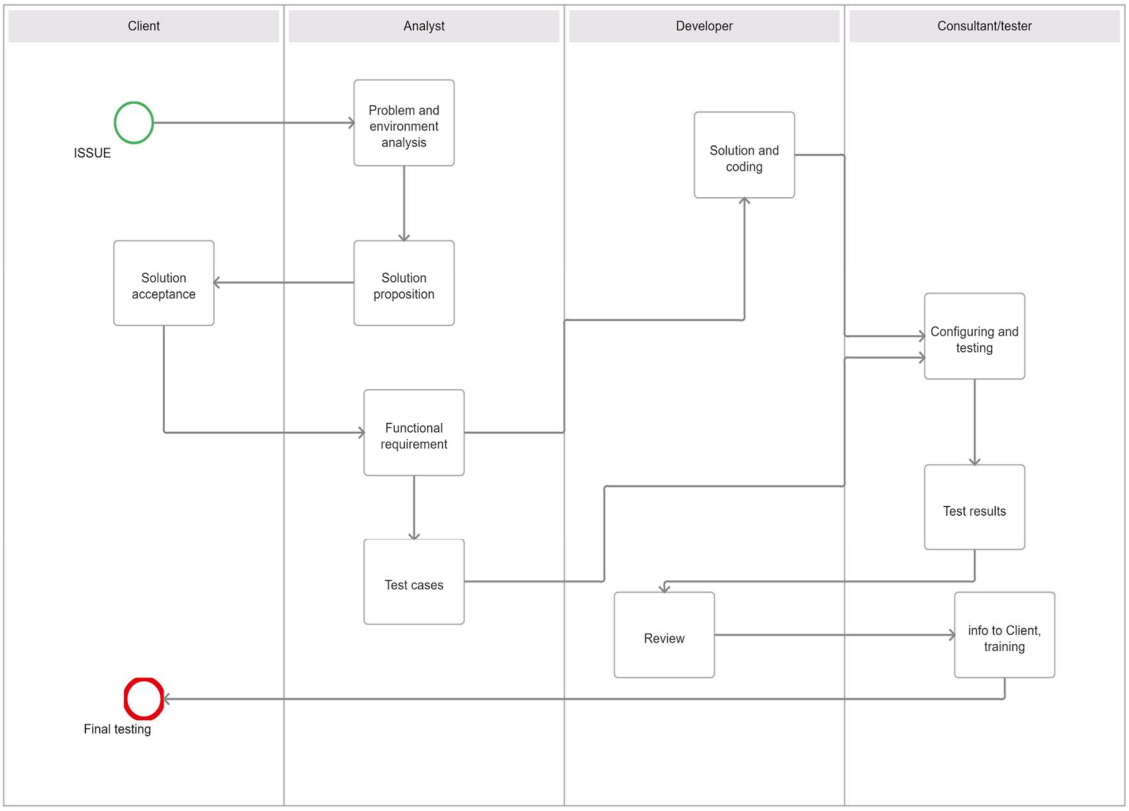


Figure 10. Overall implementation process

As part of data preparation additional fields were created as categories for projects (implementation style and type) and tasks. Prior of adding categories, dataset contextual phrases were checked to review if all tasks are recorded with right work code. In case context of text did not fit work code, code was changed. Same logic was used in context of solution codes- in case work description applied to other solution, the code was moved. Text analysis was performed using standard spreadsheet possibilities and word cloud in R.

3.2.4 Case study execution

Case study analysis is performed using R[4]. R is a free software environment designed for statistical computing and graphics. R provides not only variety of statistical and graphical

[4]https://www.r-project.org/

techniques, but is also capable of performing several activities for data manipulation. Different packages for analysis and visualisations were used.

During this work Rstudio[5] was used for easier overview of code. RStudio is an integrated development environment for R. It includes a console, syntax-highlighting editor that supports direct code execution, as well as tools for plotting, history, debugging, package management and workspace management.

During research such an approach was taken that each question is addressed based on extraction of relevant dataset from main extracted set.

In order to analyse customer satisfaction historic list of customer satisfaction query responses was reviewed.

Responses given by customers are gathered in dataset, where 7 columns are used:

- Customer code;
- time of response;
- score for recommendation (0-10);
- score for overall satisfaction (0-10);
- comments for
    a. Personnel
    b. Process
    c. Result.

All comments are classified as 1- poor, 2- could be better, 3- ok, 4- great, 5- excellent. In case no comments are provided it is assumed, that overall feedback reflects all aspects (1-3 is considered to be 1, 4-6 is considered to be 2, 7-8 is considered 3 and 9-10 is considered to be great - 4; excellent will be considered only if positive comment is provided).

Since responses alone are not in scope of thesis the remaining data set was modified starting with task data. In **Appendix 1** is given field level overview of cleaned data-set (~223000 rows; 246000h in total), that consists of data description, type and format overview. For data modification and manipulation R and spreadsheet tools were used. In order to assure,

[5]https://www.rstudio.com/

that data was not over modified, only one modification was done at the time and constant follow up checks were made.

Main focus on task level modification was to divide business analytics/analyst tasks to major groups of activities. Since there is not sufficient identifiable information about detailed activities such as time spent on elicitation with stakeholders, it is easier to divide info into larger groups based on core activities as described in chapter 2.1. In first order descriptions in ANA dataset were tested against keywords, which indicate some other types of works (such as consultation, development, drive, sales etc.). To keep modified data in same frame additional column was created for business analysis job type and was defaulted as NA. After that all major ANA expressions were tested against other types of works. Additionally word clouds were used to get most common description of words that could be used to segment work by BA task type. All works performed under code internal work tasks were tested client names list to locate all ANA works that have been listed as internal instead of part of project. All found tasks were marked and moved to predefined set.

Initial extracted dataset has key variables, that will not be changed and two major text fields, that are used for describing works performed and will be major component in analysis. Data in original dataset consist of project, client, and performer of works, order number, task number, time agreed, time worked and timestamp.
After initial analysis aggregation was performed to gain separate dataset with summarized data on agreed time and total in types of works and other task based data.

Additional project set was created with to combine main variables such as methodology and project type and amounts of tasks by type done to use in further analysis. Projects were presented with quantile distribution based batch set that is calculated based on task type data. In order to divide projects to groups of similar level of business analysis the ratio of business analysis to total number of works was used. Reason behind ratios is, that projects vary on complexity. To compare all projects it is therefore impossible to compare different projects based on time spent on each task, since the result will show each project as unique.

Project set was modified to add ratios of business analysis activities to total hours. Resulted set was divided to:

1. Set of business analysis projects; where most of work done is business analysis. Chosen ratio was set at 0,6. The extracted set is not used in analysis, since it relies only on business analysis and therefore will not contribute to research questions;
2. Set of projects, where no business analysis is conducted. This set includes all projects that have no identifiable business analysis activities. This will be used in additional analysis in satisfaction comparison comparisons. Some non-BA projects have however started with business analysis project, thus are having already all activities performed in separate projects. Therefore this set will not be used in relation to business analysis ratio in research;
3. Quantile based batches of projects that have set business analysis activities. Each project in each of four groups is used in additional analysis to produce results to be compared. In this research 4 equally sized sets of 209 observations each was used to determine projects were business analysis was done in small scale (up to 8,39 % of works), medium low scale (ratio of 8,4% to 14,91%) , medium high scale (15% to 24,69) and high scale (25% to 0,6). In some cases batches are combined to possible relations.

Overview of works performed in each quantile batch set is described in **Figure 11**.

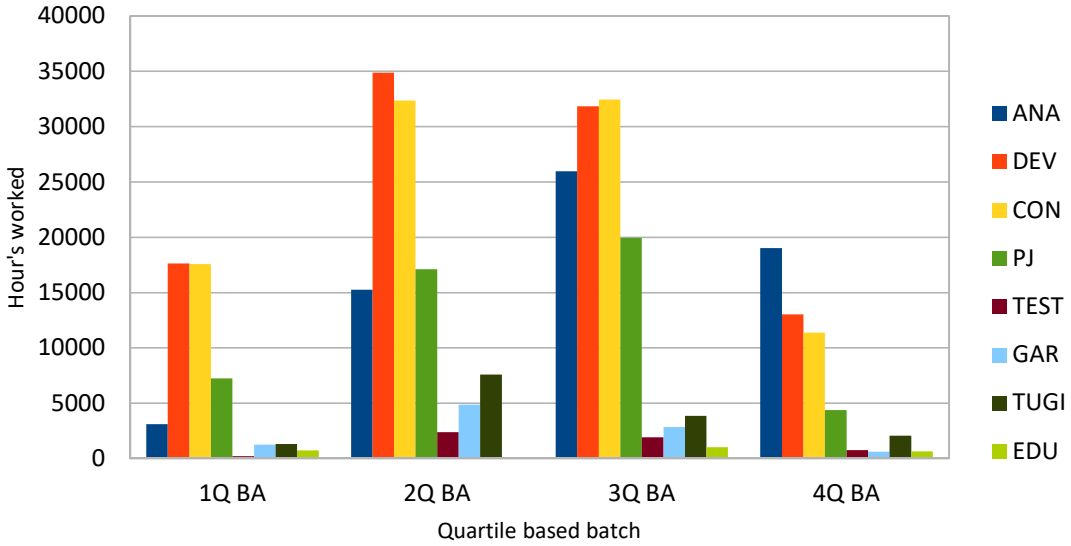


Figure 11. Implementation activities in business analysis quantile ratio batches.

Analysis was performed in each quantile batch separately and all projects together using R functions and graphical overview.

In order to spot any possible correlations in data-set, finalized data-set was tested to see any significant correlations between value sets.

Process mining

To conduct analysis on activities relevance and test processes covered against theoretical implementation methods process mining was used. Main reason for process research is to pinpoint the areas, where business analysis activities are used. Process mining has purpose of finding actual processes based on event logs to be compared against agreed or expected processes. [34]

In this thesis "Disco" from Fluxicon was chosen due to ability to its built in mining technology, that allows to create visual insight about processes variations and has built in mining technology for easier deviation analysis. [35]

Aim of process mining was to further examine relations between different types of works and the relations between them in different categories of projects.

To find all possible relations and test possible correlations between them process mining was done on each implementation style and each project type. "Disco" allows to view processes on wanted level of accuracy, so each set was reviewed as complete set and as 80-60-40-20 percent of level to find possible correlations between work types in relation to client, implementation style and project type. Despite of fact that "Disco" has built in extensive filtering solution it was decided, that in order to assure that analysed processes are in right set all events were prepared in R and exported set by set.

All different types of projects, implementation methodologies and implementation types were extracted to separate datasets using R and exported in csv format. To gain more insight how actual processes look like in reality data was separated to 7 sets based on implementation type and project type. As several types of works are not of significance in thesis, these observations were eliminated from extracted set.

4. Findings

Current chapter will include findings in dataset in relevance to research questions and theory presented. Aim of the chapter is not only to present calculated values to hypothesis, but to address all observations, that are noted during analysis.

4.1 RQ1 – business analysis impact on customer satisfaction

Research question 1: ***Does Business Analysis affect customer satisfaction?*** , explores if there is any impact on satisfaction of business analysis conducted during project. In case there is, it would be possible to search for pattern, which can be used to boost or prevent drop of customer satisfaction.

To answer research question, customer satisfaction response index was compared with prepared project set and linear regression was added

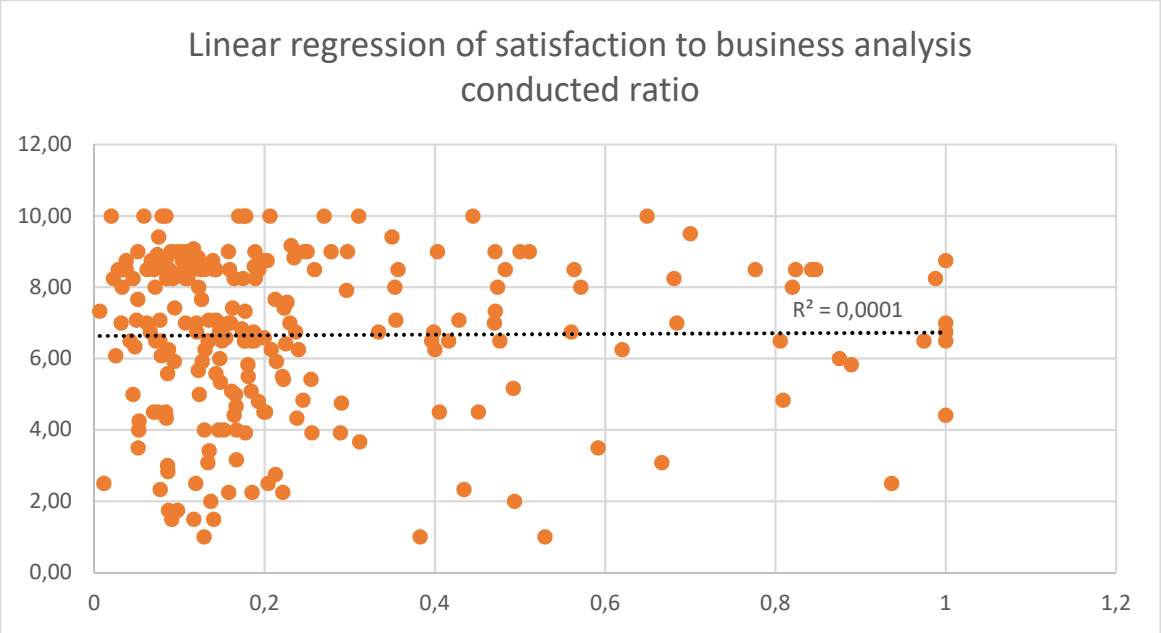


Figure 12. Linear regression of satisfaction to conducted business analysis ratio

For research question hypothesis 0 was defined as business analysis has no effect on customer satisfaction.

Hypothesis 1 is set that the more business analysis is performed, the more satisfied with service provider customer would be.

Conducted tests also prove that 0 hypothesis cannot be rejected at .05 level.

Therefore further analysis of this matter based on this survey method is not needed since business analysis does not seem to contribute to customer satisfaction in general.

Similar test was conducted using all other work types and it was determined, that either work types done nor size of project has significant relation to customer satisfaction.

4.2 RQ2 - Business analysis impact on quality

Research question 2: Does business analysis affect the quality of the project after it has been implemented explores quality of implementation in relation to business analysis.

Quality is measured by using works, that can be traced back to have been re-done during implementation or have been done during 6 months warranty period after implementation has completed.

Hypothesis 0 is defined that business analysis has no effect on amount of work that needs to be redone during or after implementation.

Hypothesis 1 is set that more time spent on analysis leads to higher quality solution.

For testing quality of overall works set of project was tested with ratio of warranty works divided by overall analysis works. Each project compared has one or more issues, that has to be redone (misunderstood requirement, insufficient testing, mistakes in code etc.) during implementation or after go-live. Projects with no warranty works are discarded. In detail analysis was performed based on quantile batches and in comparison with overall data set. Result is depicted in **Figure 13.**

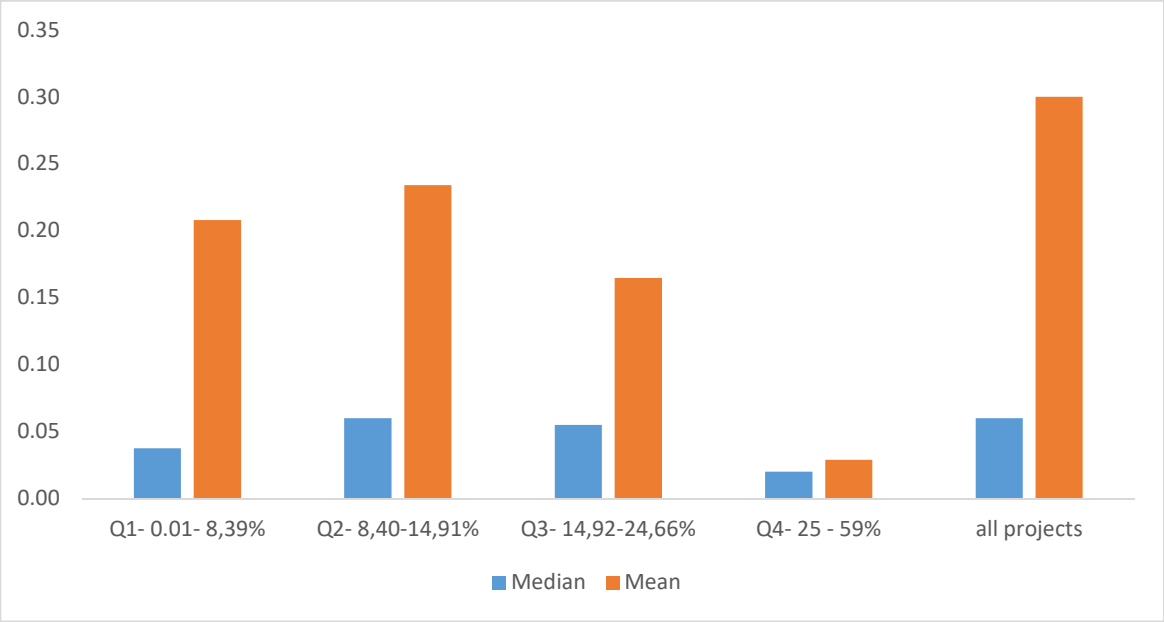


Figure 13. Warranty works in business analysis involved projects in quartile based batches of business analysis (ratios to total are shown as percentage)

Analysis show that each additional proportion of time spent on analysis reduces number of correctable errors in project. Projects defined in this thesis as business analysis projects have no warranty works present, therefore they are excluded from this research question.

Testing different sets reveal that at .05 level, that there are statistically relevant differences on projects where business analysis is conducted in higher scale and in projects, where analysis was done in lesser detail. During analysis all batches were tested against each other and result did not differ much.

Therefore hypothesis 0 can be rejected and concluded, that more business analysis conducted would more likely lead to less errors during customization process and therefore provides solutions with higher quality.

4.3 RQ3 – Business analysis impact on time (delay)?

The delivery delay is one of the most important risks when implementing a software solution that has impact on organisation. One aspect of delay could be related to insufficient business analysis.

Hypothesis 0 is set as Business Analysis amount has little or no effect on delays in implementation project.

Hypothesis 1 is, that amount of business analysis done has impact on overall project timeline.

Hypothesis 2 is, that business analysis has proportional effect on delays during project.

The dataset was used to test if there are significant differences in batches of projects that have different ratio of business analysis activities conducted.

For delay two measures were used:

1. Estimated project duration from projects set is compared with difference in days from earliest task performed to latest task performed on project. Project duration would be more accurate measure, than actual start and end date because of warranty period of 180 days. Additionally project end date was compared with latest date of performed works;
2. Agreed time on project compared with actual time spent on project.

Calculated median and end date values on delay are presented in **Figure 14** and calculated ratios of agreed time compared with actual time are presented on **Figure 15**.

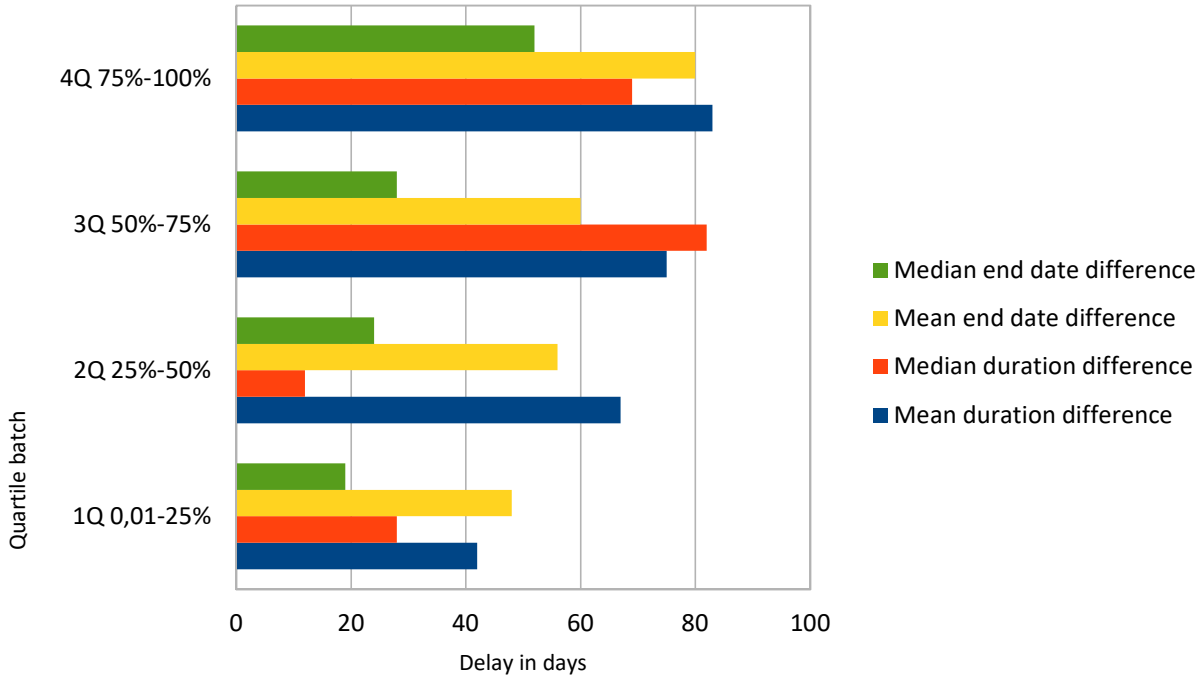


Figure 14. Mean values of delay and duration differences in each tested quartile distributed batch of business analysis

Comparison of delay in quantiles differs in quartile batches strongly. On first sight it appears, that business analysis is strongly related to delay, since rise in business analysis to total works ratio in project seems lead to delay in delivery. However it should be noted, that based on data set purpose project delay does not necessarily indicate delay in implementation, but could indicate new out of scope works.

In **Figure 15** it is depicted agreed (estimated time) time in comparison to actual time of work. There are some differences in different quantile sets, however the differences in them are not significant. The reason may be, that more analysis would be required for scope extensions and further expansion of solution's capabilities.

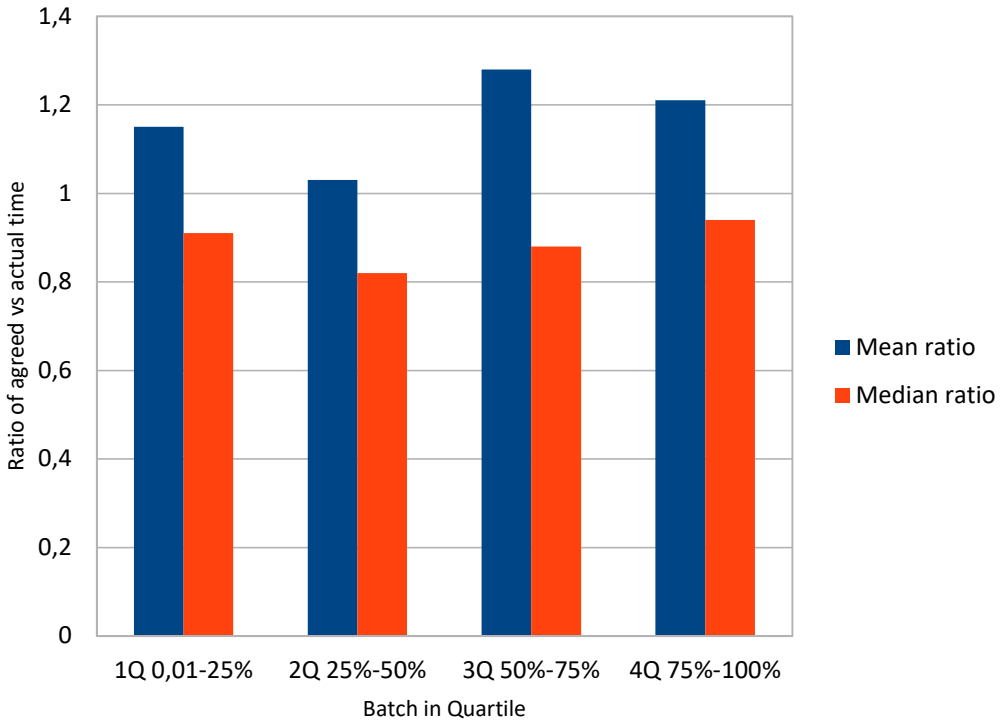


Figure 15. Mean and median of ratios of agreed time vs actual time.

To test the visible differences in project linear regression and two sided t tests were performed.

Based on outcome it is possible to conclude, that time spent on business analysis does not have effect on to delay in projects, therefore there is no statistical proof in this data-set to reject 0 hypothesis.

However further study would be recommended to get more detailed info on relation of business analysis to delay in project. Set was tested with all different implementation

methods and several sets of project size and result did not differ much. Further study on reasons of delay is beyond the scope of this work.

4.4 RQ4. Business analysis compared to other types of work

All activities have certain role in customizable ERP solution project. Research Question focuses on correlation between business analysis activities and outcome during ERP implementation and customization.

In used data-set **consulting** is referred to as consulting of client, setup and configuration of ERP, data preparation, testing and other tasks performed during projects.

Development works are considered any work related to code while modifying or extending ERP solution.

Training consists of end user training during or after end of project.

Warranty works are considered all tasks performed due to errors in code or also in ERP processes that were not identified, coded or elicitated correctly.

There is strong relation between business analysis and all other work types in project level. Major correlations are provided in **Figure 16**. The correlation between project management is not considered important due to inconsistent way project management work is recorded.

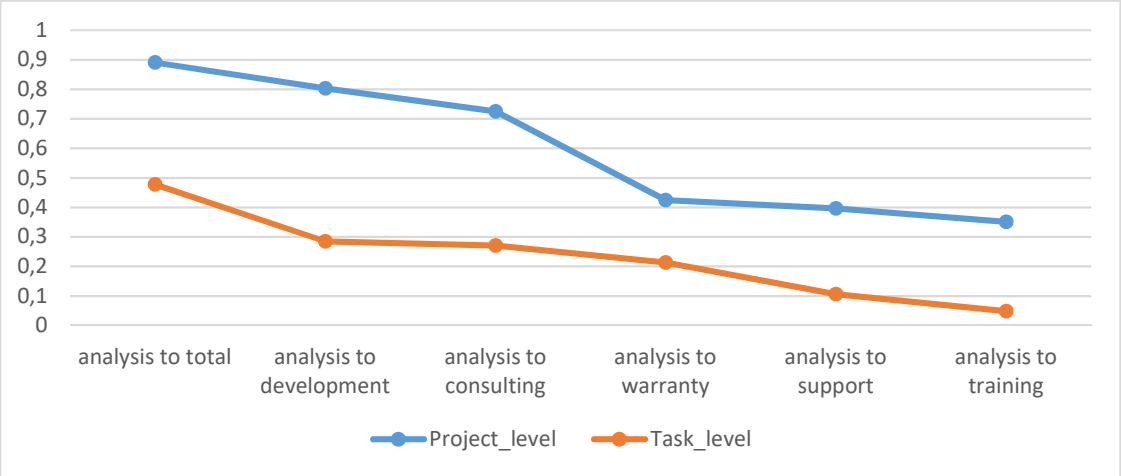


Figure 16. Correlations between types of work.

The mean values in quantile and size based distributions however show that despite of mean and median values of each type of work in different implementation methods have significant variance, the in overall the ratios do not differ much in different types of projects.

It is possible to conclude, that bigger projects (more customizations) do not have direct need for proportionally more time spent on business analysis and the optimal ratio of business analysis in COTS ERP implementation is not clearly identifiable from this set of data. Detailed calculation should be done by comparing business analysts, but this analysis is beyond the scope of this work.

4.5 RQ5 business analysis in different implementation methods

There are several methods for implementing a software. Research question itself is exploratory: „How business analysis is conducted in different software development methods?"

Identified processes differ based on type of implementation and style on implementation. Therefore it would be advisable to create separate processes for different implementations instead of trying to get all implementation done in single finalized process. It is clear, that most projects are unique, however variance in different methods remain similar regardless of project details. To answer this question the business analysis works task level description was mined and similar phrases were looked throughout dataset.

Business analysis part is present in each process. The ratio of quantile based batches are also clearly different in comparison of implementation styles.

Waterfall

In waterfall method log based mining revealed, that there are no significant deviations form methodological approach. As depicted in high level process model in **Figure 17**, business analysis is done in majority before development and testing.

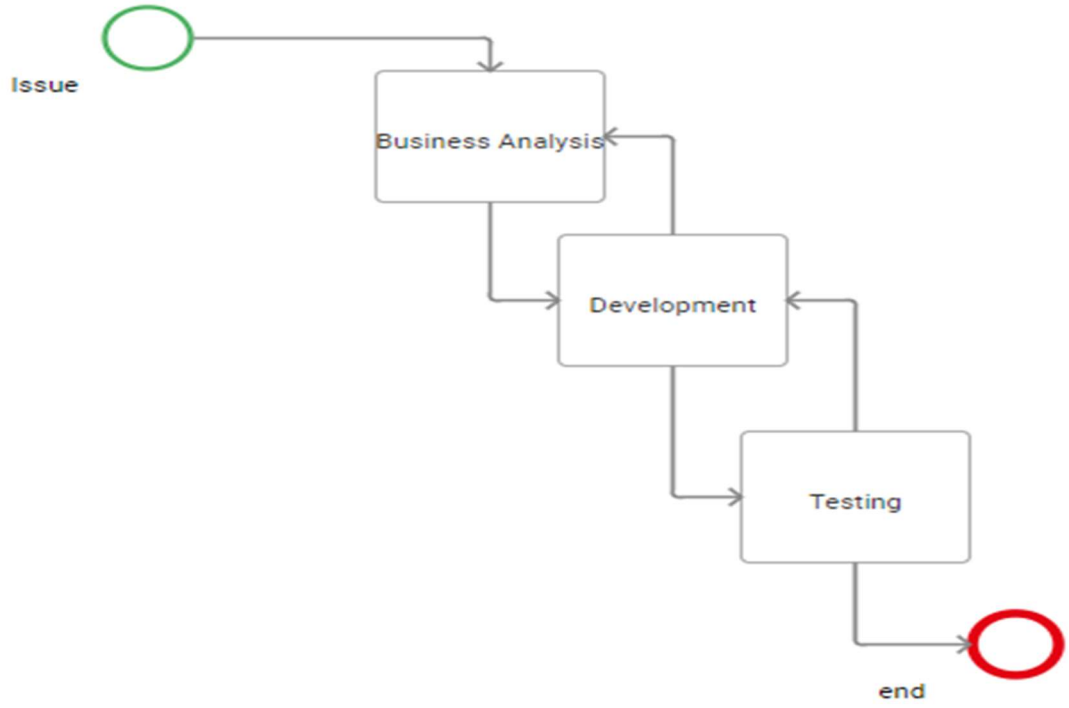


Figure 17. Identified main process regarding business analysis in waterfall

In some occasions of observed projects set business analysis is again conducted after developments have been finished. There is insignificant number of cases, where business analysis has input from other types of works than development. These cases however are generally related to maintenance types of projects and therefore are not relevant to this study. Overall structure of business analysis work is shown in **Figure 20.**

Data in set for waterfall was tested to find all possible patterns, that would help to differentiate patterns in ratios and work types that could be found. Ratios were tested against each other in median and mean as well as analysis test was created against ratios. Overall analysis reveals, that during agile implementations about 24 % of time is spent on analysis. In average 32% is spent on development and rest is spent on other activities.

V-model

Overall process in **Figure 18** shows slight difference from waterfall method, since in majority of cases business analysis is performed separately throughout process and it has no identifiable direct link to other types of work. This allows to conclude, that in V model

implementation method analysis and development method are kept independently separated and testing will follow actual coding as described in **Figure 5**.

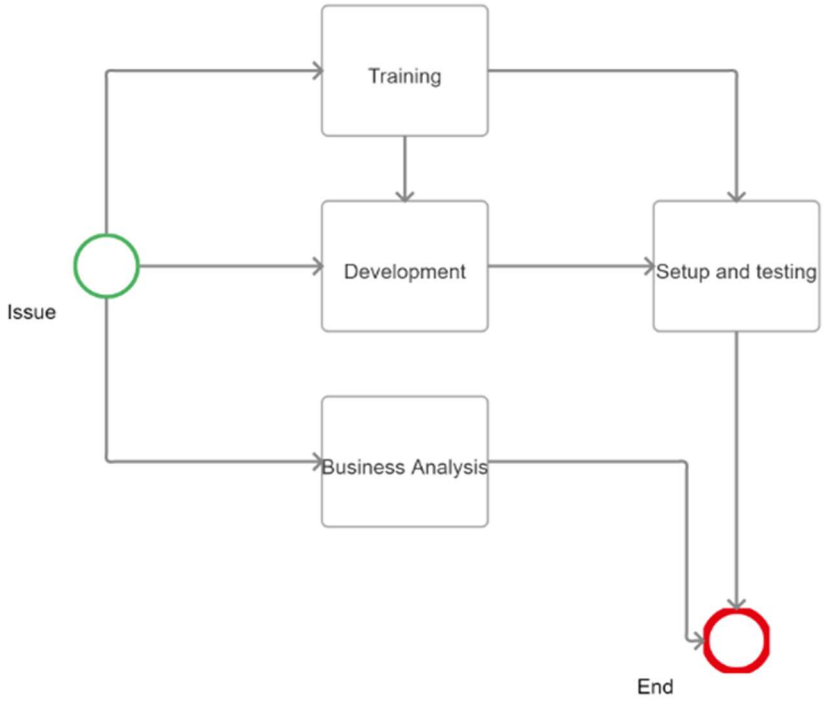


Figure 18. Identified main process regarding business analysis in V-model

Data in v-model projects indicates, that overall ratios are roughly the same as in waterfall, however the delay in delivery is bit lower. The customer satisfaction is not notably higher. Amount of V-model style projects is lowest of three compared methods, however the results in overall performance in all ways are bit higher. In average. About 15 % of time is spent on analysis and 23% of time is spent on development.

Agile

Agile process shows significant difference in overall project compared to waterfall and V model. As depicted in **Figure 19**, the main difference is, that majority of business analysis work originate from setup and development, rather than from issue itself. In 2/3 of cases internal review leads to setup, that will continue with development or business analysis activities.

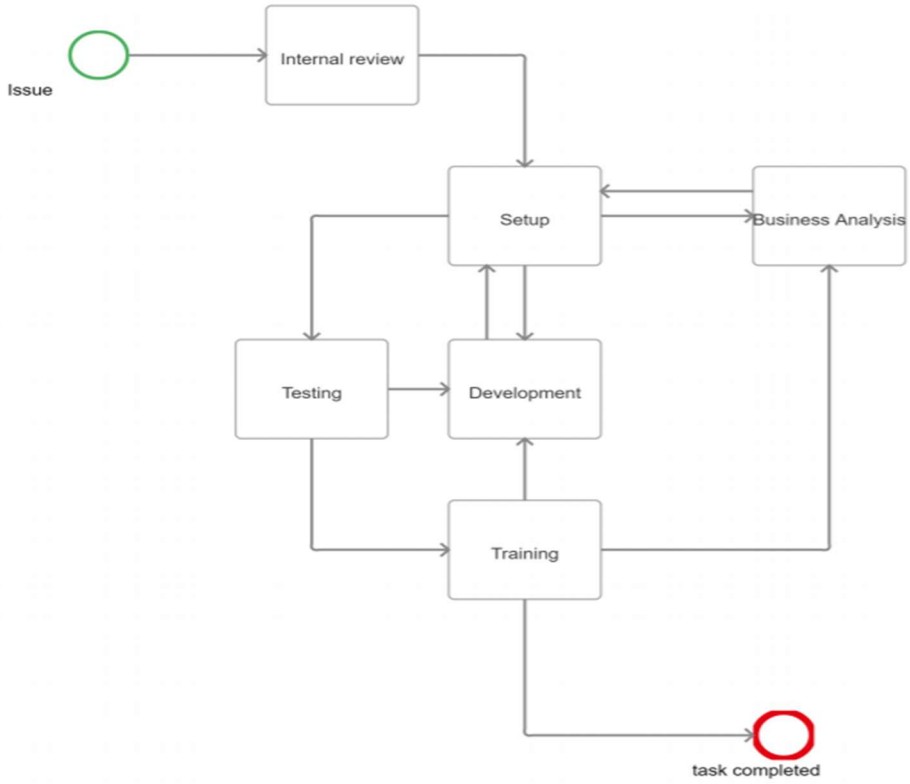


Figure 19. Identified main process regarding business analysis in Agile.

As identified process shows, work in agile projects is usually started by consultation. Since agile implementation in detail is not part of thesis the exact works performed is not studied further. After initial setup and review of work done development and analysis tasks follow. On average business analysis in agile takes 24% of overall implementation time. Unlike other methods in agile it is possible to indicate, that the overall delay is not measurable since project ends when it is decided, that all criteria is met. However, average customer satisfaction is bit higher than on other methods as can be seen in **Appendix 1**.

It should be noted, that agile type development can be based on process traced back not only to new implementation or business process change, but also to several maintenance projects, that use agile style activities for faster response.

Identified patterns of mined business processes for types of projects and detailed results in quality measure differences are found in **Appendix 1**.

Overall it can be concluded, that based on this data set, there are no significant advantages of any of the identified implementation methods. There however should be different tasks and processes as well as KPI-s to meet required level of project outcome.

It shall be stated, that choice of method for implementation is strictly up to client and overall relationship between the parties since business analysis activities in agile implementation requires in depth knowledge about customer organization or constant availability of client.

4.6 RQ6 Types of activities conducted

Since there are number of different analysis activities for business analyst, all of them have good sides in certain parts of processes. Analyzing activities in relevance to results and comparing implementation as complete case it would become clear, what are the most used activities in different implementations and if there is any identifiable link between outcome of project and activities performed.

Data set was prepared with the use of word clouds and most of phrases, that indicate type of business analysis tasks as described in chapter 2. In data set 10 types of business analysis sub tasks can be identified based on 924 projects out of 1247 that have business analysis activities recorded. Of set 924 projects, there are 90 projects, which can be considered business analysis projects since level of business analysis is over the 60% level. Overview of reported business activities data is represented in **Figure 20**. Abbriviations in chart are related to following types of business analysis activities:

PLAN *– Planning;*
RES *– Research and information gathering;*
WS *– Workshop;*
EXP *– Prototyping;*
COL *– Collaboration;*
LCM - *Life-cycle management;*
STA - *Strategic analysis;*
REQ - *Requirement analysis;*
DIS - *Design;*
SEV - *Solution evaluation.*

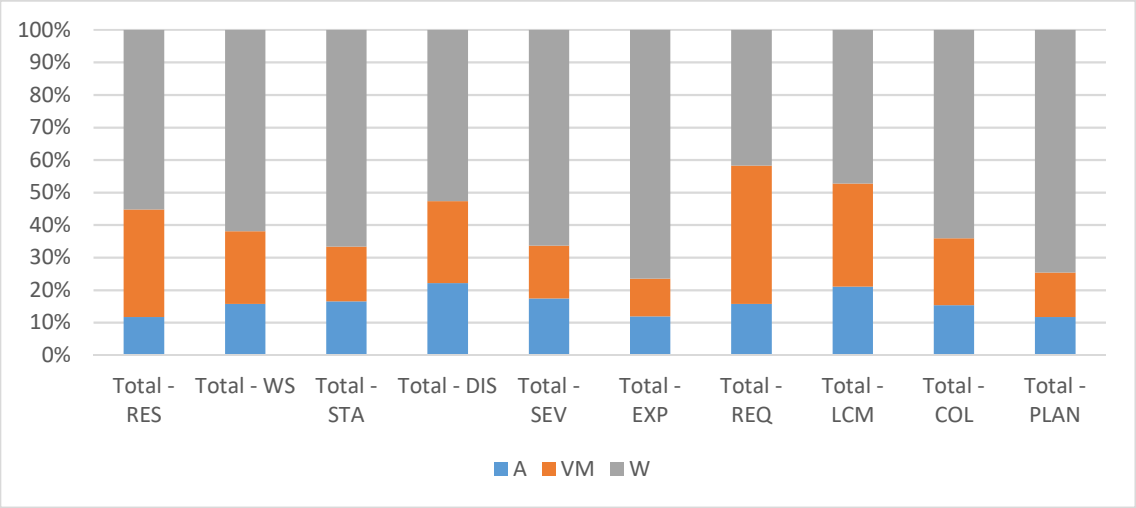


Figure 20. Distribution of types of business analysis works conducted based on complete data set.

Overall the main activity in COTS ERP implementation is as expected requirement engineering and design, that is done in 90% of projects and covers overall 60% of all time spent on business analysis. Of the 152 projects, that have no requirement engineering involved, there are 996 hours of design works performed in 55 project. It can be concluded, that all types of activities as described in chapter 2 are present in all types of projects. In average the works performed are depicted in **Figure 21**.

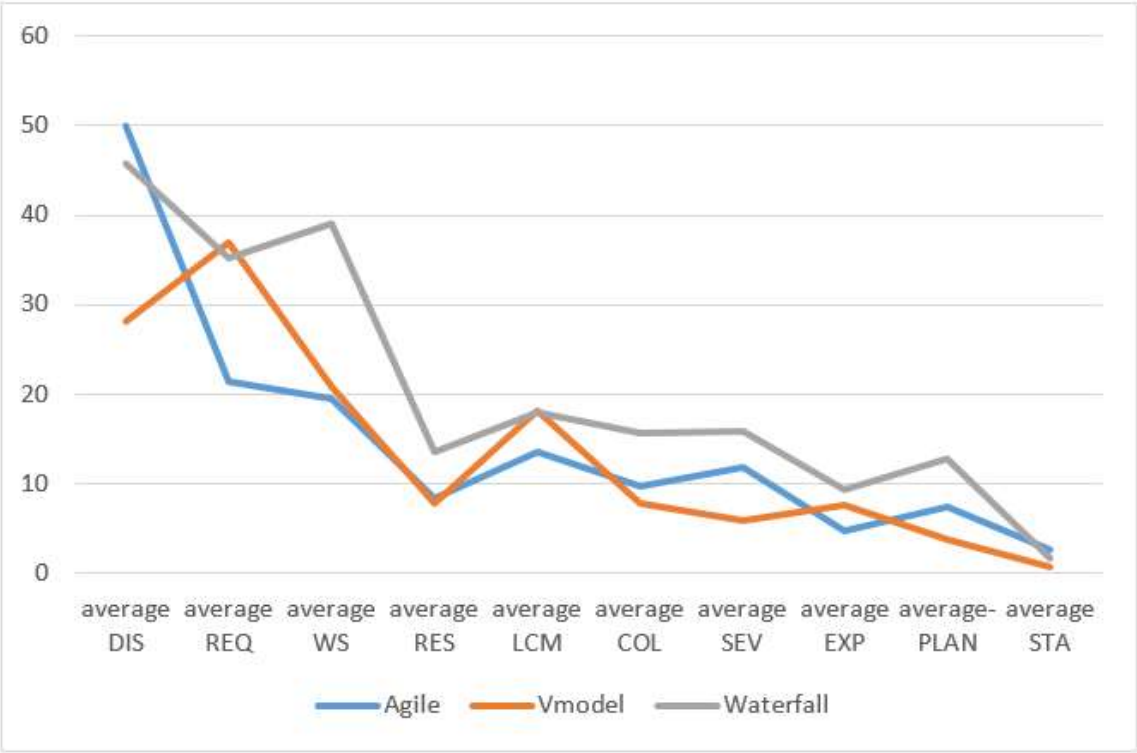


Figure 21. Average from total amount of works in project by implementation type.

As it can be seen the analysis activities in average differ throughout projects, in size, however overall ratios remain similar. Most notable part is, that by differentiating requirement analysis and design it is visible, that while classic and heavy methods like waterfall and V-model rely in similar way on requirement analysis, while agile methodology has less focus on requirement and more focus on design.

The low volume of strategic analysis performed during COTS ERP is related to nature of data set. In most cases major strategic analysis is completed before decision is taken to implement or customize ERP system.

5. Related work

As Paul [28] states, there is lack of empirical research in field of infosystem business analysis. However, there are certain aspects of research that have been part in several studies.

As Paul describes on her thesis [28], the role of business analysis in informational system development is rather new discipline, whereas other practices, such as project management, systems analysis, consultation and development are subjects of extensive research. Business analysis itself is field that is studied in several occasions, however the information systems part is not extensively articulated. It is insisted, that during last two decades infosystem related business analysis has multiplied to almost entire workload if business analyst.

British Computer Society defines *„Business analysis brings a balanced understanding of requirements and delivery capabilities allowing for sharper decision making and improved business processes. As a result, the role of the business analyst has become absolutely critical to successful transformation and business growth* [28]. IIBA's definition states that *„Business analysis is the practice of enabling change in an enterprise by defining needs and recommending solutions that deliver value to stakeholders. Business analysis enables an enterprise to articulate needs and the rationale for change, and to design and describe solutions that can deliver value (IIBA, 2015)"* [28] However Paul points out, that both authorized bodies definitions of business analyst's role is quite ambiguous and offer a level of abstraction that could describe any role in software project.

As addition in Larson and Larson [36] paper it is speculated, that role itself does not have to be described in detail. Their view is that despite of project manager and business analyst cover similar areas and compliment on each other's work, the tasks performed are still different in certain degree. That aspect is supported by Milani's [4], statement, that business analysis is set of activities as a role, regardless of person who performs it.

Despite of fact, that all these works are oriented for defining business analysis activities, none of these works cover amount of effort put in business analysis in comparison with measurable result on project outcome.

The main aspect of business analysis during implementation is requirement analysis, since it is directly in domain of business analyst [28] that is sufficiently researched.

Daneva and Wieringa [37] have created a cross organizational solution for ERP implementation, which is strictly based on issues that can address assumptions and prevent potential mismatches during requirement engineering. W. Rosa et al [30] have taken a step further and have conducted major quantitave experiment, comparing 20 different implementations in to create estimation models based on complexity of implementation. Paper concluded, that important effort factors during implementation are types of requirements and area of business over number of users or number of facilities. Vilpola [38] has looked in detail to other domains during ERP-s implementation, that cover user approach, none of the studies however does not cover detailed overview of activities performed on business analysis.

COTS ERP implementation and estimation is in detailed covered in several published case studies and experiments. Vilpola [38] has stated, that any COTS ERP can satisfy any customers requirement by using user based approach, with main aspect of matching system's functionalities to user requirements. In paper Customer Centered ERP implementation method was developed and tested. However the work does not cover all activities of business analyst.

A Al-Mudimigh et al [39] during explanation of overall ERP implementation framework notes on several occasions, that most important part of project is consultant, who has in depth knowledge of implemented system. Importance of consultant is also mentioned by Wong et al [6] in context of 14 identified critical failure factors. In depth most of problems raised by above mentioned works can be solved by conducting business analysis activities in higher amount or better quality. Somers and Nelson [23] have also listed several success factors on ERP implementation, however there is little info about business analysis activities role or impact of business analysis in field of ERP implementation.

6. Conclusions

During the research business analysis activities during COTS ERP implementation was compared with other infosystem management, training, configuration, modification and extension works to find areas where business analysis makes an important difference. The raw data was extracted from databases, modified with text mining to clean and categorize observations for finding relevant information that can be used.

Several authors have stated that business analysis has very important role in infosystem development and implementation, however the measure impact itself is not identified. This case study does not make impact in field of infosystem business analysis, however it provides sufficient proof, that business analysis activities are related on outcome of COTS ERP projects. Most business process changes require exquisite elicitation in order to keep the project cost down and provide best possible results, however since there are identifiable CSF-s or scope gathered, it is not possible to compare all aspects of project outcome with business analysis activities. Extended duration of project and quality of works can be tracked to business analysis activities, however the relation of business analysis to success factors is beyond the scope.

Relevant outcome is of business analysis activities ratio to other types of works in different implementation methods. It should be noted, that majority of projects have business analysis performed in background, so it may not be visible to customer and perhaps in some cases even to person performing analysis. Deeper insight on business is considered elementary, however the amount of time spent on analysis defines details it and can be well rewarded in latter stage of implementation.

It is possible to conclude, that business analysis differs in each implementation method and project type and mix of activities should be used to get best result. It can also be concluded, that while more time spent on business analysis does provide better suited solution with higher quality it does not affect customer satisfaction or prevent complexity based delays in overall project life-cycle.

6.1 Future Work

In order to confirm applicability of findings in this paper, the analysis should be repeated with datasets from other similar companies and products. After sufficient detailed analysis has been made it is possible to look at more detail level of business analysis impact on ERP implementation. It would be useful to measure detailed impact of each of the business analyst tasks in different implementation methods to find indication if there is a possibility for finding optimal time for business analysis activities in different projects based on several companies data.

Also additional qualitative case study would be made to get detailed overview on overall satisfaction of customer. Current satisfaction index gives overall satisfaction of individual, however it does not reflect effect on company. To measure effect on business analysis on client's each implementation should be measured by overall performance with KPI's years following implementation or to be compared with prepared CSF-s during projects.

Another area that needs further study is determining the reason behind analysis works relation to prolonged duration and delay in end date on projects. This study indicates, that more business analysis will lead to slightly higher delay in project delivery and thereby affect also duration.

7. References

[1]	Federal Acquisition Regulations System 2002, https://www.govinfo.gov/app/details/CFR-2018-title48-vol1/CFR-2018-title48-vol1-sec12-103
[2]	Panorama Consulting Group, 2009 https://www.panorama-consulting.com/erp-system-vs-best-of-breed-software (01.08.2019)
[3]	Minkiewicz, A. Six Steps to a Successful COTS Implementation. *Software Engineering Technology.* 2005, August, pg 17-21.
[4]	Milani, Fredrik. Digital Business Analysis. Switzerland, Cham: Springer. 2019.
[5]	Prasad Bingi , Maneesh K. Sharma & Jayanth K. Godla (1999) Critical Issues Affecting an ERP Implementation, Information Systems Management, 16:3, 7-14, DOI: 10.1201/1078/43197.16.3.19990601/31310.2
[6]	Wong, Ada; Scarbrough, Harry; Chau, Patrick; and Davison, Robert, Critical Failure Factors in ERP Implementation (2005).PACIS 2005 Proceedings. 40. http://aisel.aisnet.org/pacis2005/40
[7]	Abas ERP. https://abas-erp.com/en/news/7-reasons-erp-projects-fail-avoid-pitfalls (01.08.2019)
[8]	Nawaz, Nishad & Phil, M. (2013). The Impact of Enterprise Resource Planning (ERP) Systems Implementation on Business Performance.
[9]	Rishal Hurbans, To prototype or not to prototype: that is the question. 2017. https://www.freecodecamp.org/news/to-prototype-or-not-to-prototype-that-is-the-question-2f85c8cde2b/ (01.08.2019)
[10]	Brooks, Frederick P. The Mythical Man-Month : Essays on Software Engineering. Addison Wesley Longman. USA, Boston: Addison-Wesley Longman Publishing Co.. 2002.
[11]	Rajan, Christy & Baral, Rupashree. (2015). Adoption of ERP system: An empirical study of factors influencing the usage of ERP and its impact on end user. IIMB Management Review. 2011. 10.1016/j.iimb.2015.04.008.
[12]	Businessanalystlearnings.com. https://businessanalystlearnings.com/blog/2016/12/3/importance-of-documentation-on-software-projects (01.08.2019)
[13]	IIBA, BABOK v3 A Guide to the Business Analysis Body of Knowledge. Canada, Toronto: IIBA. 2015.
[14]	Courtney P. Red Flags in Your ERP Implementation Process – How to Spot and Fix Them. 2018. https://www.workwisellc.com/blog/red-flags-erp-implementation-process-spot-fix (01.08.2019)
[15]	Josh S. Top 10 Responsibilities of a Business Analyst. 2017. https://www.zarantech.com/blog/top-10-responsibilities-business-analyst (14.08.2019)

[16]	Kaupp G. Five Things a Business Analyst Is (and Isn't) in an ERP Project. 2013. https://www.erpsoftwareblog.com/2013/05/five-things-a-business-analyst-is-and-isnt-in-an-erp-project (14.08.2019)
[17]	Businessdictionary.com, http://www.businessdictionary.com/definition/resource.html
[18]	Wood B. ERP vs. ERP II vs. ERP III Future Enterprise Applications. 2010. https://www.r3now.com/erp-vs-erp-ii-vs-erp-iii-future-enterprise-applications (01.08.2019)
[19]	WalkMe Team. 2017. https://blog.walkme.com/5-types-of-organizational-change/ (04.08.2019)
[20]	Somers, Toni & Nelson, K. (2001). The Impact of Critical Success Factors across the Stages of Enterprise Resource Planning Implementations. Hawaii International Conference on System Sciences. 8. 8016. 10.1109/HICSS.2001.927129.
[21]	Abas ERP. https://abas-erp.com/en/news/optimal-erp-requirements-document (21.07.2019)
[22]	Gartner. https://www.gartner.com/it-glossary/postmodern-erp (14.08.2019)
[23]	Janssens G. Understanding complexity of ERP implementations: Exploration of three complexity research approaches. Open Universitet, Doctor's Thesis. 2017
[24]	Royce W. Managing the Development of Large Software Systems. IEEE WESCON: USA, Los Angeles 1970
[25]	Ghahrai A. V Model. 2018. https://www.testingexcellence.com/v-model-in-software-testing/ (01.08.2019)
[26]	Paulk, Mark. (2012). Agile Methodologies and Process Discipline," Crosstalk.
[27]	Runeson, P. & Höst, M. Empir Software Eng (2009) 14: 131. https://doi.org/10.1007/s10664-008-9102-8
[28]	Debra, P. Defining the role of the business analyst: The Business Analysis Service Framework. HENLEY BUSINESS SCHOOL Doctor's Thesis. 2018.
[29]	Yin R. K. Case study research. Design and methods, 3rd edn. London, Sage. 2003
[30]	Rosa, Wilson & Packard, Travis & Krupanand, Abishek & W. Bilbro, James & M. Hodal, Max. (2013). COTS integration and estimation for ERP. Journal of Systems and Software. 86. 538–550. 10.1016/j.jss.2012.09.030.
[31]	BCS Itera www.itera.ee (20.07.2019)
[32]	Microsoft.com. https://dynamics.microsoft.com/en-us/nav-overview/ (20.07.2019)
[33]	Msdynamicsworld.com. https://msdynamicsworld.com/vendor-directory (14.08.2019)
[34]	W. M. P. van der Aalst and S. Dustdar, "Process Mining Put into Context," in IEEE Internet Computing, vol. 16, no. 1, pp. 82-86, Jan.-Feb. 2012.doi: 10.1109/MIC.2012.12

[35]	Fluxicon. https://fluxicon.com/disco (14.08.2019)
[36]	Larson, E. & Larson, R. (2010). Project manager and business analyst: are they one or two roles? Paper presented at PMI® Global Congress 2010—North America, Washington, DC. Newtown Square, PA: Project Management Institute.
[37]	Daneva, Maya & Wieringa, Roel. (2008). Cost estimation for cross-organizational ERP projects: Research perspectives. Software Quality Journal. 16. 459-481. 10.1007/s11219-008-9045-8.
[38]	Vilpola I. Applying User-Centred Design in ERP Implementation, Requirements Analysis. Tampere University of Technology, Doctos's Thesis. 2008
[39]	A Al-Mudimigh, M Zairi & M Al-Mashari (2001) ERP software implementation: an integrative framework, European Journal of Information Systems, 10:4, 216-226, DOI: 10.1057/ palgrave.ejis.3000406

Appendix 1 – Data description and Analysis overview

#1 Extracted data original field description overview in sets:

Data extracted from helpdesk

Label	***Name***	***Description***	***Usage in work***
Nr	*Number*	*Unique identifier of task line*	*Used to check integrity*
Prob	*Issue*	*Unique identifier of task*	*Used to aggregate data*
Project (NAV)	*Project number 1*	*Identifier for after 2013 projects*	*Used to identify project*
Project(K)	*Project number 2*	*Identifier of pre 2013 projects*	*Used to identify project*
Arendus	*Development*	*Identifier of development*	*Not used*
Teostaja	*Performer*	*Name of person conducting work*	*Not used*
Teostaja kood	*Performer code*	*Code for person*	*Not used*
Haldur	*Manager*	*Name of person responsible for project*	*Not used*
Klient	*Client*	*Name of client*	*Used to aggregate data and identify satisfaction*
Rea ID	*Line ID*	*Unique identifier of line*	*Used as identifier for observation*
Töö kuupäev	*Date of work*	*Date on which wask was done*	*Used to identify processes and delay*
Töö kood	*Work code*	*Code marked for work*	*Used to identify, test and calculate main tasks*
Töö sisu	*Work description*	*Description of work done*	*Used to identify actual type of work*
Töö	*Worn name*	*Description of task*	*Used to identify actual type of work*
Tegelik aeg	*Acutal time*	*Time marked for completing task*	*Used to calculate time spent*
Kokkuleppeaeg	*Agreed time*	*Time agreed to be spent on task*	*Used to calculate differences between*

			planned and actual time on task an project level
Kordaja	*Multiplier*	*Coefficient for work (in out of office hours etc)*	*Not used*
Kogus	*Amount*	*Amount of work invoiced*	*Not used*
Hind	*Price*	*Price of hour*	*Not used*
Summa	*Sum*	*Total sum invoiced*	*Not used*
Arve	*Invoice*	*Indicator of invoicing (yes/no)*	*Partially used to test amounts of work*
Arve rida	*Invoice line*	*Identifier of invoice line*	*Not used*
Aeg	*Time*	*Date of completion*	*Partially used in reference to satisfaction*

#2 Projects data extracted from ERP

Label	*Name*	*Description*	*Usage in work*
Nr.	*Number*	*Unique number of project*	*Used to compare projects*
Kirjeldus	*Description*	*Description of project*	*Used to identify project type and tasks*
Märkuse kp	*Comment date*	*Date of comment*	*Not used*
Maksja nimi	*Client*	*Name of client*	*Used to identify solutions*
Märkus	*Comment*	*Comments about project*	*Partially used to identify project*
Maksja kontakt	*Client representative*	*Name of represenative*	*Not used*
Projektijuht	*Project manager*	*Code of responsible person*	*Partially used for identification*
Alguskuupäev	*Start date*	*Estimated start date of project*	*Partially used to calculate delay*
Lõppkuupäev	*End date*	*Estimated end date of project*	*Used to calculate delay*
TIIM	*Team*	*Team responsible*	*Not used*

Valdkond	*Area*	*Type of field area*	*Partially used to identify project*
Prioriteet	*Priority*	*Priority of project*	*Not used*
Tüüp	*Type*	*Type of project*	*Partially used to identify project*
Eelarveline maksumus	*Estimated cost*	*Estimation of project budget*	*Not used*
Olek	*Status*	*Status of project*	*Partially used to identify project*
Põhjus	*Reason*	*Reason for gain/lose project in sales*	*Not used*

#3 Cleaned and modified initial dataset for project

Column name	*Descriprion*	*Values*
project code	*Unique identifier of project*	*Random code*
project type	*Type of implementation project; not present in extracted dataset. Categorization is based on project description.*	*New implementation* *Maintenance /support* *Business requirement change* *Platform upgrade*
Implementation methodology	*method, that is chosen to implement or customize solution. Implemetation methology was added to extracted dataset based on project activities.*	*Waterfall* *V-model (or any similar combined method between* *waterfall and agile)* *Agile*
price of h	*sum of task and sum of requirement can be calculated if needed*	

Implementation type	*Not in initial dataset, implementation type was added based on solution*	*Full implementation* *ICV (ERP is accompanied by specialized modules for business line, making it simpler to implement); partial* *(some activities, such as CRM or POS etc) is implemented to other system and interfaced,* *postmodernERP (ERP is core of infosystem and best of breed software is implemented to back it up)*
Start date		
End date		
Client		
Manager		

#4 Modified final task data set fields Task data:

Column name	*Descriprion*	*Values*
task nr	*Unique identifier of task*	
Actual time	*Time spent on task*	
job nr	*Unique identifier for job (in project each job represents set of activities or separate requirement)*	
agreed time	*Time agreed on filling the requirement*	
client code	*Each code corresponds to individual solution*	
performer code	*Each person is given separate code*	
managers code-	*Each client or project has single manager appointed*	
Date performed	*Time task was performed*	*DD-MM-YYYY format date*
Time completed	*Job completed*	*MM-YYYY format date*
Invoiced		*Y/N*

Task type	*Each job is recorded in helpdesk system as category.* *Inital dataset was reviewed based on*	*PM (project management);* *ANA (analysis; including business analysis);* *CON (consultation of client,* *change of setup etc)* *DEV(development);* *GAR (warranty – development of setup, that did not meet* *requirement);* *SISE (additional time spent on task, that is not covered by* *customer) TUGI (support);* *EDU (training of clients);*
BA task type	*Business analytics/Analyst tasks are divided to major groups of activities. Since there is not sufficient information about detailed activities such as time spent on elicitation with* *stakeholders etc it is easier to divide info into larger groups based on core activities.*	*Planning-* ***PLAN*** ***RES*** *– research and information gathering.* ***WS****- workshops with client.* ***EXP*** *- prototyping.* ***COL*** *- Collaboration.* ***LCM*** *-Life-cycle management* ***STA*** *-Strategic analysis –* ***REQ -*** *Requirement* ***DIS -*** *Design* ***-*** ***SEV -****Solution evaluation, testing*

#5 Customer satisfaction details

Given score is recalculated to eliminate impact unmotivated answers (score 10 out of 10 without comment is recalculated to 6,5). All comments are classified as 1- poor, 2- could be better, 3- ok, 4- great, 5- excellent.

In case no comments are provided it is assumed, that overall feedback reflects all aspects (1-3 is considered to be 1, 4-6 is considered to be 2, 7-8 is considered 3 and 9-10 is considered to be great - 4; excellent will be considered only if positive comment is provided).

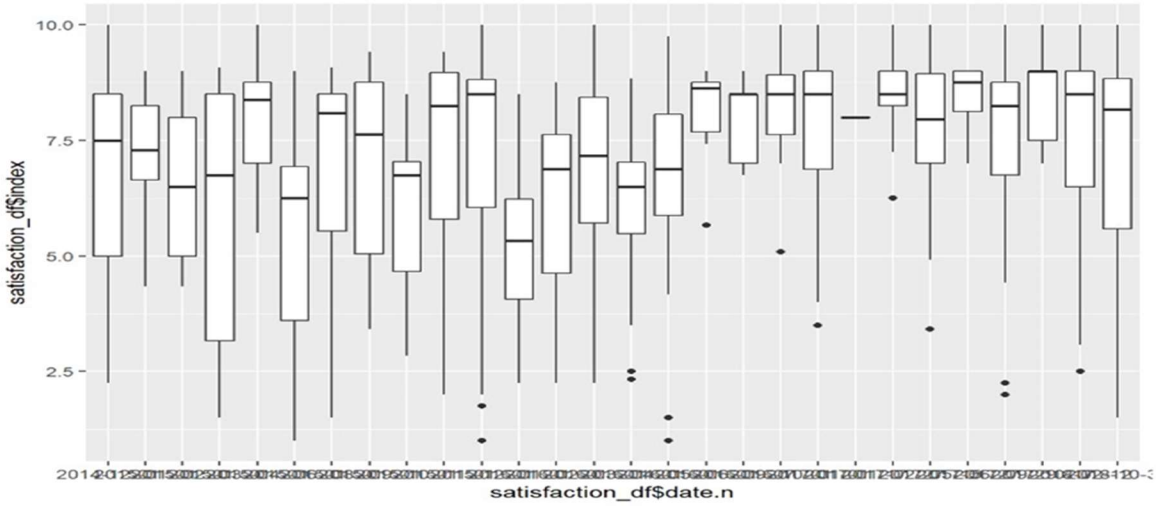


Figure 1. Overall satisfaction over period of time

Recomendation	Experience	Index	Personell	Process	Result
Min. : 0.000	Min. : 0.000	Min. : 1.000	Min. :1.0	Min. :1.00	Min. :1.000
1st Qu.: 7.000	1st Qu.: 7.000	1st Qu.: 6.062	1st Qu.:3.0	1st Qu.:2.00	1st Qu.:3.000
Median : 8.000	Median : 8.000	Median : 7.417	Median :4.0	Median :3.50	Median :4.000
Mean : 7.502	Mean : 7.514	Mean : 7.057	Mean :3.5	Mean :3.18	Mean :3.266
3rd Qu.: 9.000	3rd Qu.: 9.000	3rd Qu.: 8.604	3rd Qu.:4.0	3rd Qu.:4.00	3rd Qu.:4.000
Max. :10.000	Max. :10.000	Max. :10.000	Max. :5.0	Max. :5.00	Max. :5.000

Due to scewness of data set projects over 1500 hours were eliminated. Resulted overall index of satisfaction based on project side is presented in Figure2.

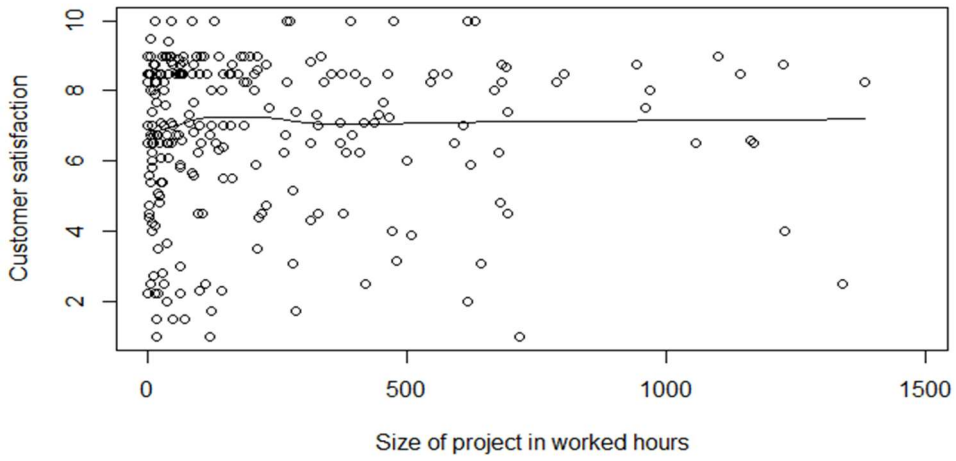


Figure 2. Customer satisfaction index in relevance to project size

As it can be seen from **Figure above**, the satisfaction varies strongly despite of size of overall project. In order to test if there is link between business analyses conducted same data was used with time spent on business analysis (**Figure 3**) and of overall ratio of business analysis work to total hours spent on project (**Figure 4**).

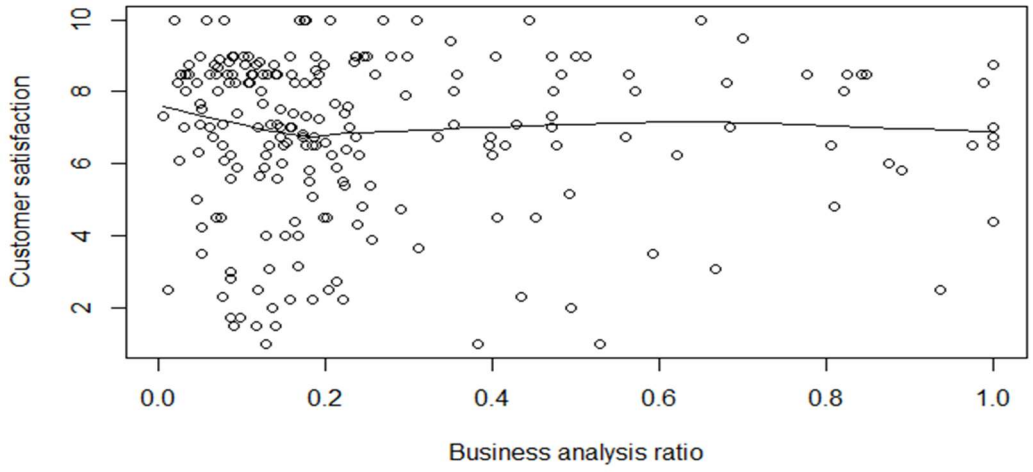


Figure 3. Customer satisfaction in relation to business analysis ratio

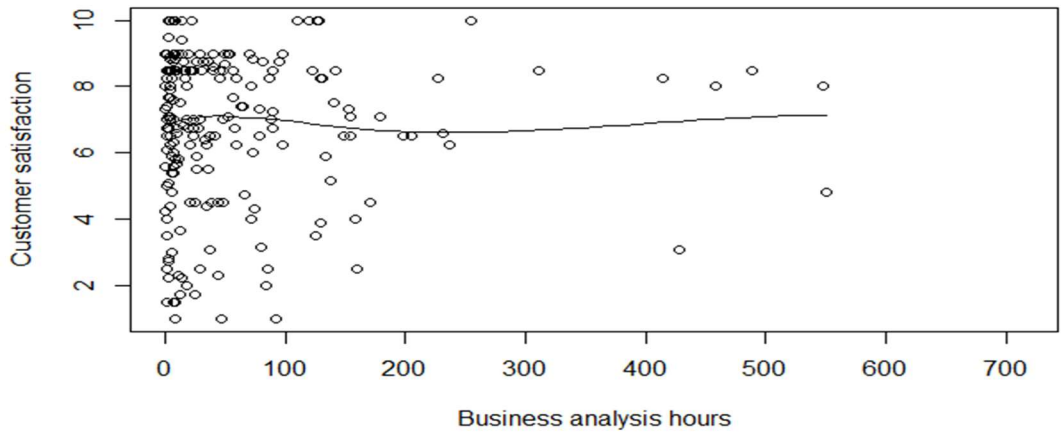


Figure 4. Customer satisfaction in relation to business analysis ratio

Based on observations there seems no significant difference between project size or business analysis regardless of time spent.

#6 Measures

*Tables are displayed as **five-number summary** from R function Summary*

During proccess analysis data was divided to 4 different category based on listed evaluation using quartile distribution and business analysis activities are divided to datasets.

After initial dividing resulted dataset was applied additionally to Projects to compare ratios and works, that were labelled warranty.

Measure	*Ratio of warranty works performed in projects by quantile of Business Analysis*					
Description	*Each project has one or more issues, that has to be redone (misunderstood requirement, insufficient testing, mistakes in code ect) during or after go-live.* *Projects with no warranty works are disgarded.*					
Presence of BA	*Min.*	*1st Qu.*	*Median*	*Mean*	*3rd Qu.*	*Max.*
Q1_warranty_h	*0.5*	*1*	*3.75*	*20.79*	*13*	*302*
Q2_warranty_h	*0.5*	*2*	*6*	*23.39*	*17.5*	*403.5*
Q3_warranty_h	*0.25*	*1.75*	*5.5*	*16.46*	*15*	*97.75*
Q4_warranty_h	*0.5*	*1*	*2*	*2.89*	*4.19*	*8*
Measure ana_gar_r	*Ratio of analysis work compared to warranty works performed in projects by quantile of Business Analysis .*					
Description	*Measure is obtained by dividing all hours of Business Analysis to total hr of warranty works*					
Quantile of BA	*Min.*	*1st Qu.*	*Median*	*Mean*	*3rd Qu.*	*Max.*
Q1	*0.07*	*1.22*	*3.4*	*9.28*	*10.98*	*93*
Q2	*0.44*	*3.92*	*9.63*	*18.78*	*19.32*	*260*
Q3	*1.13*	*5.84*	*20.61*	*33.95*	*34.74*	*274.33*
Q4	*4.12*	*9.7*	*40.04*	*126.22*	*151.75*	*951.25*

To get results on customer satisfaction following results were revieved.

Measure satisfaction index	*Customer satisfaction responses (440 observations on projects) were divided to quantiles based on index of answers:*					
Description	*Index of given responses on set of quantiles thereby dividing set to four*					
Quantile of score	*Min.*	*1st Qu.*	*Median*	*Mean*	*3rd Qu.*	*Max.*
Q1	*1*	*2.77*	*4.42*	*4.01*	*5.17*	*6*
Q2	*6.08*	*6.5*	*6.75*	*6.77*	*7*	*7.33*
Q3	*7.42*	*8*	*8.38*	*8.25*	*8.5*	*8.58*
Q4	*8.67*	*8.83*	*9*	*9.17*	*9.42*	*10*

To get better overview additional business anaysis ratios were created inside each quantile projects

Measure ratio_q1$ana_tot_r	*Hours of analysis performed divided by total hr of project*						
Description	*Ratio of analysis to total work compared in satisfaction quantiles. Normalized by 100*						
Quantile of score	*Min.*	*1st Qu.*	*Median*	*Mean*	*3rd Qu.*	*Max.*	*NA's*
Q1	*1,12*	*11,64*	*16,4*	*24,19*	*24,49*	*100*	*7*
Q2	*0,61*	*11,9*	*16,31*	*25,83*	*29,19*	*100*	*7*
Q3	*2,24*	*9,26*	*14,23*	*24,05*	*25,18*	*98,8*	*9*
Q4	*1,96*	*9,4*	*16,1*	*22,84*	*26*	*100*	*8*
Measure ratio_q1$ ana_dev_r	*Hours of analysis performed divided by time spent on developments of project*						
Description	*Ratio of analysis to development compared in satisfaction quantiles.*						
Quantile of score	*Min.*	*1st Qu.*	*Median*	*Mean*	*3rd Qu.*	*Max.*	*NA's*
Q1	*0.09*	*0.39*	*0.82*	*3.96*	*1.27*	*125*	*21*
Q2	*0.05*	*0.34*	*0.81*	*3.15*	*1.26*	*118.63*	*20*
Q3	*0.05*	*0.26*	*0.66*	*2.78*	*1.33*	*68.5*	*23*
Q4	*0.07*	*0.34*	*0.59*	*1.42*	*1.24*	*22.13*	*21*
Observation	*Combined with last measure this shows correlated view on business analysis and development. The two tables combined show, that customer satisfaction is not related to amount of business analysis,.*						
Measure ratio_q1$ANA	*Total hours of business analysis performed by project*						
Description	*Total amount of analysis in satisfaction quantiles.*						
Quantile of score	*Min.*	*1st Qu.*	*Median*	*Mean*	*3rd Qu.*	*Max.*	*NA's*
Q1	*0.5*	*7*	*35.25*	*100.74*	*125*	*951.25*	*7*
Q2	*0.5*	*6.5*	*31.25*	*99.59*	*131.88*	*1711*	*7*
Q3	*0.5*	*9.13*	*40.75*	*127.46*	*126.75*	*1711*	*9*
Q4	*0.5*	*12.5*	*46*	*131.3*	*127.6*	*1711*	*8*
Observation	*Combined with last two measures it is possible to conclude, that based on nature of survey data collection, customer satisfaction is not related to business analysis performed.*						
Importance							

To test if there are changes in different ratios, the BA activity set was applied to project task and projects were divided to quartiles and tested against quantiles of satisfaction.

7 Time comparison

To compare agreed time with actual time spent dataset was modified to summarize all time spent on task with relation to project. Since time agreed is marked on issue (requirement) level, in first order the quantiles were applied to task level dataset.

After quantile description was added, all observations actual time were summarized to issue level, since agreed time is set on issue level. After that all duplicate issue numbers were eliminated from dataset and not nessesary fields were removed.

Then all data was aggregated to project level by summarizing all work time actually performed and all time agreed and additional ratio was added. Choosen ratio was actual time spent compared to time agreed. Since number of issues are without agreed time, this ratio allows to get best insight on project level overall performance.

Results of different sets were as:

Quantile	*Min*	*1st Q*	*median*	*mean*	*3rd*	*max*	*comments*
1Q ANA	*0.42*	*1.31*	*2.2*	*13.99*	*10.42*	*336*	
2Q ANA	*0.45*	*1.95*	*4.06*	*15.1*	*10.42*	*482.75*	
3Q ANA	*0.56*	*1.69*	*3.46*	*11.65*	*8.01*	*510.25*	
4Q ANA	*0.23*	*1.26*	*2.47*	*6.35*	*5.01*	*85.5*	

#8 Warranty works:

After initial dividing resulted dataset was applied additionally to Projects to compare ratios and works that were labeled warranty.

Presence of BA	*Min.*	*1st Qu.*	*Median*	*Mean*	*3rd Qu.*	*Max.*
Q1_warranty_h	*0.5*	*1*	*3.75*	*20.79*	*13*	*302*
Q2_warranty_h	*0.5*	*2*	*6*	*23.39*	*17.5*	*403.5*
Q3_warranty_h	*0.25*	*1.75*	*5.5*	*16.46*	*15*	*97.75*
Q4_warranty_h	*0.5*	*1*	*2*	*2.89*	*4.19*	*8*
No BA warranty	*0.25*	*0.75*	*1.5*	*4.07*	*3.5*	*20.5*

P-values were calculated as follows:

data: Q1 and Q2

df = 111, p-value = 0.08265

data: Q1$and Q3

df = 101, p-value = 0.002728

data: Q1 and Q4

df = 64, p-value = 0.0006028

data: Q2 nd Q3

df = 118, p-value = 0.06721

data: Q2 and Q4

df = 81, p-value = 0.0003593

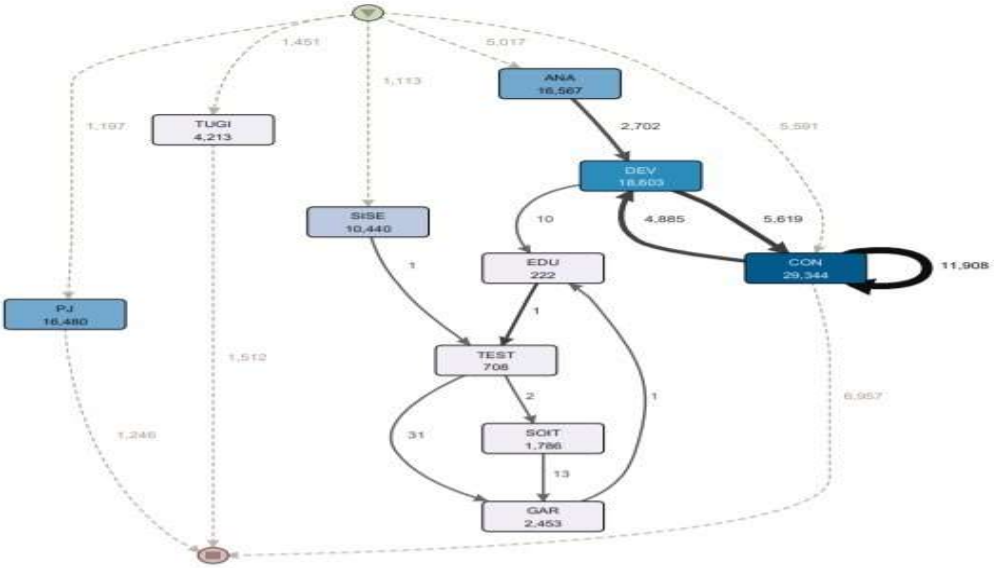
Q3 and Q4

df = 71, p-value = 0.006116

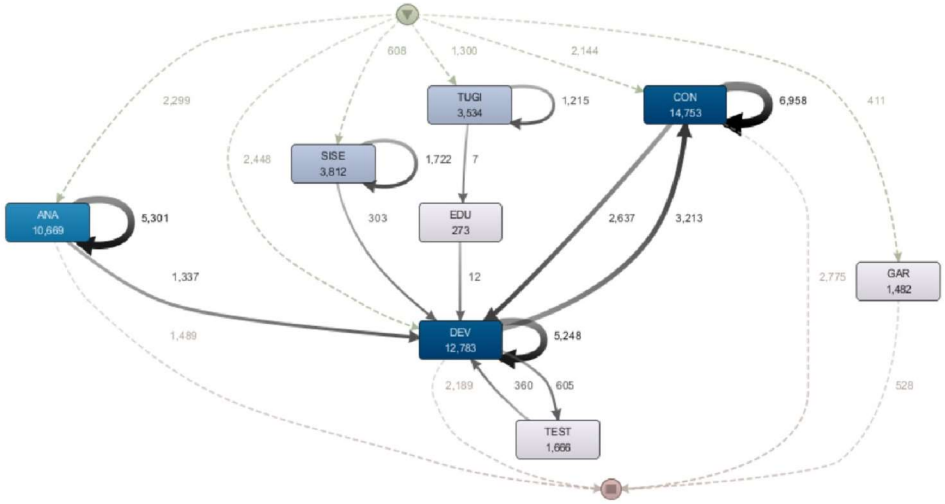
#9 Process mining has purpose of finding actual processes based on logs. In thesis differences between methods were presented. Since all different types of projects, implementation methodologies and implementation types were extracted to separate datasets using R and exported in csv format.

Here are presented project types process charts, that are not relevant to thesis.

Mining result 80% on maintenance

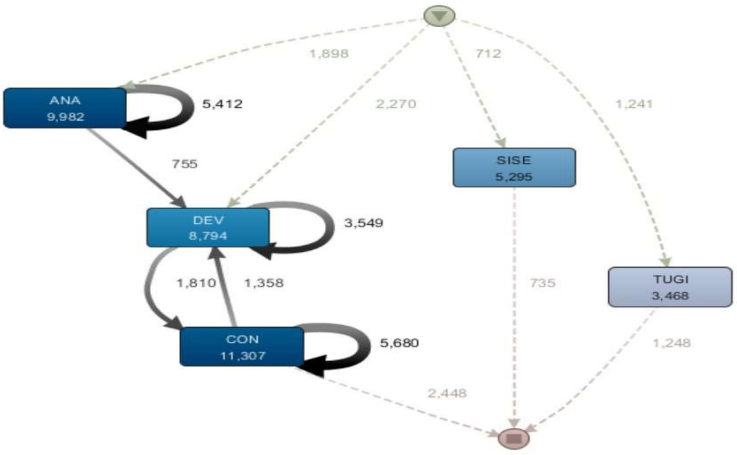


Mining result on Business Proccess Change -> process starts with analysis that is usually separated on different task, after analysis is completed, new task is created, where testing is recorded.



Mining result on new implementations-> it is identifiable, that the process starts with analysis, then moves to development and after that to consultant. In 80% level the main process remains similar.

Process was also tested in each quantile of BA activities, but it remained still the same.



#10 Implementation style based differences in satisfaction and delay

	Satisfaction		Delay	
	mean	median	mean	median
Waterfall	6.72	7	195	96
Agile	7.26	8	221	94
V-Model	6.53	7	171	56

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13/08/2019