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BENEFITS AND CHALLENGES OF USING CLOUD-BASED TOOLS TO SUPPORT SOFTWARE DEVELOPMENT PROJECTS

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ABSTRACT

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The goal of this work is to understand better how companies use cloud technology to support their software development. The analysis of six IT projects, collected from five companies in St. Petersburg, was performed. A list of various cloud-based tools, which used by companies to support the software development project activities, was studied. The factors influencing the cloud-based tools adaptation within the software development projects were highlighted. Moreover, based on gathered data, the benefits and challenges of cloud-based tools usage in software development projects were described. Also, the framework of companies’ behaviour and cloud-based tools adoption was proposed. The results obtained in this work can be used by companies in order to create a set of cloud-based tools for conducting their software development projects.
РЕЗЮМЕ

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Ключевые слова: облачные вычисления, облачные сервисы, облачные инструменты, проекты разработки программного обеспечения, команда проекта, управление проектами, контекстный интеллект, поведение компании

Целью данной работы является изучение и анализ использования облачных технологий различными компаниями для поддержки деятельности в проектах по разработке и внедрению программного обеспечения. Был произведен анализ данных шести проектов в пяти компаниях Санкт-Петербурга. Были отмечены факторы, влияющие на адаптацию облачных инструментов в рамках проектов разработки программного обеспечения. Кроме того, на основе собранных данных были описаны преимущества и проблемы использования облачных инструментов в проектах разработки программного обеспечения. Также был предложен фреймворк на основе поведения компаний и внедрения облачных инструментов. Результаты, полученные в данной работе, могут быть использованы компаниями для создания набора облачных инструментов для ведения проектов по разработке программного обеспечения.
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LIST OF SYMBOLS AND ABBREVIATIONS

IT – Information Technology
RQ – Research Question
IaaS – Infrastructure-as-a-Service
PaaS – Platform-as-a-Service
SaaS – Software-as-a-Service
API – Application Programming Interface
SRM – Supplier Relationship Management
TQM – Total Quality Management
CI – Contextual Intelligence
1 INTRODUCTION

Today the world is continuously changing. Science, society and business tend to be more and more global. The companies become international and geographically distributed, while seeking for the sustainable development on the same efficiency level as if they were collocated. The companies, which run the software development projects are facing the same globalization and internationalization tendencies, moving their business to the considerably new level, which requires outsourcing specialists from all over the world and high efficiency of new-formed distributed teams (Eckstein, 2013).

The use of different tools by software development teams have been considered as an important factor for the team efficiency over the past few year and there is vast amount of stand-alone (desktop) software to support all the range of project activities (Kelter et al., 2002). However this type of tools becomes less and less compatible to catch up with the speed of growing number of companies’ needs in alignment with business globalization. The possibility of distributing data and tools through Internet is increasingly important aspect in modern conditions (Bompani et al., 2000).

The first ideas of how to distribute services and tools via the Internet have emerged in early 1960s, when the society’s growing needs boost up the development and introduction of the term “cloud” (Jadeja and Modi, 2012). Cloud computing is a type of internet-based computing, that provides shared computer processing resources and data between devices on demand (Buyya et al., 2010). Cloud technology represents data storage and processing environment that combines hardware, licensed software, communication channels, and technical support for users (Mell and Grance, 2009). It denotes a model, on which a computer infrastructure is viewed as a “cloud”, from which businesses and individuals access applications from anywhere in the world on demand.

The importance of cloud computing is dictated not only by the possibility of remote access from any part of the world to the team resources, but also by the increasing of data processing speed and refusal of a large volume of company’s physical resources (Ju et al., 2010). Moreover, the previous studies highlight that cloud services are likely to become a solution for many modern business challenges, as they have a number of advantages and
opportunities. Among those there are: no need for software or hardware depending on the cloud technology type, possibility of combination with different software solutions existing in the company, highly customizable environment, simple deployment and easy access (Jain and Rani, 2012). The latest research also state that cloud-based tools can enhance the speed of software development, maximize the product quality and its value, as well as to reduce internal costs (Sajad et al., 2016).

With the rapidly growing need for cloud technologies, the big IT (Information Technology) market players, such as Google, Amazon and Microsoft have started to sell powerful, reliable and cost-efficient cloud platforms (Zhang et al., 2010) in order to meet new business needs. The table below illustrates a few examples of cloud solutions.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Vendor</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apps.gov</td>
<td>Number of vendors</td>
<td>Services for federal agencies</td>
</tr>
<tr>
<td>CareCloud</td>
<td>CareCloud</td>
<td>Electronic Health Record systems</td>
</tr>
<tr>
<td>IBM Bluemix</td>
<td>IBM</td>
<td>Development and integration platform</td>
</tr>
<tr>
<td>Amazon EBS</td>
<td>Amazon</td>
<td>Data warehouse</td>
</tr>
<tr>
<td>Amazon Athena</td>
<td>Amazon</td>
<td>Analytics tool</td>
</tr>
<tr>
<td>Amazon VPC</td>
<td>Amazon</td>
<td>Network</td>
</tr>
<tr>
<td>Google Drive</td>
<td>Google</td>
<td>Files storage</td>
</tr>
<tr>
<td>Lync</td>
<td>Microsoft</td>
<td>Tool for communication</td>
</tr>
</tbody>
</table>

The strengths of cloud-based tools and the opportunities, which they are providing, have already been acknowledged by previous researchers. Rozman and his colleagues (2017) indicated that with support of cloud the efficiency of activities within the project increased. In these cases cloud was used to support activities within the software projects, such as documentation storage, communications, planning, budgeting, remote and parallel work. In the research of Hashmi and his colleagues (2011) highlighted that the use of cloud technologies in the software development is highly beneficial. For instance, cloud solutions reduce costs because of “pay as you go” model; provide software scalability and efficiency increase. Moreover, cloud is able to cope with geographic issues, linguistic and cultural challenges, as it provides customizable and easy accessible solutions.
Despite the identified strengths of using cloud-based tools to support software development, many software development project still prefer to use stand-alone or physical tools (Azizyan et al., 2011). This finding raises the need to understand better how cloud-based tools are used, how they support the software development, and what factors may be hindering the adoption of cloud-based tools in software development projects. To this end, this study investigates the use of cloud applications in 6 software development projects.

In the study the following research question (RQ) and their sub-questions will be addressed:  

**RQ1: How do the companies use cloud-based tools to support their software development projects?**  
   a. For which activities the cloud-based tools are used?  
   b. Which cloud-based tools are used in the companies?  

**RQ2: What are the factors influencing on cloud-based tools adaptation?**  
   a. What are the benefits of using cloud technologies?  
   b. What are the challenges of using cloud technologies?

The research is structured in the following way. The chapter 2 highlights the key aspects of the previous studies in order to describe the background of cloud computing. The chapter 3 describes the chosen methodology and main steps of conducting the research, including the research methodology structure and description of the research processes. The chapter 4 provides reader with results of the research and it’s analysis, here there research questions will be answered. The next chapter represents the discussion about the results, supported by presenting the previous researches. Finally, the chapter 6 represents the conclusions and research achievements.
2 LITERATURE REVIEW

Cloud computing is a technology of distributed data processing in which computer resources, capacities and services are provided to external users on demand over the Internet (Foster et al., 2008). In order to use more detailed description of cloud technologies in current research the previous studies were addressed. In the research of Geelan (2008) different definitions, proposed by number of ICT experts, were presented. One of these experts, Reuven Cohen, defines cloud computing as “Internet centric software”, where the possibility of distributing processes through the Internet will make the software development more global and perspective. Moreover, another representative of IT world, Praising Gaw, assumes that cloud is the “concept of using the Internet to allow people to access technology-enabled services”. This is presented as highly scalable software, which allows users to use such technologies in day-to-day activities or to build complex systems. Also, according to Jeff Kaplan, the concept of cloud computing can be defined as "broad array of web-based services”. All these different definitions were used as a baseline of cloud computing determination in current research, because among all these descriptions the main characteristics can be distinguished.

In the document “The NIST Definition of Cloud Computing” of Mell and Grance (2009) distinguished following main properties of cloud technologies:

- On-demand self-service;
- Broad Network Access - the high availability of services;
- Resource pooling (examples of computing resources of the provider can be storage systems, computing power, memory, network bandwidth);
- Rapid elasticity and scalability - allocation and distribution of resources to user depending on his/her needs;
- Measured service (system automatically monitors and optimizes resources allocation based on measured service parameters: storage size, bandwidth, number of active users).

Cloud technologies have great capabilities and are able to provide a large number of services that can be used to support project activities. The current concept of cloud computing is able to provide users with the following main types of services:
• Infrastructure-as-a-Service (IaaS). Banerjee and his colleagues (2010) described that by this services the user is provided with a computer infrastructure, usually virtual platforms (computers) connected to the network, which user independently adjusts for his/her own purposes.

• Platform-as-a-Service (PaaS). According to Lawton (2008) the users of PaaS are provided with a computer platform, with the operating system and software installed. PaaS is mostly used by software developers as a development and deployment platform.

• Software-as-a-Service (SaaS). This type of service is usually referred as "software on demand", this software is deployed on remote servers and user can access it via the Internet, all issues of updating and licenses for this software are regulated by the provider of this service (Benlian and Hess, 2011).

All described models are able to support all types of software development project phases and activities. It was described by Boehm (1988) that among main phases of software development can be distinguished:

- Planning and requirements analysis.
- Modelling and software design.
- Development, implementation and maintenance.
- Testing.

Further cloud computing usage in software development phases and activities with the most popular tools examples will be presented.

**Planning and requirements analysis.** The goal of this phase is to reduce risks, schedule software development processes and to identify a set of activities, effective methods and tools necessary for successful project completion. Depending on project methodology planning can be done by Project Manager, analysing the recourses and requirements, or it can be done by project team, for example, by Planning Poker (Dvir et al., 2003). To support this activity, various tools, both desktop and cloud, can be used. But, for example, desktop Microsoft Project does not have enough flexibility to manage changes in the plan, it does not have the ability to access from mobile devices, there are no notifications on it. The use of
cloud technologies in this case will allow to be more flexible. Planning and requirements analysis can be supported by cloud-based tools, such as Trello, Gantto, Atlassian JIRA Software or other. Often the cloud-applications for planning and requirements analysis are able to visualize the tasks by means of Scrum or Kanban board, create the reports and burn down charts, track project and issues (Atlassian, 2017). Moreover, with add-ons the visual roadmaps can be planned, teams' velocity can be managed and real-time forecasts can be done. For instance, in the case described by Fisher and his colleagues (2013) JIRA was successfully used in software development project with nearly 40,000 issues. This tool helped to enhance several levels of acceptance and testing by task prioritization, origin and category description and specification of the software version this issue relates to. In order to represent daily workload in this particular project filtering and built-in dashboards were used.

**Modelling and software design.** The main goal of this phase is to analyse requirements and transform them into a prototype of the future system, to build architecture for the system, to adapt models and design to the implementation environment and to increase the level of understanding between all project stakeholders (Yu and Mylopoulos, 1994). This activity is can be supported by cloud-based tools in order to increases the speed of feedback from users and gives a possibility to work in parallel by several project team’s members. Different SaaS solutions are able to support different notations and techniques. For instance, Creately can be used to create UML diagrams (Creately, 2017). NinjaMock gives a possibility to create paper prototypes of software interfaces (NinjaMock, 2017). In Axure project team can create digital prototypes (Axure Software, 2017).

**Development and maintenance.** The main advantage of developing software based on cloud technologies is the frequent integration of changes and automated deployment. Because of this, the code is unloaded regularly and fully automatically deployed, thereby increasing the speed of software development (Aiello and Sachs, 2014). One of the most used cloud-based tools solution for software development is Windows Azure - a cloud services platform developed by Microsoft, which implements models PaaS and IaaS. It was presented by Calder and his colleagues (2011) that this platform provides the ability to develop and execute applications and store data on servers located in distributed datacentres.
Testing can be described as a finding and documenting mistakes in software, checking the software quality, validating the software functions and verifying the appropriateness of implemented requirements. Increasingly, testing takes place in the cloud, because, for example, the cloud allows to perform a mass load test. This allows groups of programmers to easily develop and test scalable applications. Also cloud technologies give a possibility for convenient versioning and switching between versions and assemblies, which speeds up the software development process (Rhoton, 2013). In the research by Alam and his colleagues (2015) testing cloud-based tools were highlighted, since more and more companies started to move their activities into the cloud. Such services as TestMaker, SoapUI, LoadUI are one of the most downloadable testing tools.

Documentation and data storage in the cloud give a possibility to project team to access to project documentation remotely, to work in parallel and, based on this, increase the level of communication and to speed up the processes. One of the most popular service for documentation and data storage is Amazon Simple Storage Service (Amazon S3), which provides the ability to store and retrieve any amount of data, at any time from anywhere in the network, the so-called file hosting (Amazon Simple Storage Service (S3), 2017). In case, presented by Nasuni (2014), the transmission of massive amount of data (12 TB) between two cloud services, derived from huge software development project, was organised. Amazon S3 showed the best rate of data recording, where the transfer of data from two other services took only 4-5 hours. Another widely used solution owned by Google is Google Drive. This is a cloud-based data warehouse, which allows users to store their data on servers in the cloud and share them with other users on the Internet (Google Drive, 2017). Here the project documentation and artefact can be stored, shared and edited. Moreover, in their study of mobile cloud storage Huang and his colleagues (2013) highlighted that Google Drive offers users convenient software for devices based on different platforms, with different interfaces and with different operational systems.

Communication and remote work. In case study, provided by Kalem and his colleagues (2013) Skype represents the most usable solution for communication in software development projects. This SaaS technology can support calls and video calls, group conferences, messaging, file’s sharing, screen sharing, translation features and other (Microsoft, 2017).
Moreover, in cases presented by Inayat and his colleagues (2013) the communication within the distributed team in software development project was also build by means of Skype.

In all described cases cloud computing makes software development projects’ activities easier, it increases the speed of development, increases its quality and assumed to be more fruitful for software development projects comparing to desktop tools.
3 METHODOLOGY

In order to design the current research, the first aspect, which needs to be addressed, is the research paradigm. Different sources state that more the software industry matures, the more it is accepted that people involved in software development processes deserve special attention (Tomayko and Hazzan, 2004). For this reason, it is essential to understand the importance of subjectivity and personal interpretation of the reality and the meaning behind it. This is particularly important in this study, because it addresses the tools usage. This research area is extremely dependent on different human aspects and the way how companies organize it needs to be investigated. The interpretive paradigm was adapted in this research, because it seeks explanation within the realm of individual consciousness and subjectivity, within the frame of reference of the participant as opposed to the observer of action (Burrell and Morgan, 2011).

The previous studies define a number of common choices for gathering the research data, which can be done by means of different approaches (Silverman and Marvasti, 2008). These approaches are categorized into quantitative, qualitative or combination of both (Saunders et al., 2009). In order to study the numeric data, the quantitative approach is commonly used, while the qualitative approach is applicable when the textual data is needed for the research. The qualitative approach was selected for data gathering and analysis by means of interviews and surveys. Qualitative approaches were considered suitable for this study, because it allows the investigation of different aspects of the field, connected with professional background and past of the interviewee, as well as to study current and future ideas. For this, the open-ended interview was formed in order to study the companies.

3.1 Data Gathering

The interview questions were designed accordingly with the research questions and aimed to highlight the aspects of running software projects, connected with tools usage and project results in order to highlight the possible relation within these aspects.
The design of the questions for the interview was organized in a spiral manner and the questions were revised several times after receiving feedback. The feedback was provided by an external reviewer with practical background and research experience. The initial approach towards the interview questions formation was based on the practical and research experience. The questions were formulated based on the listed aspects, and put in a chronological order, derived from the project activities sequence. Literature was studied mostly after the interviews and the results analysis in order to formulate scientifically-based research results and compare them with the existing knowledge of the topics. The research process is presented in the Figure 1.

All the questions were formulated as open-ended questions (Cooper and Schindler, 2014). The key motivation for this choice was the interest towards getting a vast amount of information about the companies and provoking discussion if possible. Different companies have their own definitions in scopes of analysed topics, which also came out to be a factor for choosing the open-ended questions to avoid pushing the interviewee into the frames. It will help avoid restriction on their opinions about different aspects.

The interview procedure was organized in a number of steps:

1. Contacting the company’s representative and arranging a meeting.
2. Meeting with the representative and conducting the interview, using tape recorder after asking for the permission, and writing down the notes. The interview is conducted by 2 researchers (the interview data was further used for different studies). One is responsible for tracking notes and one participates in the dialog.

Figure 1 – Research process
3. Filling the form of Data management.
4. Transcribing the interview record.
5. Analysing results by each researcher personally and further discussion of the findings.
6. Formation of the analysis document and validating it with the interviewee through email.
7. Highlighting all the challenges and concerns for future improvement of the interview questions and survey process.

The convenience sampling strategy of Marshall (1996) was adopted for choosing the companies in the current research, because of the limited timeframes and the uncertainty about companies availability at the start of this research. The following criteria were chosen to form the sample of the companies:

- The companies run IT software development projects;
- The companies are located in Saint Petersburg;
- The companies are ready to share information about their operations.

The representative of each company was asked to pick one project to discuss it in scopes of the interview. The basic information about each interview is represented in the Table 2.

<table>
<thead>
<tr>
<th>Interview number</th>
<th>Code</th>
<th>Date</th>
<th>Duration</th>
<th>Number of interviewers</th>
<th>Representative title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C1P1</td>
<td>17.02.2017</td>
<td>1:33:13</td>
<td>2</td>
<td>Developer</td>
</tr>
<tr>
<td>2</td>
<td>C2P1</td>
<td>02.03.2017</td>
<td>1:21:39</td>
<td>2</td>
<td>Business analyst</td>
</tr>
<tr>
<td>3</td>
<td>C3P1</td>
<td>07.03.2017</td>
<td>0:42:00</td>
<td>1</td>
<td>Lead business analyst</td>
</tr>
<tr>
<td>4</td>
<td>C4P1</td>
<td>09.03.2017</td>
<td>0:52:13</td>
<td>1</td>
<td>Process Orchestration, Process Integration analyst</td>
</tr>
<tr>
<td>5</td>
<td>C3P2</td>
<td>10.03.2017</td>
<td>0:41:36</td>
<td>1</td>
<td>Business analyst</td>
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<tr>
<td>6</td>
<td>C5P1</td>
<td>12.03.2017</td>
<td>1:15:00</td>
<td>1</td>
<td>Business analyst</td>
</tr>
</tbody>
</table>
3.2 Data analysis

The study was conducted using an inductive approach. Empiric data gathered from different projects was gradually investigated from interviews to the more abstract level to propose theoretical framework. This approach let the research to be more innovative and provoke new ideas, which will contribute to theory and practice in software engineering field of study (Kothari, 2004).

The research strategy, adopted for this study, is Grounded theory-like approach (Strauss and Corbin, 1967). The analysis of the results is based on data structure concept for qualitative research, adopted from Gioia and his colleagues (2013). The analysis consists of several numbers of steps and is presented on Figure 2:

- Defining the 1st-order concepts from original quotations out of the transcribed data from the 6 interviews one by one.
- Based on defined categories the 2nd-order themes are formulated. Themes are formed in order to merge extracted similarities and differences in 1st-order concepts, which concern different aspects of cloud-based tools adaptation within the analysed sample. The process of defining the 2nd-order themes is linked to the analysis of any theoretical realms, derived from the scientific literature. This step aims to investigate whether the emerging themes suggest any concepts to help in outlining any scientific findings.
- The 2nd-order themes are further aggregated into dimensions in order to generate and formulate the key finding from the gathered data, which would give the answers on the research questions.
The representation of the chosen methodology was adapted from Saunders and his colleagues (2009) and its summary can be represented by the Figure 3.

3.3 Addressing validity

In qualitative interpretative research, there is always room for diverse exegesis depending on the point of view of every party involved in the research, including readers. Wagner and his colleagues (2010) proposed that there are certain aspects, which need to be addressed carefully in order to ensure that the conclusions are plausible and defensible. The following aspects need to be considered based on the previous research:
• Credibility refers to whether the results are believable from the perspective of the subjects under investigation.
• Transferability refers to whether findings from a research sample can be transferred to a broader population or to more general theoretical propositions.
• Dependability refers to whether it is possible to replicate the study, and whether this will lead to the same results.
• Confirmability refers to the degree to which the interpretations and findings of a study can be confirmed by others.
• Applicability refers to the context in which a method should be used. Thereby, the researcher's goal and the character of the research question to be examined determine the appropriate research method (Shenton, 2004).

In order to address the indicated aspects, a number of techniques, proposed by Lincoln and Guba (1985), were adopted in scopes of the current research:

• Triangulation: Two interviews were conducted by two researchers, while there were also 4 independently conducted interviews.
• Peer debriefing: The analysis of gathered data was also carried out by three researchers and then compared and discussed to ensure the exchange of ideas. Also the external researcher participated throughout all meetings and provided his feedback on the matters.
• Referential adequacy: All interviews have been recorded and transcribed.
• Member checking: The final analysis has been presented to each interviewee in order to discuss the results.
4 RESULTS

4.1 Interviews analysis

Transcribed data from interviews was divided into quotations for further analysis. Based on these quotations the 2nd order themes were formulated. The analysis of each company is divided into 2 parts. The first part addresses the overall context of tools utilizations within specific project. The second part is dedicated to addressing the reasons for using or not using the cloud.

C1P1 Project

The project was done for large production company. The goal of the project was the SRM (Supplier Relationship Management) system development and implementation. The project was performed by internal IT department with 3 developers, where the team leader was highly experienced and professional person. According to the company’s representative, the project was admitted as successful, because most of the projects success parameters were achieved:

✓ Cost
✓ Scope
✗ Time
✓ Client satisfaction

In scopes of the conducted interview the company’s representative has been constantly addressing the issue of using different tools and urgent need in them. This is supported by the following quotations:

• “All documentation and specifications are stored on servers”.
• “Simple online task desk is needed, such as Trello”.
• “Team work and task management can be supported with cloud-based tools. Right now it is hard to track tasks, no visualisation”.
• “We have wiki for documenting the coding, which we need to share and update”.


It can be seen that there is strong need in tools support of different processes and the interviewee knows the purposes where the support would be appropriate. The 2\textsuperscript{nd} order theme for this issue was called “Vision of tools capabilities”.

Furthermore, the interviewee seemed to be well aware of the tools, which are actually appropriate for the particular situation (“There is a possibility to work remotely by RDP connection”; “Google Drive for documentation was not useful, because of access problems”). The representative is able to “choose appropriate tools and techniques”.

In addition, an important factor was addressed by the representative, which concerns the overall performance within the company. The interviewee pointed out:

- “I would like to know how to use the tools better”.
- “Company buys video tutorials for coding improvement and system optimization”.

The first quotation could be the potential indicator that the company does not want to implement technology just for the sake of implementation. But the key aspect for it is actually processes improvement. The second quotation is supportive in this judgment. The 2\textsuperscript{nd} order theme here is “Willingness for processes improvement”.

All the 2\textsuperscript{nd} order themes and their supportive quotations are summarized in the Figure 4.

![Figure 4 – C1P1 project’s analysis](image)

Addressing the issue of why or why not the cloud-based tools could be supportive within the studied company, revealed a number of judgements, provided by the representative:

- “We’ve got no time even to think about process improvement”.
- “Once we decide to use cloud-based tools, we’ll need the processes reengineering”.
- “If one day cloud is be hacked, company will lose a lot of money”.
There were different aspects highlighted about the factors, which enhance or do not let the company to adapt cloud. The reasons for not adapting the cloud-based tools came out to be the privacy and security issues mainly (2\textsuperscript{nd} order theme - “security risks”). The second reason was lack of time for implementation the software.

Though, the advantages, such as “mobile access” were clearly indicated (“I can easily open my app anywhere from the mobile phone and always be ready to act”, “I always need to be aware of the project”).

In addition, the interviewee argued that external servers are very useful for the company:

- “We do not need to care about the servers, the 3\textsuperscript{rd} party cares about them”.
- “We store everything in the cloud, it’s very convenient for us, because we do not need to buy servers, we can just rent the amount of memory we need”.

The summary of the 2\textsuperscript{nd} order theme is provided in the Figure 5.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{C1P1 project’s judgments about cloud-based tools}
\end{figure}

**C3P1 Project**

The goal of the project was the accounting system implementation in the production company. The project was performed by external team (3 analysts and Project Manager), which were constantly presenting on the factory. The customer’s plant and office were placed in another city and the project team was working on the customer’s territory. According to the companies’ representative, the project was admitted as a highly successful:
The company’s representative has been constantly addressing that the main aspect, which affected the overall project execution, was the project team. This is supported by the following quotations:

- “We came from factory and continued to work”.
- “We had a cohesive team”.

The 2nd order theme for this aspect was called “Round-the-clock team”.

Moreover, the level of communication between project team and customer was also highlighted by representative with the following quotations:

- “We had our own phone and everybody knew it”.
- “We had only face-to-face communications”.

These aspects can be formed into the 2nd order theme called “Full availability of the team”.

In addition, the representative indicated that it was urgent to adapt the existing approach (which is accepted in the company) in order to fit the project context. This is supported by the following quotations:

- “We had a project not entirely in terms of implementation project technology”.
- “We did not have a classic survey or modelling, the whole project began with the trial”.

As it can be seen, the company has this “implementation project technology”, but the team had to adapt in scopes of the specific project. The 2nd order theme is “Adjust the project approach”, which summarized the quotations.
The specific issue, which was pointed out by the representative, was the way how team performed:

- “We analysed the requirements only within the team, by brainstorming”.
- “We were just taking decisions inside the team, no pending tasks”.

It can be seen that the decision-making process was rather simple or simplified in the project. The team was working intensively, there were “no pending tasks”. The 2\textsuperscript{nd} order theme for these concepts is “Intuitive team decisions and processes”.

Finally, the representative continuously addressed the tools and techniques, which team has used within the projects:

- “We had a notebook with special notes, who does what”.
- “We planned only for a week ahead”
- “We did not have classical modelling with notations, we did not need it”

It can be noted that the set of tools was very simple, the team was just using paper notebook, and they did not utilize any modelling notations to produce extra artefacts. The derived 2\textsuperscript{nd} order theme is “Choosing appropriate tools and techniques”, because the team was adapting the tools, which were really needed to support the product delivery and simplified their work.

The summary of the 2\textsuperscript{nd} order theme is provided in the Figure 6.

| In the morning we got up and went to the factory. Then we came from the factory, gathered in one room and continue to work further. | Round-the-clock team |
| We had our own office in the factory, we had our own phone, everyone knew it. We had only face to face communication. They [users] just called and we came. | Full availability of the team |
| We had a project not entirely in terms of implementation project technology. We did not have a classic survey or modelling, the whole project began with the trial. | Adjust the project approach |
| We analysed the requirements only within the team, by brainstorming. We were just taking decisions inside the team, no pending tasks. | Intuitive team decisions and processes |
| We had a notebook with special notes, who does what. We planned only for a week ahead. We did not have classical modelling with notations, we did not need it. | Choosing appropriate tools and techniques |

Figure 6 – C3P1 project’s analysis
The “why” analysis of the cloud-based tools utilization was useless for this project, the representative pointed out the following:

- “I can not comment on cloud usage for this particular project. It was kind of unusual and extreme, everything was done intuitively, and sometimes we connected to our remote servers”.

The tools seemed to be not needed in the team in the context of this particular project.

**C3P2 Project**

The C3P2 project was done for the production company in order to implement and develop ERP system. Project was performed by external business analyst and internal IT department. The project was conducted by 2-persons project team (analyst and developer). The project was admitted as failed, as the initial objectives did not cover business needs.

The interviewee was constantly addressing the issue of money saving in this project, there were different quotations on the way how company tried to reduce investments:

- “They wanted to save money, they decided to implement system by themselves, but with the involvement of contractors who would help them”.
- “The whole project was led by one programmer (not an analyst, not an architect). And I was there to help. They did not want to invest”.

It can be proposed that the company was seeking for the costs reduction and was not ready to invest in the comprehensive software project. The 2nd order theme, derived from this analysis is “cheapest is the dearest”. It represents that the costs saving seemed to be more primary goal than the actual implementation.

In addition, the representative addressed the issue of planning in scopes of this project:

- “They had no planning. Only when I came I've created Excel with daily and weekly plans”.
- “I was checking the plan only by myself”.


• “They were not interested in on-going activities”.

It can be seen that the planning was poorly organized, nobody was tracking the progress mindfully except for the one team member. The organization of project planning could be potentially the result of this “cheapest is the dearest” theme, indicated above, because of low interest in project results. These planning issues were formed into the 2nd order theme “No planning habit”.

Moreover, there were other indicators of the low interest in the project, supported by the following quotations:
  • “It was immediately clear that the project would fail”.
  • “We decided to send normal specialists to more perspective projects”.

These statements clearly indicate that the project had very low chances to be finished successfully. The 2nd order theme is “Initial understanding of the failure”.

Another issue, which affected the project execution, was the way how employees (future potential users) behaved and their attitude to the project. The interviewee mentioned the following quotations:
  • “They had some kind of accounting policy, but they really did not know how to conduct all this”.
  • “Everything they had to do was never done”.
  • “Employees did not care much about the processes”.

This attitude description and kind of passive resistance to the project was formulated into “Low responsibility of company employees” theme.

Another aspect, discussed by the employee was the technological awareness of the customer, described from the different perspectives:
  • “In this IT department, everything, including IT infrastructure, was like “old school””.
  • “They were used to work with an old system”.


• “Nobody wanted to perceive the advantages of the new software”.

This reluctance to try new software system and the issue of being used to the existing software seemed to be influential on the overall low level of project performance. The 2\textsuperscript{nd} order theme, which was derived from these quotations, is “technology immaturity”.

Finally, the representative constantly addressed the way how company perceived their own way of working:

• “They had modelling, another company did it to them, but as they said, it's all nonsense, because it's not very suitable for their processes”.
• “They decided to take the processes as it is. They were just correct by default”.

It can be seen that despite all the indicated aspects, the company is still confident in the way how things should be organized. The processes were taken as granted without any changes. The issue is summarized in 2\textsuperscript{nd} order theme “Overconfidence in processes”.

The summary of the 2\textsuperscript{nd} order theme is provided in the Figure 7.

![Figure 7 – C3P2 project’s analysis](image)

Analysing why cloud-based tools could or could not be adapted in this project, the representative highlighted that cloud-based tools are unlikely to be used:
• “Everything, including IT infrastructure, was like “old school”. I can’t even suggest how they could implement cloud tool – the representative again addressed the “Technology immaturity” theme.
• “But right now no one wants to pay for it. Deploy cloud is more complicated than install software.” – the representative pointed out the need to invest in implementation and changes in internal processes, which seemed to be difficult for the company.
• “Nobody wants to study how to work in a different way. Cloud for them is something very difficult.” – the problem of personnel education could potentially be critical for this type of company.

The summary of the 2nd order theme is provided in the Figure 7.

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**Figure 8 – C3P2 project’s judgments about cloud-based tools**

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**C4P1 Project**

The goal of the project was the integration platform development and implementation in a large retail company. The project was performed by external team with 2 Project Managers and 4 integrators (from customer’s and contractor’s side) and customer’s developers. According to the company’s representative, the project was admitted as a successful:

- ✓ Cost
- ✓ Scope
- ✓ Time
- ✓ Client satisfaction

The company’s representative was constantly addressing the issue of tasks setting and the way how they were delegated:

- “Tasks management was done by Architect and Project Manager”.

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• “Tasks were shared according to competency of each team member”.
• “We used physical Kanban board to manage tasks to simplify the process”.

It can be seen that tasks setting was clearly defined and their management was organized in a simple way in order to make the process easier and more understandable. The 2nd order theme is “Clear tasks' management”.

The interviewee also addressed the way how team performed the projects:
• “Our main deliverable was new workable system”.
• “We had several deployments per day”.
• “We have documented in later on, because the customer needed the product first of all”.
• “We worked 16 hours a day intensively and collocated”.

The first quotation clearly defines that the team was focused mainly on the product delivery, while the rest statements are supportive and show how intensive was the work of the team. The 2nd order theme for these statements is “Focus on fast delivery”.

Finally, the representative discussed the way how tools were adapted in the project:
• “With JIRA risks to make mistakes are much less, everything is clearly defined”.
• “The combination of board for tasks and JIRA for bug tracking”.
• “We stored wiki in confluence”.

Based on these quotations it can be proposed that the team knew exactly why they were using each particular tool and tried to utilize it in a way to improve their own processes. The 2nd order theme can potentially be “Taking advantage of tools”.

The summary of the 2nd order themes is provided in the Figure 9.
Addressing the issue of why the cloud tools were or were not used in this project, the representative stated the following:

- “With JIRA application, I can access to my tasks and comment on every case from all over the world”.
- “In JIRA it is very clear who did what and for how much time. You know who is responsible even with his/her photo”.

Both quotations could be interpreted differently. The first one seems to be important, because the representative is able to react fast and from any place. The 2nd order theme for it is “Mobile access”. Though the second one more dedicated to the user-friendliness aspects, the 2nd order theme is the “high visualization”. It actually can poorly be characteristic of the cloud-based tools, because can be also used for the desktop tool. Despite that it can be proposed that “high visualization” actually enhances the use of the cloud-based tool. The 2nd order themes are presented in the Figure 10.
The project was done in the trading company of the holding group in order to develop and implement ERP system. The project was conducted by internal IT department of 6 people (2 analysts and 4 developers). The project was admitted as the successful one:

✓ Cost
✓ Scope
✓ Time
✓ Client satisfaction

The interviewee pointed out many different aspects, which concern how teamwork was established:

- “We want to use automatic configuration checking, auto testing”.
- “We try to maximize direct project work of each analyst”.
- “We always have meeting to see how we can act better”.

The last quotation clearly indicated that the team was aiming to improve the way they were working. In addition, the team adapted different tools to deliver high quality product and also tried to avoid project overheads. All these can be summarized in the 2nd order theme – “Willingness for processes improvement”.

The representative described the collaborative work with top-management:

- “Top management set time scopes, placing the highest priority tasks”.
- “Top management sets strategic tasks in alignment with business development”.

The quotations propose that this was not the manner of work when the top management just states what “we must do”, but it can be characterized by the 2nd order theme “High involvements of top management”. It shows that the management of different levels is aligned in their vision.

Except the collaboration with top-management, the interviewee described how the team performed:

- “We do not have the hours, but the value of the task are S, M, L, XL”.
- “We’ve got a tracking system”.
• “We use separate help desk board to work with users”.
It can be seen that the organization of work is very clear: the tasks are evaluated, the tasks
are tracked for users, and the tasks are tracked and managed in the team. The 2nd order theme
can potentially be “Clear tasks' management”.

In addition to the performance description from the organizational point of view, the inter-
viewee stated other interaction issues:
• “We deliver results every week”.
• “On Fridays, customers have the news instead of the desktop that we changed some-
thing, attached there are links to the instructions”.
• “We seek for implementing Agile principles”.

It can be seen that these quotations mean slightly different aspect than the previous para-
graph. Here the representative addressed the issue of Agility and fast value-adding work. It
is also supported by mindful approach to changes implementation. The aggregate dimension
could be “Focus on fast delivery”.

In addition to these “fast delivery” aspects, the company’s representative described the way
how interaction with users was organized:
• “We specify tasks very much, because we don’t want to understand users incorrect-
ly”.
• “We constantly ask for the feedback from users”.
It can be seen that the team is constantly seeking for understanding the users. They seem to
be admitting that the users’ needs are extremely important for the project. The 2nd order
theme could be “High attention to users’ needs”.

The summary of the 2nd order themes is provided in the Figure 11.
The “why” analysis of the cloud-based tools adaptation was further provided with the company’s representative. The interviewer mentioned the following aspects:

- “In Lynk we can easily share files, attach our emails, share calendar and see availability information” – this quotation can be potentially interpreted, that among the benefits of cloud the “easy sharing” could be mentioned.
- “We were dealing with accounting information; sometimes not all stakeholders want to make the processes transparent” – this aspect does not let the company use cloud everywhere in their business processes. These “privacy risks” can be the challenge for cloud use.

The 2nd order themes are presented in the Figure 12.
consisted of 6 people: Project Manager, Product Owner, 2 developers, designer and architect. The project was admitted as a successful:

- Cost
- Scope
- Time
- Client satisfaction

The interviewee was constantly addressing the aspects of quality management within the project:

- “Code review is done by developers, technical leader, and internal testers from agency, external team review functionality, managers test final interfaces”.
- “Philosophy says that the documentation is not the first, the main thing is the collaboration and working high quality product”.

The first quotation shows the way how technical quality is mindfully addressed in the company, while the second proposes the quality aspect from the point of view of needs coverage. Both quotations could be aggregated into the 2nd order theme “Willingness for high-quality delivery”.

In addition to this focus on needs coverage, the interviewee specifically pointed out the issue of working with the users:

- “We knew our target audience”.
- “We knew what it was looking for and then we started to find the most effective way to convey information for them”.

The team pays specific attention to the issue of mutual understanding, they seek for the better way to communicate with the users. This shows the attitude, which can be characterized by the 2nd order theme “High attention to users needs”.

The way how tools were used was also addressed by the interviewee:

- “For tasks, we use the YouTrack task-tracker, which is sharpened to work in Agile”.
- “YouTrack supports wiki”
- “We can attach code and comment tasks”.

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It can be seen that the tools choice seems to be quite mindful. The team exactly knew what could be useful for them. This is aggregated into “Taking advantage of tools”.

Another aspect, which was described by the interviewee, was the issue of methodologies choice for running the project:

- “Conditionally, we can say that we work on flexible methodologies, but the first iteration is waterfall, to get at least a minimal valuable product”.
- “The first waterfall stage helps to deliver minimum viable product (MVP) fast and then react on changes”.

The company seems to be able to combine the methodologies mindfully. The team does not put themselves in the frames of any specific project approach, but they seem to be able to recognize the advantages of different methodologies and use them. This aspect is formed into 2nd order theme “right methodology in the right place”.

Finally, the representative commented on the way how company came to this issue of approaches combination:

- “1.5 years ago our head decided that we can do more cool things and we decided to practice in such and adapted Scrum”.
- “We combine different approaches to act effectively”.

It can be seen from the quotations that the company tends to seek for better ways of doing their work. As a result, they adapt different methodologies and seek for tools, which increase their performance. The aggregate dimension could be “Willingness for processes improvement”.

The summary of the 2nd order themes is provided in the Figure 13.
The issue of reasons for using (not using) the cloud tools was further addressed. The representative stated the following reasoning for different tools usage:

- “We use YouTrack for planning, requirements analysis, task tracking and reporting. It is useful and for technical and for managerial part of the team and we do not need to download “heavy” software”.
- “In YouTrack it is very convenient to work with Agile and it is very flexible to configure each project”.
- “MindMeister is convenient to conduct team brainstorming sessions. It works from the different browsers and from the mobile application for iOS and Android”.
- “We can share documents in Google Drive with all international stakeholders and work together on some documents”.

These quotations could all potentially be interpreted differently. For example, the first quotation seems to mean that the company’s representative values that the tools could be used for different purposes. This could mean the “one solution for several project activities” is valuable for the companies. This cannot be admitted as an advantage of the cloud specifically, but can be applied for the tools of other types.

The next quotation is dedicated to “Agile support” and seems to be an important aspect for choosing the tools in the company, which tends to adapt this methodology.
The last two quotations reveal potentially quite important issues, which make cloud-based tools useful for the companies. They were interpreted as “cross-platform” and “parallel work and access”.

The summary of the 2nd order themes is provided in the Figure 14.

![Figure 14 – C6P1 project’s judgments about cloud-based tools](image)

**4.1.1 Aggregate dimensions – understanding the context of cloud adaptation**

According to the empiric data analysis and description of the 2nd order themes, there are potentially similar aspects, which describe the context of cloud based tools usage.

The themes “Seeking for technological support” (C1P1), “Choosing appropriate tools and techniques” (C1P1) and “Willingness for processes improvement” (C1P1, C5P1, C6P1) are all potential indicators of the companies, which are ready for either organizational or technological changes. The aggregate dimension could potentially be “Readiness for changes” and seem to be supportive for cloud-based tools adaptation (as the projects C1P1, C5P1 and C6P1 promoted using of “cloud”).

In addition, there were different issues of the way how management is established in scopes of the interview. There were 2nd order themes derived, which concern different levels of management: team management (“Clear tasks' management” (C4P1, C5P1)) and top management involvement (“High involvements of top management” (C5P1)). Both themes could be summarized as “Management maturity”. This is also a potentially enhancing factor if addressing the issue of cloud-based tools usage based on the gathered data.
There were potentially similar themes found, which consider the aspect of product delivery: “Focus on fast delivery” (C4P1, C5P1), “Willingness for high-quality delivery” (C1P1, C6P1), “High attention to users’ needs” (C5P1, C6P1). They all could potentially provide similar underlining meaning and describe how the team is focused in the product. The summary of these 2nd order themes could be aggregated into the theme “Being product-oriented” and represents the style of value-adding work. This is principle of Agile approach based on Fowler and Highsmith (2001), it potentially indicates the overall mind set of the company and its openness towards seeking of improvement. It can be admitted as an enhancing aspect of cloud-based tools use.

Studying the themes “Taking advantage of tools” (C4P1, C6P1), “Right methodology in the right place” (C6P1), “Choosing appropriate tools and techniques” (C1P1, C3P2), “Intuitive team decisions and processes” (C3P2), it can be proposed that they all consider the same way of context perception. This mindful choice of tools, methods, style of work or techniques in the particular situation is aggregated into the dimension “Contextual intelligence”. This factor is promoting the cloud-based tools usage within particular companies.

The themes “Cheapest is the dearest” (C3P1) and “No planning habit” (C3P1) seem to be potentially close on the higher abstraction level. They could both represent that the management has rather low competences level. The aggregate dimension could be “Management immaturity”. This factor could become an obstacle for adaptation of the cloud-based tools or other supportive technologies, as the process management seems to be lacking other organizational aspects.

There are also potential similarities between “Initial understanding of the failure” (C3P1) and “Low responsibility of company employees” (C3P1). The themes represent the issue of motivation lack in the project team to participate in the projects. This low motivation could be the reason of perceiving the project as the failed before it had begun. The aggregate dimension could be “Team low motivation”. It can potentially be hindering for the cloud-based tools adaptation, as the companies, indicated in its themes, seem to have different managerial problems.
Furthermore, there were two themes, which were not directly close to each other, but further analysis revealed they are actually closer. The themes are “Technology immaturity” (C3P1) and “Overconfidence in processes” (C3P1). They address different aspects of the company, but the potential underlining meaning for them could be the same – “Unwillingness of changes”. This aggregate dimension could be characterised as a hindering factor of adapting the cloud-based tools, as both themes have been indicated in the project, where the team did not adapt cloud due to different reasons (C3P1).

Finally, there were very close issues of team performance, but divided into different 2nd order themes. Those are “Round-the-clock team” (C3P2) and “Full availability of the team” (C3P2). They both address the high level of team’s availability for both team members and the customer. The aggregate dimension could be the “At hand jelled team”. The characteristics of this dimension have been derived from the themes of the C3P2 project, which has been executed without any tool. This might potentially mean that “At hand jelled team” might be a hindering factor for adapting the cloud-based tools.

The 2nd order themes summary and derived aggregate dimensions are demonstrated in the Figure 15.
4.1.2 Aggregate dimensions – understanding the advantages and disadvantages of the “cloud”

The next step is dedicated to the analysis of the judgements about the advantages and disadvantages of cloud-based tools.

According to the gathered data, representatives highlighted different advantages of using cloud in software development projects. For example, they pointed out “Wide choice of free tools”, “External servers” and “One solution for several project activities”. All these reveal the opinion of the companies that cloud-based tools actually reduce the total cost ownership of companies’ IT infrastructure. The aggregate dimension for this issue is “Cost saving”.

In addition, the themes “Agile support”, “Mobile access”, “Cross-platform”, “High visualization” - all potentially have similar underlining meaning, which represents the style of work of the companies and comes out to be the “for” of using cloud. The aggregate dimension is “Flexibility and Agility”. Cloud gives ability to be flexible in terms of support of Agile activities and the mobile access to the project.

Finally, among the positive aspects of adapting the cloud, several issues on communication and collaboration were mentioned:

- Parallel work and access,
- Easy sharing.

They are aggregated into the dimension “Collaboration increase”.

The summary of cloud-based tools advantages in the views of the companies is presented in the Figure.
Despite the benefits, named by interviewees, some representatives also mentioned negative aspects, which would be an obstacle for adapting the cloud tools. The second order themes, which were derived from the negative feedback, are:

- Need of changes in internal processes (C1P1, C3P1),
- Technology immaturity (C3P1),
- Need of education for personnel (C3P1),
- Privacy risks (C3P1),
- Security risks (C1P1).

Analysing these themes, it can be proposed that the first 3 themes can be potentially summarized into one dimension on the higher level of abstraction. They all indicate the attitude of the company to the business development and the investments, linked to it. The potential aggregate dimension could be “Extra investment”. It seems that the need for of processes reengineering, necessity of re-education of employees, high costs on preparation for cloud implementation, need of certain level of IT infrastructure, could be an obstacle for adapting cloud-based tools in some companies because of extra investments.
The last two themes are both connected with risks, but emphasize their different types. They could be aggregated into the “Additional risks” dimension, which can become an obstacle for the companies. Here the risk could be potentially linked to data loss or acquisition of information by third parties.

The 2nd order themes and the aggregate dimensions, which concern disadvantages of the cloud-based tools in the vision of the companies, are represented in the Figure.

![Figure 17 – Disadvantages of cloud-based tools](image)

**4.2 Investigating the tools choice**

While the factors of using cloud-based tools in general as well as their advantages have been investigated in the previous section, the deeper analysis of the ways how the tools were actually used need to be addressed. In order to study this issue, the first aspect, which was addressed based on the gathered empiric data, is the list of activities, which were supported by cloud-based tools within each particular project. The summary of investigation is represented in the Table 3. It shows within which projects and for which activities the “cloud” was adapted. In order to provide reader with more relevant data, the cases of cloud-based tools usage are highlighted with light-blue colour, while the desktop tools are highlighted with white.
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<td>Axure RP</td>
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<tr>
<td><strong>Development</strong></td>
<td>1C platform</td>
<td>-</td>
<td>1C platform</td>
<td>Confluence</td>
<td>ERP</td>
<td>Drupal</td>
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<tr>
<td><strong>Testing</strong></td>
<td>Manual testing on</td>
<td>-</td>
<td>Manual testing on</td>
<td>Solman</td>
<td>Manual testing on</td>
<td>Mercurial</td>
</tr>
</tbody>
</table>
Based on interviews results, in every project, where the cloud-based tools were used (C1P1, C3P1, C4P1, C5P1, C6P1), tools for communication were utilized in each case. They can potentially be admitted as the most popular cloud-based tools within the research sample.

At the same time, the tools, which seem to be not very popular for using in software projects, can be clearly indicated. Only in one project (C4P1) cloud tools for automated testing were used, as well as only in one project there was modelling, supported by “cloud” (C6P1).

While according to the data analysis, each project activity can be supported by cloud-based tool, their popularity seem to be considerably different among the studied companies. Cloud-based tools distribution among the projects is represented in the Figure 18.

<table>
<thead>
<tr>
<th>Possibility of new/other cloud-based tools usage</th>
<th>platform for task tracking, planning, managing</th>
<th>No</th>
<th>No</th>
<th>No</th>
<th>For testing</th>
<th>No</th>
</tr>
</thead>
</table>

Figure 18 – Cloud-based tools distribution among the projects
Aside from the distribution of different tools among the companies and their ability to support different project activities, another potentially important aspect can be revealed. Some of the tools, mentioned by interviewees, were used for several activities within the project:

- YouTrack tool was used as a task-tracking tool, tool for planning and requirements analysis.
- Atlassian JIRA was used for managerial activities and as a tool for remote work.
- MOTIW cloud-based tool was used to support planning, task tracking and requirements analysis.

These tools are less popular, but seem to be adapted mindfully. This indicates not only the broad functionality and usefulness of this software within specific project, but potentially, can reveal different characteristics of the companies, which use them.

The way how tools are adapted can become an indicator of high awareness of the ways how to run the projects and which tools are needed for it by the company. Further investigation is dedicated to the understanding the difference between the companies, which use cloud-based tools.

4.3 Towards a framework of cloud-based tools utilization

The research questions that were formulated in introduction section were consistently answered based on interviews' analysis and were discussed earlier in this chapter.

The section 4.2 gives an overview of cloud-based tools usage within software development projects. This answers the RQ1: How do the companies use cloud-based tools to support their software development projects?. According to the conducted research companies use cloud based tools in each case (6 project from 6), but the number of tools varies. In the Table 3 the project activities, which can be supported by cloud-based tools, were analysed. In can be noted that Requirements Analysis, Planning, Task Tracking, Communication, Documentation, Remote Work, Modelling, Software development and Testing can be supported by cloud. This can be the answer to the RQ1a: For which activities the cloud-based tools
are used?. Based on Figure 18 the RQ1b: Which cloud-based tools are used in the companies? can be responded.

The different factors derived from analysed data (section 4.1), which influencing the cloud-based tools adaptation, were highlighted in the Figure 15. Among them the two groups of factors were distinguished: enhancing and hindering. Readiness for changes, management maturity, being product-oriented and contextual intelligence are likely to be fruitful for cloud-based tools adaptation. The following factors have the opposite effect: management immaturity, low team motivation, unwillingness of changes and at hand jelled team. These factors can be presented as an answer to the RQ2: What are the factors influencing on cloud-based tools adaptation?. Talking about advantages of cloud technologies in software development project, the Figure 16 represents the answer to the RQ2a: What are the benefits of using cloud technologies?. According to gathered data cloud usage leads to costs savings, flexibility and agility and increase of communication. Based on interview’s analysis, in the Figure 17 the challenges of cloud based tools adaptation were presented. Among them are extra investment and additional risks. This gives an answer to the RQ2b: What are the challenges of using cloud technologies?.

The investigation of the gathered data and addressing different aspects of choice and utilization of the cloud-based tools among the companies revealed the possibility of conceptualization of “cloud use”. Further addressing of the obtained data and research outcomes is an attempt to provide a framework of “cloud” within the companies.

4.3.1 Addressing the difference between companies characteristics

Based on the summary of the gathered data and gradually defined aspects of adapting the cloud-based tools, there could be 3 different types of companies derived. The companies can be divided into 3 categories by the cloud-based tools adaptation influence: enhancing, disputable, inutile.

Enhancing adaptation type
The companies of this type are potentially to be more efficient when adapting the cloud-based tools. They could benefit from using the cloud-based tools, because they are able to enhance the processes due to different factors.

The recognition indicators based on the enhancing aggregate dimensions are the following:

- Readiness for changes
- Management maturity
- Agile principles (Being product oriented)
- Contextual intelligence of the team

**Disputable adaptation type**

This type of companies is likely to face difficulties in achieving project objectives, with or without the help of cloud technologies. The projects, which they execute, tend to end up with failure and the use of cloud technologies has low chances to change the project outcomes because of number of organizational reasons.

The recognition indicators based on the hindering aggregate dimensions are the following:

- Management immaturity
- Team low motivation
- Unwillingness for changes

**Inutile adaptation type**

These type of companies performs successfully, project team and users are self-sufficient and balanced, can be proposed as well established without the tools. This type of companies is particularly specific, because it encompasses both enhancing and hindering factors of cloud-based tools adaptation. The key difference of this type from Enhancing adaptation type is the team being collocated and highly jelled, but there could be potentially other aspects.

The recognition indicators based on the aggregate dimensions are the following:
• At hand jelled team
• Contextual intelligence of the team

4.3.2 Addressing the difference between companies behaviour

The behaviour of indicated 3 types of companies in scopes of different projects could be potentially divided the 4 different types:

“Resistance” type of behaviour - this is the behaviour of the companies of Disputable cloud-based tools adaptation type. The most influential hindering factor here is Unwillingness of changes. Alongside with the hindering factors of cloud-based tools adaptation, which characterize them, these companies recognize the disadvantage of cloud-based tools – need for extra investment (this could be either need for processes changes, technology immaturity or issue of personnel education). These companies are likely to fail the projects because of different internal challenges, such as ignorance of ways of improvement.

“No-go” type of behaviour - this is the behaviour of the companies of Disputable cloud-based tools adaptation type. This type can be also described based on factors of Disputable cloud-based tools adaptation, but the most influential hindering factor here would be Low team motivation. These companies recognize Extra investment as less influential disadvantage then the “Resistance” type, but they are more concerned about Additional risks, such as privacy and security of data.

“Handymen” type of behaviour - this is the behaviour of the companies of Inutile cloud-based tools adaptation type. The project team does not see the need of cloud-based tools usage, because the users and team are collocated and work effectively on the project goal. The team perceives themselves as highly effective without any specific tools, but tend to focus more on interpersonal interaction. A kind of indifference towards “cloud” could be indicated in this type of behaviour, there are no advantages or disadvantages of cloud provided by this type.

“Trailblazers” type of behaviour - this is the behaviour of the companies of Enhancing cloud-based tools inutile type. Alongside with all the factors, which are enhancing the
cloud-based tools adaptation, there is recognition of different advantages of “cloud”, such as: Costs saving, Flexibility and Agility, Collaboration increase. The projects execution within this type of behaviour is supported by all parties involved, the cloud-based tools are considered to be support of processes.

The behaviour framework is presented in the

![Figure 19](image-url)

- **Failure zone**
  - "No-go"
  - Characteristics:
    - Unfounded usage of cloud-based tools
    - Low contextual intelligence of company
    - Low team motivation
  - Philosophy:
    - Incomprehension of way of improvement

- **Success zone**
  - "Trailblazers"
  - Characteristics:
    - Effective cloud-based tools usage
    - High contextual intelligence of the company
    - High team motivation
  - Philosophy:
    - Understanding the possibility of improvement

- **Assertive zone**
  - "Resistance"
  - Characteristics:
    - No usage of cloud-based tools
    - Unreadiness for changes
    - Company, team and users immaturity
  - Philosophy:
    - Ignorance of need of improvement

- **Alterable zone**
  - "Handymen"
  - Characteristics:
    - No usage of tools
    - High contextual intelligence of the team
    - Highly motivated collocated team
  - Philosophy:
    - Understanding the needless of improvement
Figure 19 – Framework of companies’ behaviour and cloud-based tools adoption

<table>
<thead>
<tr>
<th>Alterable zone</th>
<th>Failure zone</th>
<th>Success zone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“No-go”</strong></td>
<td>Characteristics:</td>
<td>Characteristics:</td>
</tr>
<tr>
<td></td>
<td>- Unfounded usage of cloud-based tools</td>
<td>- Effective cloud-based tools usage</td>
</tr>
<tr>
<td></td>
<td>- Low contextual intelligence of company</td>
<td>- High contextual intelligence of the company</td>
</tr>
<tr>
<td></td>
<td>- Low team motivation</td>
<td>- High team motivation</td>
</tr>
<tr>
<td>Philosophy:</td>
<td>- Incomprehension of way of improvement</td>
<td>- Understanding the possibility of improvement</td>
</tr>
<tr>
<td>Assertive zone</td>
<td>“Resistance”</td>
<td>“Handymen”</td>
</tr>
<tr>
<td>Characteristics:</td>
<td>- No usage of cloud-based tools</td>
<td>Characteristics:</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td>- Company, team and users immaturity</td>
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</tr>
<tr>
<td>Philosophy:</td>
<td>- Ignorance of need of improvement</td>
<td>- Highly motivated collocated team</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Understanding the needless of improvement</td>
</tr>
</tbody>
</table>
5 DISCUSSION

The final framework, derived from the empiric data, addresses the issue of linkage of companies’ behaviour and cloud-based tools adoption in scopes of software development projects. This study identified four different types of companies’ behaviour among the 6 explored projects: “Resistance”, “No-go”, “Handymen” and “Trailblazers”. Based on the description of each type of companies’ behaviour, their trends can be highlighted.

According to the framework can be proposed that if company, team and users are immature and resist to changes, the projects, which they execute, tend to end up with failure. Also, the use of cloud technologies is unlikely to be beneficial in these projects, because of companies’ unwillingness of improvement.

Case of resistance and rebelling for changes was reflected by different researches. In the research of Glenny (1994) the case of Total Quality Management (TQM) implementation was presented. According to this research, previously, such implementation has been successfully adopted by the vast number of companies. Nevertheless, author presents the projects, where process improvement was met by scepticism and rejection, which resulted in project’s failure. Readiness or resistance for changes both influence company’s development and improvement.

It was argued that low team motivation could be the factor of unsuccessful cloud-based tools adaptation, as well as in project failure. The influence of team motivation on project success was frequently mentioned in previous studies. In the research of Markus (1983) the linkage between individual’s motivation and project success was reflected. In his work the case of management information systems implementation was described. It was proposed that low project team motivation lead to system implementation project failure. It was also emphasized by Walsh and Schneider (2002) that low motivation of team reduce its interest towards organizational goals, which means the unwillingness to work and to reach the project goal.

Another issue, which concerns the team performance in scopes of the proposed framework, is linked to its skills and collocation. These “at hand” teams are more likely to support their activities with physical tools, spending more time on collaboration and communication.
Such teams are likely to succeed if the members of the team are high experienced, ready to communicate, opened towards dialog and discussion. These findings can be supported by previous researches. Rafii (1995) actually assumed that team collocation can ease the communication, increase the work intensity and reduce the overall project time or development cycle time. Moreover, according to the research of Teasley and his colleagues (2000) the collocated team with professionals will help project to succeed. This was proved by case study of team collocation as a pilot project of a huge company. It this case study on the software development projects the six teams were working in a special “team rooms”. It was found that collocated teams are able to double the number of function points per man-month comparing to other teams. Moreover, the level of satisfaction of team and end-users increases, when project is lead by collocated tea. Also, the collocated teams preferred to use physical tools, for instance, they used wall to share documentation, tasks, achievements and ideas.

CI of the company actually seems to be one of the most influential factors on successful cloud-based tools adaptation and even the baseline for adapting the cloud. In scopes of this research, aspects of project management and team collaboration, which influence on the overall level of company’s CI, can be highlighted. Among them: the ability to adjusting to circumstances, Agility, readiness for changes and management maturity. All these parameters seem to be interrelated with each other, being a part of the overall concept of the ability of the company to adapt. It actually includes using appropriate tools, techniques and approaches in specific situation, reflecting the contextual intelligence of the company. In the Figure 20 the level of influence on contextual intelligence from the point of view of cloud-based tools adaptation within the project activities is presented.
Different researches mentioned the value and high influence of CI on project and company’s success, but it was not described from cloud-based adoption point of view. For instance, according to Kutz (2017) CI can be presented as advantage of business leaders. According to this research, companies and projects where CI was exercised, were more likely to succeed. In this case among the aspects of behaviour associated with CI are: ability of influence on others, interpreting the changing environment and adjusting to it, critical thinking and understanding the future perspectives and opportunities. Kutz and Bamford-Wade (2013) also assumed that CI correlates with leadership in particular project or company. They presented the Contextual Intelligence Model for Organizational Leadership, where described the previously listed behaviours according to the CI triad. Moreover, in this research the value of one’s ability to successfully adjust to changing environment including social and organizational context was emphasised. Moreover, according to Logman (2008) the CI influences not only project management and organizational aspects, but also can be represented in different business dimensions.
6 CONCLUSION

6.1 Summary

Current research addresses the cloud-based tools adaptation within the software development projects. The objective of this study was to find out benefits and challenges of using cloud-based tools in such projects. On the first step of conducted study, the inductive research approach was chosen, while the research strategy was the adaptation of Grounded theory. In order to answer the research questions, the interview with open-ended questions was created. After this, in literature review the basic theory about cloud computing was introduced. On the next step of conducted study, in order to receive relevant data, six interviews with Saint Petersburg companies were conducted. Based on gathered data and its analysis, the research questions were answered and the framework of companies was presented.

The contribution of this research for the software engineering research filed of study is the reasoning of cloud-based tools usage within the software development projects, which became a basis for building a framework of companies’ behaviour and cloud-based tools adoption. The possibility of cloud-based tools adaptation depending on project’s type and characteristics was described. Moreover, the contribution of this research for the practitioners is the analysis of linkage between project’s context and cloud-based tools usage.

6.2 Limitations

The main limitation of this research is linked to the number of companies and projects, which were analysed. The scope of the research could be broader in order to provide more comprehensive answers on the research questions.

Another important limitation is in the market segment of chosen companies. Not all companies were IT, which could affect the issue of implementation of cloud technologies in specific project activities.
Also among the limitations of the research can be distinguished the type of software development projects. In some cases such project were conducted for system customization and implementation. Some project activities could possibly been organized differently from software development “from scratch”.

6.3 Future researches

The conducted research has created additional questions that can be considered further in future studies. As it was highlighted in results, there are tools, which are able to support several project activities. The possibility of combination of such cloud-based tools in order to cover all project activities and avoid overlapping functions would be beneficial to investigate in further researches.

In addition, the cloud IT architecture, which covers all business processes of companies and supports all project activities can be addressed. Such research would provide companies with relevant information about cloud market, different cloud solutions and their benefits in order to “migrate into cloud” safely and successfully.

The last issue, which could be studied further, is the framework appliance to different projects in different areas. As the framework describes different behaviour types of companies, it has potential to be tested in organizational, economic and social types of projects.
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