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THE IMPORTANCE OF ICT IN CONSTRUCTION INDUSTRY'S BUSINESS STRATEGY

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ABSTRACT

Construction Industry is one of the largest economic sectors, which is characterized as a traditional industry with a low innovation rate. The aim of this thesis is to study the recent developments of Information Communication Technology (ICT) introduction and their alignment to Business Strategies in the companies of Construction Industry. As strategic options are influenced by different managerial and economic factors, the related matters are discussed. The proposed qualitative methodology identifies three main study areas and evaluates the situation of ICT introduction, the approaches of managers and their interaction to ICT as a strategic value.

The conducted research in Estonia reveals that Estonian AEC Industry has well-developed ICT infrastructure in order to create a collaborative environment in the industry. More advanced Scandinavian provide new knowledge which improves local working methods. ICT introduction can open new markets in south-eastern Europe. In order to implement collaborative tools a critical mass of users need to exist.

Companies are using internal and external ICT tools to improve efficiency. The motivation to invest in these ICT solution is mainly driven from need for efficiency which is not directly linked to strategic goals, but support them indirectly. The strategic directions and the client segmentation of the AEC companies guide the need for ICT usage. ICT introduction provides positive influence to professional client. Non-professional clients have not yet found a value for advanced ICT usage during the construction process.

The results of the study provide an insight regarding the current philosophy of linking ICT to Business Strategy and current situation analyze in Estonian Construction Industry. The mindset of managers shows that the industry is in general ready to introduce new ICT possibilities to achieve directly or indirectly strategic goals.

Keywords: Business Strategy, ICT Strategy, Construction Industry, Innovation, Technology

INTRODUCTION

Construction Industry is one of the largest economic sectors which is linked to the whole population. Nevertheless there has been rather few new process and technology related developments to provide new value to the stakeholders. The innovation is driven from technological need, is project-based and is therefore not providing support to long-term strategic goals. The top-level business driven strategies have the possibility to increase the productivity in the globalizing world. ICT paradigm shift has changed the way of thinking in most of the economic areas and Construction Industry has the potential to benefit from this existing know-how from other sectors. The research aims to define the need to implement ICT to Business strategy and to identify specific issues which need to be addressed in more detail.

The results of the thesis are useful for managers in Construction Industry to be aware of the current developments in this specific business environment and to get new insights of the need for ICT strategy. The research provides recent developments in the area of ICT strategy in general and recent ICT related developments specifically in Construction Industry.

As strategic management is continuously evolving and has high interest among practicians and theorists, there are numerous of books and deliberative journal articles available. Although strategic management in a holistic approach is extensively represented, the relevant literature regarding Construction Industry is rather hard to find. Studies and public discussions regarding ICT alignment with business strategy have received little attention and they need more devotion especially in the level of Small and Medium Enterprises (SME) in order to provide more benefits to the sector.

ICT implementation and alignment to business strategy has proven to have a positive effect in other economic sectors. The recent developments in Architectural, Engineering and Construction (AEC) Industry have shown advantages and more innovative companies are looking for new technologies and solutions. In order to challenge the mindset of the industry, critical mass of early adapters need to understand the need for change.

To narrow down the topic, the studied key focus areas are covering ICT Strategy in general (Chapter 1), impact of technology to businesses (Chapter 2), characteristics of Construction Industry and ICT usage in the industry (Chapter 3). The topics are creating a foundation for this research which ends with a comparative description of situations in Turkish and United Kingdom's economy. The identification of challenging issues are selected in Chapter 4. In Chapter 5 research design is proposed and the results of conducted qualitative research is analyzed in Chapter 6 and discussed in Chapter 7. Conclusions and recommendation in Chapter 8 deliver the main results and recommendations for the companies and further research.

1. INFORMATION AND COMMUNICATION STRATEGY

A formulated ICT Strategy is one of the important factors, which could help to understand strategic benefits of technology. In order to transfer knowledge from other sectors to Construction Industry, general overview of the topic is discussed in this chapter. The drivers of ICT implementation and the link between ICT and business strategy is emphasized.

The role of ICT could be described in metaphors like ‘glue’ by Hidding (2001) and ‘railway’ by Bennett (1996, preface). They represent the link between various parts of the system, which makes it possible to work together in more effective way. As the system is belonging to a company or group of companies, it enables the internal knowledge transfer and reduces the external unwanted usage, that creates competitive advantage to the group (Hidding, 2001). This infrastructure needs to be indistinguishable from the overall business activities and the alignment to business strategy maintains the wanted expectations of competitive advantage. At the same time it is seen as common investment to the company (Andresen et al., 2000).

The main purpose of ICT Strategy is to manage information in such a way that it can be used to gain competitive advantage and support business strategy in general. ICT may give new insights to customer needs, internal process modifications and new strategic options for future (Bennett, 1996, 220-221). These actions are the basics for disrupting fundamental procedures of competition, structural and market appearances, business scopes and competitive approaches (Targett et al., 1999, 244).

Bennett (1996, 219) discusses that the implementation of ICT deals with necessary essentials for the following improvements:

- more efficient control by management,
- better monitoring options for procurement process,
- faster reactions to external changes,
- quality management improvement,
- business partners are linked in more efficient collaboration form,
- business partners and users are more engaged to provided systems, making it difficult to adapt alternatives (competitive advantage),

- better strategic decisions,
- increase of operational productivity.

Targett et al. (1999, 75) discusses different approaches from IT managers and CEO's. The main statement from the firms' representatives is that ICT improves competitive advantage through the increase of efficiency. If it is seen as one time investment and it gives good results, then it will be imitated by competitors. As it is copied, the previously owned competitive advantage is lost. Therefore there is a need to understand the depth of ICT related competitive advantage and expand it to a system of developments sustainable to stay ahead from competitors.

1.1. Motivation for ICT implementation

Technologies will increase their importance and should be normal fragment of business life (Targett et. al, 1999, 74) and could be used to improve strategic planning (M. Salo, 2006) through integrating holistic approach while using components from business strategy (Targett et al., 1999, 74). Since 1990's the costs for information processing and communications are dropping (M. Salo, 2006). At the same time the volume of external and internal information is increasing, and successful managers need to adopt with huge amounts of data. The potential growth of the companies could base on IT solutions, while their organizational procedures and techniques need to deal with the information wisely. The keyword to success is *integrated data*, which covers the need of entire organization. The same data could be introduced very differently in specific departments and should be used simultaneously (Bennett, 1996, 216-218). The most challenging area is the external information exchange with business partners. Smart integration is a major challenge to today's approach and understanding to business relationships in more traditional economic sectors (J. Salo, 2006).

Bennett (1996, 218) states that one of the major management functions in the modern business environment is to deal with the following challenges:

- globalization and changes of market boundaries,
- additional information management from external resources,
- Increase of internal information amount,
- competitors' actions and their change in their focus.

Targett et al. (1999, 22) discuss in their book that the core motivation to use Information Technology and its relevance to Strategic Management has transformed three times in the recent history as shown in Table 1. Today the aim of Information Technology is to create additional business value. At the same time the characteristics of previous eras are included to new approaches.

Table 1. IT evolution.

Timeframe	**Motivation to use IT**	**Relevance to strategic management**
1950 - 1970	Efficiency	Operations (control and monitoring)
1980 - 1990	Effectiveness	Problem solving (new information)
1990 to present	Business value	Strategic actions (supporting organizations)

Source: Authors interpretation of the work by Targett et al. (1999, 22)

The motivation to use IT has shifted several times. Today it is pushed by the need to deliver integrated support to business units.

1.2. ICT in Business Strategy

To benefit from aligning ICT and Business Strategy it is necessary to reveal their dependancy from eachother with the intention that recent developments are known to decision makers (Bennett, 1996, 222). ICT needs to support and unfold new opportunites to business development. In order to do so, the Business Strategy aims to show the direction and ICT has to analyze what is required to support the selected goals and how it could be done (Targett et al., 1999, 74). ICT adaption open the opportunity to expand to foreign markets and internationalize (Kajewski, 2010) and with the right usage it is possible to adapt environmental changes and avoid past mistakes. Bennett (1996) and Hidding (2001) discuss that ICT Strategy needs to base on Corporate Business Strategy and contain different aspects of organization's arrangement. The rearranged and combined ideas of these authors are presented in Figure 1.

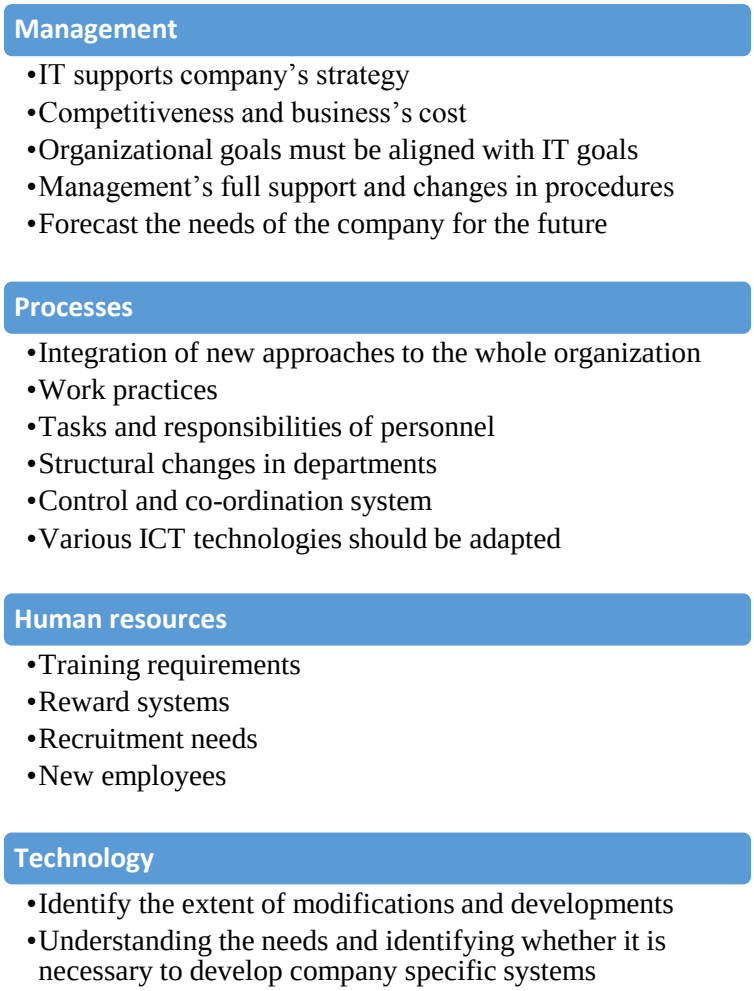

Figure 1: Elements of ICT Strategy.
Sources: Interpretation of Bennett (1996) and Hidding (2001)

Papastathopoulos & Beneki (2010) have categorized companies to three different levels based on their ICT performances as shown in Figure 2. The companies which have ICT adaption strategies invest more in this field. Interesting is that basic users have no higher margins if they have previously adopted ICT Strategy. In comparison the margins increase if the company is positioned in advanced or superior performance levels as the pace of technological innovations increase and new business opportunities will arise. They are more oriented to customer needs and information sharing while cooperation will be the key success factor (Kajewski, 2010).

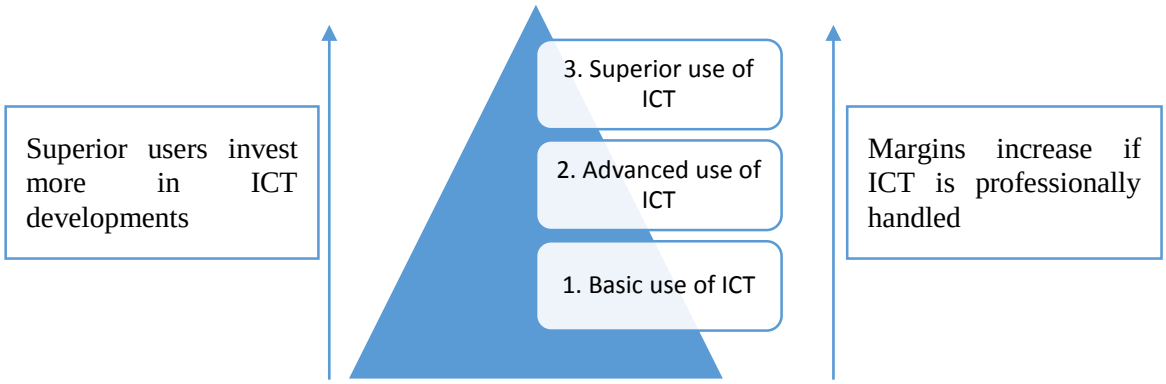

Figure 2: ICT performance levels.
Source: Papastathopoulos & Beneki (2010), modified by the author

Hamza (2014) describes in his paper, that previous researches have concluded that the influence of ICT on company can be described by five elements, which are linking the transformation between ICT and organization as they affect each other. The tasks which need to be done for implementing ICT Strategy concern many other areas of the business. The management should compare the competitors' actions regarding ICT adoption, find competitive advantage, define how IT could help them and analyze the impact of different IT solutions. The teams who work with the idea should not be only IT specialists, but also general planners and managers from the main departments. It is crucial to look the best options for the future needs as the IT systems tend to age rapidly.

To benefit the most from ICT strategy, the following steps are suggested to be followed (Bennett, 1996, 220):

1. identify key objectives of IT and the linkage between overall corporate strategy,
2. select suitable methods and procedures to benefit the most from the information,
3. identify different options for systems and procedures,
4. examine the effect on organization structure,
5. design the architecture of the system while focusing on business needs,
6. select new organizational structure which supports ICT and business strategy.

There is a need to predict the essential factors for coming years. If it is possible to skip some generations of the system, it is advised to do so.

It must be noted that there are also a number of threats that need to be considered when adopting ICT solutions. The main challenge is the rapid pace of change, which makes it difficult to predict the need for new improvements. In addition, in the early stages it is hard to calculate

the amount of investment needed and the final cost factor will remain unidentified. Another unknown factor is the need and cost of highly skilled employees to keep complex ICT systems running (Carayannis & Ziemnowicz, 2006).

2. IMPACT OF TECHNOLOGY

Technology is developing rapidly and it innovates at the same time business models. In order to be successful in the market, data needs a fast analyze. The impact of technological change is discussed in this chapter as they need to comprehend to organizational culture, align to Business Strategy and take into account paradigm shifts.

Competitive advantage is the capability of an organization to travel beyond the public knowledge and add additional value to the development through defining the goals and means (Kotler, 2012, 80; Salo, 2006). As the industries are adapting new solutions from other economic areas and combining new approaches, one of the option is to build competitive advantage and to use the possibilities technology has to offer.

The large number of opportunities and the diversity of choices are time consuming. Therefore the right strategy can multiply the effort many times if the organization encourages middle managers to learn and experiment. Strategic innovation has to prevent the company to limit the thinking with the conventional approaches (Grant, 2013, 258). The advantage is even greater if the company uses technologies or the combination of technologies, which are difficult to replicate by the competitors (Teece, 2010).

Innovation requires financial resources, research and development skills, facilities and organizational skills to spot new trends (Kotler, 2012, 80). Koch (2006, 91) points out the following reasons when to think about implementing innovation:

- the industry has low rate of product or process development,
- the client and suppliers need modifications,
- there is a possibility to find new clients,
- new trends can be transposed from other industries,
- fresh developments are carried out in other countries.

Technology has changed the way clients and suppliers communicate and there are numerous of obvious alternatives. As the end goal of a business is to create additional value with the existing resources, it is essential to re-think the possibilities. Innovators have to

understand the changing business environment, innovate product and use the most effective technologies to create value for the client. This is a pathway to competitive advantage and the business model has to change periodically, because the market for tomorrow's services and products might not exist today (Teece, 2010).

2.2. Aligning technology to Business Strategy

Technology has changed our business world during the last decades. The existing industries have been transformed and new industries (robotics, wireless technology, digital imaging, etc.) have emerged. These changes are a source of opportunity for companies who are more open-minded to adopt new technologies (Grant, 2013, 223)[1]. Predicting the forthcoming alterations has become very difficult as the social cultures are shifting. Today's successful companies are using the known path and repeat their way of doing business. A threat of missing new challenges concerns them because of lack of technology planning methodologies (Hakkarainen & Talonen, 2006). Therefore an adaptive mindset is necessary for existing effective companies to continue their successful path (M. Salo, 2006)[2].

Strategy should separate the existing products, services and technologies from the opportunities, which drive the upcoming demand to create value through innovation (de Kluyver, 2000, 77). Grant (2013, 97) describes the concept of Schumpeterian competition, which discovered the link between industry and competition. He states that innovation is the fundamental factor of industry's driving force and new methods to competing are the result of innovation's creative destruction. As economies are changing it is clear that the pace is more likely going to accelerate even more and the rivalry is going international (de Kluyver, 2000, 14). Koch (2006) has labeled the most effective area to focus on as a "sweet spot". To control

[1] A study conducted by Koch (2006, 38) revealed, that the companies who are in the leading positions of the market, have climbed to the top level after a change in demand or breakthrough in technology occurred. The leading companies were the first who seized the opportunity. They weren't necessarily the first in the field, but the first who recognized and understood the meaning of change. At the same time experts believe that many successful companies have implemented insufficient technology planning and could be even more effective (Hakkarainen, 2006, 136).

[2] Some examples of companies with strategic management of technology are Sony, Toyota, Canon who come from dissimilar industries (Hakkarainen, 2006, 135).

the "sweet spot" and receive exceptional earnings, continuous innovation must occur[3]. The awareness of the strategic significance of technology is increasing over time as competitive advantages and value adding activities become more visible on specific markets. A good strategy includes the analysis of the best options, which need to reflect business opportunities and technological possibilities (Hakkarainen, 2006, 143). The integration of technology into Business Strategy and planning requires the understanding nature of the altering business situation in a long term (Phaal, Farrukh, & Probert, 2000). None of the strategies are good enough separately, but gain effect as they are combined. The Business Strategy has to meet prudent decisions of Technology Strategy and vice versa to support each other (Hakkarainen & Talonen, 2006).

Hakkarainen (2006) has summarized the types of technological advances described by Schumpeter which should motivate entrepreneurs to take action:

- qualitative change in product performances,
- process innovations,
- new clients and markets,
- organizations change to be more effective.

Hamel & Välikangas (2003) present a clear opinion that the technology breakthroughs are changing business models. The companies which constantly discuss and analyze the topic of emerging prospects and trends are more resilient to economic impacts. They are not defending their past, but are remaking their future. The road to revolutionary changes need to meet new technological challenges. The challenges are more action-oriented and concentrate clearly of using the existing know-how (Phaal et al., 2000). The use of technology can assure firm's competitiveness and manage knowledge and specific skills more effectively (Hakkarainen, 2006, 170).

[3] These rules have the most influence to the companies who focus on "knowledge" or "specialization" as innovation is their focus point (Kotler, 2012, 78)

2.3. Paradigm shifts

Bailey and Johnson (2006) researched innovative business models and concluded that innovation could be categorized in ten topics, which are the basics for fresh strategies. It is interesting that these themes are not industry-specific and can be accommodated as required. The trends shown in Table 2 are basing on long-term economic changes and the progress can be predicted. As these dominant strategic approaches have changed the organizational culture, they can be named also as paradigm shifts. These paradigm shifts have provoked industry-wide views and approaches and changed the way business has been done. Therefore in the mature industries the groundbreaking solutions are mainly related to the companies which are outsiders and can easily adapt new industry-wide transformation (Grant, 2013, 258).

Table 2. Synopsis of paradigm shifts

Strategic paradigm shift	**Stating point**	**End result**
Convergence	Discrete	Converge
Experience	Product based	Experience
Immediacy	There and then	Here and now
Mass-customization	Mass	Individual
Universalization	Elite	Universal
Providing solutions	Component	Solution
De-virtualization	Vertical	Horizontal
Consolidation	Fragmented	Consolidated
Disintermediation	Intermediate	Disintermediate
Going virtual	Physical	Virtual

Source: interpretation of Bailey & Johnson (2006)

Grant (2013, 108-111) describes that every industry has four stages: introduction, growth, maturity and decline. The forces and key success factors which drive the companies in each stage are different. The maturity phase is described by de following characteristics (Sabol, Sander, & Fuckan, 2013):

- demand: customers are price sensitive,
- technology: pursuit for technical improvements,
- products: attempts to differentiate by quality,
- manufacturing: deskilling of production,

- trade: production is moving to industrializing countries,
- competition: price competition increases,
- key success factors: cost reduction by scale efficiency.

Most of these characteristics are suitable to describe Construction Industry in general. Grant (2013, 111) has identified growth phase with the following characteristic: *"shifting from product innovation toward process innovation*". In the context of integrated ICT solutions in the industry, it can be categorized into growth phase where technology has rapid process innovation, but the AEC industry has not used new possibilities[4]. Organizational structures are in need to orientate more to client and become aware of economic and social changes. These shifts are starting an innovation process in this mature industry. The ability to compete in the construction market in the near future will depend from the openness to innovation adaption. For an effective transformation, the innovation process has to be approached from integrated point of view (Girmscheid & Hartmann, 2001).

[4] Innovation can occur when there is a need from product and also from service side (Kotler, 2012, 82). There has to be pull-effect from the market to bring changes in the services.

3. CHARACTERISTICS OF CONSTRUCTION INDUSTRY

In this chapter the specific characteristics of AEC industry are presented in order to understand the specific needs of the economic sector. The results are used to isolate and focus on industry specific strategic issues.

Construction Industry is rather slow adapter in terms on firm-specific process innovation and can be identified as a "complex system industry" (Miozzo & Dewick, 2002). Even if innovative concepts are introduced, the slow diffusion is noted in several European countries[5].

Different companies involved in the same project have adapted in the region similar work methods. To start the innovation introduction process in industry, the key player is the client and main contractor, who have a vision that there are long-term benefits if they adapt new methods (Miozzo & Dewick, 2002). Even in such case of adaption, the process in the whole sector will be slow because of high number of partners involved in construction projects. To change the project-based system to be more collaborative, the interest of all stakeholders is still necessary (Blayse & Manley, 2004).

The industry is beginning to look for best options to control new processes, while maximizing the benefits of their investments. This can be done by increasing strategic importance of ICT (Underwood et al. 2010). IT expenditure in Construction Industry is significantly lower than in other sectors and there is a lack of knowledge regarding the role of ICT. The project-based investment projects compete against each other and the decisions are taken upon calculated results, while it is hard to find the short-term return on ICT investment. In order to improve the situation, it is critical to understand that full benefits can only be achieved if ICT is part of overall firm strategy (Andresen et al., 2000). Overpowering the disintegration could be achieved by technological breakthroughs and the hidden advantages can change the whole industry[6].

[5] An example can be found in the recent increase in the interest of multi-story wooden and passive houses, which were introduced several decades ago (Hemström & Gustavsson, 2011).

[6] A survey concerning Turkish construction industry by Sarsar & Iskidag (2004) concluded that to overcome low productivity factors, there is a need to engage more R&D programs and the industry needs to adapt future directions of technology readiness.

The following sections introduce the issues of ICT adaption in AEC Industry. Section 3.1 discusses Industry characteristics which influence ICT adaption. Section 3.2 describes the possibilities for the companies and Section 3.3 describes some comparative industry's ICT adaption issues in order to compare the situation in Estonia based on the results of the thesis.

3.1. Innovation in Construction Industry and the role of SME's

The Construction Industry is the third largest non-financial business economy in European Union, generating 10% of GDP and involving more than 20 million employees. This sector can be characterized as cyclical, dependable from macroeconomic stability and slow adaption of innovations. The SME's in Construction Industry cover about 85% (European Commission, 2011) of the workforce which leads to low capital investment possibilities needed for innovation adaption[7]. While 56% of manufacturing companies are exporting, the Construction Industry reports are as low as 7% (European Commission, 2010). On the other hand there is a correlation between high internationalization rate, better business performance scores and innovation capability.

Internationally active SMEs report higher turnover growth and are more innovative[8]. One way to innovate is to introduce process innovation, which is already in the market. Internationally active companies are more able to provide innovative products or services. As they gain competitive advantage, the foreign investors are more likely to invest in international scope. It is probable that internationalization leads to innovation due to the need to have competitive advantage in other markets. The result is also called "learning-by-export" or internationalization effect (Branstetter, 2004). It can be said that internationalization is one of the drivers for innovation and already the plans to start export or technological cooperation with companies abroad, tend to rise the process innovation rate. The main business environment

[7] In European Union there were 135.8 million people employed in 2008. 90.6 million persons were active in SMEs and 45.2 million in large enterprises. Although the SME's embrace 66.7% of workforce, they create 58.6% value added (European Commission, 2011). Value added increases with the size of the firm (Vetter, 2014) and SMEs have aggregated efficiency in the economy.

[8] 24% of micro, 38% of small and 53% of medium sized companies have export activities. Also the countries with smaller internal market (Estonia, Denmark, and Sweden) show higher internationalization rate. As technical cooperation is necessary to improve the product or increase the productivity, the medium-sized enterprises are three times more active in this field than micro enterprises (European Commission, 2010). 7% of all SMEs have cooperation with enterprises abroad. (Micro 7%, small enterprises 12%, medium-sized 22%).

related barriers for Internationalization in EU markets are lack of capital, lack of adequate public support and lack of acceptable information regarding the specific need (European Commission, 2010)[9].

The AEC industry can be characterized with a structure of the pyramid. Large companies on top of the pyramid have the control, while relying on large number on SME's. At the same time the scientific researches on organization readiness and ICT adaption case studies have focused on top construction organizations (Hamza, 2014; Peansupap & Walker, 2004). To change the industry it is needed to modify the strategies of SME's to more collaborative approach (Hamza, 2014). SME's are able to achieve different outcomes compared to large corporations.[10] For SME's it is crucial to analyze possible strategic directions, which could benefit them the most (M. Salo, 2006). Although the amount of ICT investments are increased after 1990's, the AEC sector has lower technology adaption rate and still lags behind (Hamza, 2014; Hosseini, Chileshe, Zuo, & Baroudi, 2012). It is expected, that the use of IT will improve communication between organization in near future (Stewart et al., 2004). In developed economies the pressure from clients has increased, resulting ICT supported high-quality process and project management (Alkalbani et al., 2012).

Fragmented industry characteristics which are defining AEC Industry are by de Kluyver (2000, 74): easy access and low exit barriers, unattractive consolidations, local control and the need to customize products and services. Small and medium enterprises, which do not have resources for long-term innovation, are more often created because of these coexisting factors. As synergy comes from collaborative approach it is necessary to focus on the process efficiency inside of SME's (Stewart et al., 2004) and also the partnership between SME's and corporations (Hamza, 2014).

Among CEO's there is a strong belief, that new technologies provide competitive advantage in Construction Industry. Technology push makes it available to belong to the group of early adopters, as new technologies deliver benefits. 95% of the top-level managers, who

[9] It is notable that European Union countries are providing support for SMEs, but the minority is aware of them and rather low rate actually uses them. SMEs from Austria and Turkey have used the support very actively (47% and 32% accordingly), while the majority of countries report that the use of financial support is lower than 5%. In comparison to general outcome, only 17% in construction sector are aware of the possibilities and less than 2% of internationally active SMEs have reported that they have used them.

have invested previously in advanced ICT solutions are considering new investments in this field (Alshawi et al., 2010).

As an example to be mentioned, UK government has announced to demand the usage of new methods in public procurement in the beginning of 2016. It is identified, that SME's have inferior position to receive benefits from the change. To improve the adaption there is a need to provide professional guidance (Hamza, 2014). Recent surveys have stated that as the companies are in the adaption process, the talents are trained mainly inside the organizations (Wu & Issa, 2014). To understand the scope the following steps should be elaborated:

- identify the strategic direction,
- forecast the need for workforce,
- analyze the foreseen gap if competencies, skills and number of employees,
- implement an action plan for development of employees,
- execution of the action plan with scheduled monitoring.

One of the obstacles for companies is the lack of professionals with adequate skills to implement new technologies successfully. At the same time population in the European countries is decreasing. Therefore there is a practical need to increase workforce' productivity in the near future. To implement ICT to company's strategy, the employees' requirements have to meet new needs. As the developments of technology are emerging and there is a direct link between planning of human resources and firm's strategy, development plans should be flexible and be able to adopt latest ideas. It has been noted that new technologies have made the construction sector a bit more exciting for younger generation, creating new positions[11].

To make a positive decision regarding ICT investments, a promising impact to the business outcome should be predicted. In the multi company scenario it is difficult to find reliable method and to represent the outcomes in one model (Ahuja et al., 2009; Isikdag & Underwood, 2008; Kajewski, 2010; Aranda-Mena et al., 2009). This has resulted with a undervaluation of ICT investments (Isikdag & Underwood, 2008) and seen as a risk for stakeholders (Azhar, 2011). Less than half on the companies have stated that they have the competence to measure and value ICT investments in their firm (Isikdag & Underwood, 2008).

[11] In UK during years 2010 and 2011 the employment of construction professionals increased in consultation from 13% to 31% (Wu & Issa, 2014). This means there is a sudden need for professionals who can introduce new technologies in the company if technologies pull is present the market.

As the industry is cautious in investing to ICT, the trend of a paradigm shift is influenced by organizational readiness and by the culture of the companies (Alshawi et al., 2010). Hosseini & Chileshe (2013) has identified three main reasons why the companies adopt ICT changes: globalization, specific needs and proven benefits delivered by ICT. Brewer & Runeson (2009), Underwood (2010) and Isikdag & Underwood (2008) add the importance of technological pull, the personal attitude of the manager, cost effectiveness, need for added value, alignment with business objectives and industry driven needs to the list. There is a need to combine these inter-related drivers into an ICT strategy, rather than look them in isolation (Ahuja et al., 2009).

During the investment decision-making process the feasibility, direct and indirect cost of investment and expected outcome should be considered (Irani & Love, 2001). The cash flow of Information system implementation shows immediate costs (direct and indirect), but the incomes are only estimated and can be seen only somewhere in the future (Irani & Love, 2001). Furthermore, the expected improvement must be compared by the actual results to provide measurable and quantifiable results. Different studies have reported that the return on investment (ROI) for the use of new technologies varies from negative values to +60% depending from the calculation scope and timeframe. To measure long-term benefits, the time-frame should exceed up to 8 years (Love et al., 2013). Therefore it is reasonable to understand the evaluation process.. For the assessment it is essential to clarify what, when and how has to be evaluated (Stockdale, Standing, & Love, 2006).

As there can be different drivers in the corporation, additional research at the strategic level gives significant influence to the business outcome. Structure of the company (ownership, management) and the financing options affect the positive decision regarding investments. Even if the activities' themselves come from different levels, the decision of adaption must be approved from top level and involve high capital investments (Miozzo & Dewick, 2002). As the return of the investment depends form other stakeholders of projects, it makes it difficult to calculate the outcome of R&D activities by individual company. Furthermore if the investment needs to be funded externally, it might be difficult to get a debt from the lender (such as banks). In European collaboration programs it is recommended to maximize the effect of the investment (Miozzo & Dewick, 2002). This applies when contractors have rather little amount of liquid fixed capital. At the same time rather small amount of investments are derived from abroad and the companies are more influenced by local economy. Widely used approach of lowest cost

tendering limit the possibility to change design or use alternative approaches to the problem (Sarmet, 2014).

The need for increased productivity in Construction Industry has been high priority research topic during the last decades. Although there has been many studies regarding the performance measurements by implementation of digital technologies, it is difficult to reveal existing benefits in reality (Love et al., 2013). As the use of ICT influences all partners in the process, the investment calculation must take into account the whole supply chain. As the ICT paradigm has modified the way of thinking and business concepts are altering the Construction Industry and evolving during use. Therefor decision-making investment is a difficult procedure. The investors need to estimate the technology, organizational change during its introduction and potential of the employees (Love et al., 2013).

3.2. Maximizing the benefits with ICT introduction

In this section the current situation of ICT introductions in AEC companies is discussed. The reasons for existing ICT strategies are discussed and couple of other industries are compared in order to relate the thesis research to recent developments in European economy.

It is forecasted, that global Construction Industry will grow up to 70% by the year 2025 (HM Government, 2015). Basing on recent changes in other industries, the increased adaption of ICT could help to manage this issue more effectively.

Underwood et al. (2010) argue in their paper that not all ICT investments in Construction Industry have delivered strategic value. One of the reasons is that the end goals are not aligned with Business Strategy. Companies need to focus on the outcomes of the innovation to set targets and understand the strategic value ICT strategy can derive (Joshi et al., 2010). A strategic approach means that the introduction of ICT is basing on corporate strategy. The innovation has to be done with the support of management, include the real users and the goals have to be linked by software developer (Peansupap & Walker, 2004). The construction sector is maturing in the context of understanding strategic benefit of ICT investments and project oriented views are changing to strategic views in the context of business. It is clear that most of the investors would invest if the improvements were driven by strategic goals (Alshawi et al., 2010).

Construction projects and management enhance a large amount of documents and information which link many project participants. Without ICT solutions, as it is usual today, these documents are moved physically. This means enormous amount of paper is printed out, filed, delivered and archived. Rapid achievements in technology can change the situation enabling to be more effective in communication information exchange (Onyegiri & Nwachukwu, 2011).

To improve collaborative approach ICT solutions should be implemented in the organization. In order to do that effectively in short-term, the education and training should be thought through. There might be cases that the workforce is not ready for the ICT adaption[12]. Effective training is needed and the team members need to be brought together to get the collaborating effect (Hamza, 2014). As the keyword is collaborative approach, it is presumed that government takes actions to improve the overall situation which cannot be changed by firms alone[13].

AEC industry is project based and each project is different in many aspects. Andersen (2000) has identified more than 30 investment calculation methods, which base on financial ratios or subjective approaches. Although many of them are proven to useful in other industries, they are aimed for continuous activates and can't be implemented in Construction Industry. There is no dominant method which is used in by individual firms nor by group of organizations. The basic principle is that a strategic alignment has to occur to measure paybacks after innovative method is introduced. Otherwise the evaluation might not have holistic approach and does not give truthful result. In order to evaluate ICT innovation it is required to understand the Business Strategy and ICT infrastructure integration to reach the stated goals (Hidding, 2001). More recent study by Alshawi (2010) has shown that a shift from project based approach is moving to organizational level regarding ICT investments.

Smaller firms are on the lower level of the supply chain and the main innovative initiative needs to begin from the top of hierarchy. A study by Sexton & Barrett (2004) has identified that SME's use the technology which has quick results, is easy to integrate and there

[12] It is the case for Turkish Construction Industry, where rather low rate of ICT skilled people are available for AEC sector (Sarshar & Isikdag, 2004).

[13] A research based on Iranian Construction Industry stated that government should focus on ICT infrastructure, high quality internet access and targeted training, common standard for information and financial support to smaller organizations (Alaghbandrad & Nobakth, 2011).

is already existing know-how in the company's personnel. Risky investments, which require too many resources are not introduced.

Construction Industry' organizations have not enough experience to emphasize organizational issues regarding ICT adaption (Peansupap & Walker, 2004). Ahuja (2009) has conducted a research regarding ICT implementation in project perspective of AEC industry. Her main concern was how to evaluate these benefits in fragmented industry which has multiple-enterprise environment. The results show that the collaboration of companies and the need to look for broader strategic benefits is essential. It is rather hard to benefit in isolation and difficult to forecast the benefits of single company. IT tools could provide business process integration to multiple organizations (Andresen et al., 2000) and reduce costs for all participants (J. Salo, 2006). Also Hosseini & Chileshe (2013) points out that there are potential benefits for collaborative approach in the globalizing environment of AEC industry which can't be achieved by single company. He suggest to increase motivation by highlighting the potential benefits to the industry.

Most of the innovative developments originate today from the supply industry, however it is not the critical chain link in the process. The most critical and most beneficial barrier is the co-operation between all Construction Industry participants and their business units, while the knowhow could be transmitted to ensure higher productivity (Hartmann, 2006)[14]. To introduce collaborative technologies in SME's, the companies should focus on defining the responsibilities of collaborative technologies, understanding the importance of highest level commitment, understanding intellectual property rights and making the technology use as common behavior (Hamza, 2014).

SME's have little or no resources to innovate. They choose less expensive technologies, which are universal and not fitted to their specific needs (Hua, 2007). This way of thinking doesn't provide the highest potential. Competitive advantage can come from adapting ICT solutions in the first line, therefore the companies invest in ICT solutions that are fitted for their organization's specific needs (Peansupap & Walker, 2004).

Different studies, such as Hua (2007) and Sarshar & Iskidag (2004), have stated that SME's have lower rate of ICT awareness, competency, and the potential benefits for using ICT to achieve strategic goals. This shows that innovative and collaborative approaches cannot be

[14] In Australian construction industry, the major challenge is the inter-operability of electronic information exchange and the SME's could benefit after the open standards are developed by leading companies and the learning curve is shorter (Stewart et al., 2004).

implemented while addressing these companies more intensively. The study by Hua (2007) states that middle-sized companies have adapted more ICT solutions than Small and Micro organizations as the senior management understands that the main driving forces for the future are knowledge based technology and globalization. The main advantages for middle-sized companies are efficiency growth through networking and e-commerce, aligning ICT strategy to business strategy to achieve greater returns on investments, possibility to orientate more to customer & benefit from long-term growth and to benefit from standardization of information to reduce rework.

Larger firms favor technology to rise customer satisfaction and technology leadership and use it much more likely on strategic level[15]. In comparison, the Small and Micro organizations would need the same benefits, but the barriers are from their side the price of innovative solutions and software compatibility. SME's are using rather traditional working methods in Construction Industry because of high risk of innovative solutions, technology changes rapidly, high training investments, lack of standardization in the industry and low investment margins which leave no room for innovation (Andresen et al., 2000).

Hosseini et al. (2012) have studied and summarized different approaches how and why ICT implementations in Construction Industry have occurred. They discuss that to change the slow adaptive approach, a great motivation is needed. Their core concept is to promote successful ICT introductions. The main driving forces for ICT innovation are productivity (Process efficiency), globalization (Globalizing trend), industry habits and scheduling problems, competitive SME's have new approaches, location of the company limits possibilities, need for visualization, short-term business relationships limit productivity and changes in the approach to project life cycle from the client side. The researches show that the use of ICT can affect the productivity of coordination and collaboration in Construction Industry[16].

[15] To master the innovative ICT possibilities, the Industry in UK has seen evident shift of focus to organizational level which addresses the readiness and maturity of the organization (Underwood et al., 2010).

[16] Turkish construction industry has had a positive effect in the following areas: cost, information exchange simplicity, cost and competitive boost. The availability of appropriate technology is existing, but there is a lack of support by managers (Iskidag et al, 2008).

3.3. Few studies from selected industries

The following section is introducing similar researches conducted in Turkish[17] and UK's[18] Construction Industry. The descriptive appearance of these studies support the author to find suitable research methodology and give an internationally comparative background to the thesis.

Iskidag and Underwood (2008) have completed a study regarding the importance of ICT strategy in Turkish Construction Industry, concerning mainly business processes. 40% of the organizations stated that ICT is not important to win work. The hypothesis is that the percentage is that high because the clients and customers are not aware of the possibilities and aren't requesting new methods during bidding process. The organizations which see that ICT strategy is important for them (38%) aim to reduce costs of the construction process. ICT investments are mainly made with the intention to support the processes not to improve competitive advantage. The investments are driven by cost reduction and value adding in process level.

A more recent study by Alshawi et al. (2010) has acknowledged that strategic significance of ICT is rising among construction companies in UK. The decisions of ICT investments and the nature of them is concerning more and more the organizational-wide aspects and they are started to integrate them into business strategies, while understanding the potential for competitive advantage. At the same time 77% of the questioned ICT directors and CEOs believe that the aim of ICT innovation is to improve organization performance. Although all participants stated that the use of ICT strategy is essential, the methods are rarely used in the industry. Investments of ICT of contractors are mainly driven by customer demands (53% of the cases). The organizational readiness is one of the main components which affects the decision and former failures or successes by adopting ICT innovations are not very relevant in the decision making process. The industry in UK has shifted their focus from cost reduction at an operational level towards the organizational level. More attention is given to external and internal perspectives and to products and services.

[17] The study in Turkey focused on the strategic importance of ICT (21 major consulting and contracting firms). It was conducted by using questionnaires and personal interviews. Their main concern was to evaluate current state of ICT usage in Turkish industry.

[18] The research conducted in United Kingdom is focused on the 100 most influential contracting firms. Their aim was to identify current gaps in decision making process and in thinking by investigating critical elements for decision making process and drivers. A questionnaire was created with 11 questions and 5 answer options based on maturity concepts.

In comparison the Turkish AEC industry does not show this alteration as there are less ICT usage in general. The UK' industry understands that ICT can play a role in strategy setting and the main success factor has been internal improvement. The focus has shifted from winning next work (also internal focus) to communication improvement in the supply chain (also called external focus). In UK the driver is the overall thinking how to improve the external communication and the readiness for digitalization is one of the major issues to deal within organization. In Turkey this shift is not noticed - ICT investments do not depend on external communication improvement. The focus is clearly towards internal factors.

Both industries see that ICT can deliver competitive advantage and there are strategic benefits. At the same time both industries take a conservative approach to invest in the ICT innovation. The alignment of ICT and Business Strategy is important, but it is not done in either country. Both industries are facing the challenge of understanding new processes and adding additional value through ICT. The investing decisions are based on the competitive advantage the technologies could offer them. The authors discuss, that the greater integration of ICT in the economy overall has resulted higher growth rates in UK. As the Construction Industry lags behind, it is important to fully introduce ICT to remain competitive in the case that 75% of investments did not achieve business objectives[19]. One of the reasons of these failures is the lack of understanding of ICT's strategic value as it is mainly seen as cost decreasing tool by the managers. Because of the misalignment it is not possible to get strategic benefit with this approach.

[19] The cost of ICT projects which fail, is 6.18 trillion USD (indirect and direct costs) and the trend is worsening (Underwood et al., 2010).

4. IDENTIFICATION OF CHALLENGING ISSUES

The studied literature gives in-depth overview of the topic and the main arisen questions for further research are formulated shortly in this chapter.

It is noted that during the last decade the interest in this field has increased in order to understand new innovative solutions. There are many different strategic option for a company to implement new technologies, but the decision to invest into more advanced technologies must be taken from top-level management. The study raises three main issues which need to be addressed in the Construction industry.

The motivation for innovation in other industries has changed from efficiency and effectiveness to business value creation as discussed in Chapter 2. The shifts have occurred because of the changes in the society. Globalization is increasing the need for higher and faster collaboration, information's flow from external and internal sources is growing and the businesses are changing their focus more often. At the same time client pull, as new needs are evolving, and technology push is noticed. This means that the traditional industry is on the verge of change and there might be benefits for early adapters**.** The question arises whether more advanced firm's see the need to adapt their current Business Strategy to the new situation.

Recent studies show that most of ICT investments have not achieved business objectives and the trend is worsening. The presumable reason is that the managers do not understand the strategic value of ICT and do not implement it horizontally in the company as discussed in Chapter 3. The misalignment in company's strategies disables the possibility to find new business-driven solutions to achieve competitive advantage. As the literature gives new insights to the need of implementing ICT to business strategy, it is presumed that this integration opens new possibilities to the companies. Further research is required to understand which business objectives could be achieved through ICT introduction.

Construction Industry is fragmented and there are many partners throughout the supply chain and they are influencing each other's productivity. In theory the use of ICT should

increase the efficiency of internal and external communications and data flows as discussed in Chapter 3. In the other hand the given overview of AEC industry characteristics in Chapter 3 show that the SME's have shot-term visions and have low innovation capability. In order to improve the collaboration every part of the supply chain needs to adapt new solutions and create a critical mass of adapters in order to receive more benefits. In this case it would be appropriate to map the motivators in the specific companies who have established ICT based collaboration in order to evaluate the ICT potential.

It is seen by the author that the selected topics could open new insights and possibilities in the construction industry to implement ICT to business strategy. Following topic is providing research methodology to reveal new insights in these fields.

5. RESEARCH DESIGN

Current chapter is arguing and selecting suitable methodology for the thesis. It is aimed to shape the methodology to be repeatable by other researches. The description for research design by White (2002, 26) is: "*Overall, the research design is the blueprint or detailed outline for the whole of your research and dissertation*".

The following research design chapter clarifies the aims of the research and contains the discussion of selected methodology. Section 5.1 clarifies shortly the academic background of research philosophy and its ethical considerations. The arguments of suitable methodology are explored and selected. The explanation of data collection techniques clarify data analyze and interpretation methods. Section 5.2 discusses Interview design, research questions and participant selection.

5.1. Research philosophy and data analysis procedures

Research methodology and the way of thinking direct the research, the results and further interpretation. Simultaneously during the research personal values, previous experiences and mindsets create assumptions (Greener, 2008, 16). In order to direct and evaluate current study, basic theories regarding the way of think are discussed in this section. The argued qualitative and quantitative methodology approaches conclude with suitable methodology selection by the end of the section.

Qualitative research is a descriptive way to collect information and is more often associated with interpretive model and inductive approach and the style of constructionism (Byrman & Bell, 2011; Greener, 2008). Inductive research starts with a focused problem statement, investigates it thoroughly and generates theory. It is mainly used in social sciences, economics and politics. Interpretivist research is more common in social sciences as it is interpreted through subjectivism.. It tries to understand the ideas of participants and understand multiple perspectives (Greener, 2008, 16). Most probably the researcher conducts data

collection personally. Qualitative data collection methods are interviews, case studies, and observations (White, 2002, 29). The research questions have the following characteristics (Creswell, 2014, 110):

- There is no mature understanding of the topic and a lack of previous research
- Available theory can be inappropriate or inaccurate
- There is a need to develop the existing theories or explore the phenomena
- The phenomena could not be described by quantitative measure

The research problem could be understood better when the phenomenon or concept is explored and the research is also exploratory in nature. The research question should have one central question and up to seven associated sub questions (Creswell, 2014). The idea of objectivism is stating that social objects are reality.

Quantitative research is presented in numerical values and the method is mainly associated with deductive approach, positivism and objectivism (Byrman & Bell, 2011; Greener, 2008). Deductive research begins with the concept survey, produces hypotheses and then tests the theory. The idea of positivists is more implemented in natural sciences as the research should be "value free" and create more objective statements.

Statistical and mathematical treatment is needed to present the results (White, 2002, 25). The method describes, clarifies and tests the presented links and their relationships. The data is analyzed after the research is conducted. In business main data collection methods are experiments and surveys. The general idea of quantitative research is that a hypothesis is set up and tested with the data. Depending from the results, the hypothesis is rejected or accepted. Measurements and values are given in numerical data, presented in units, time or positions. If specific statistical analysis is used, then it needs to be cleared in the beginning to be able to collect needed data. The comparative characteristics of discussed research philosophies are presented in Figure 3.

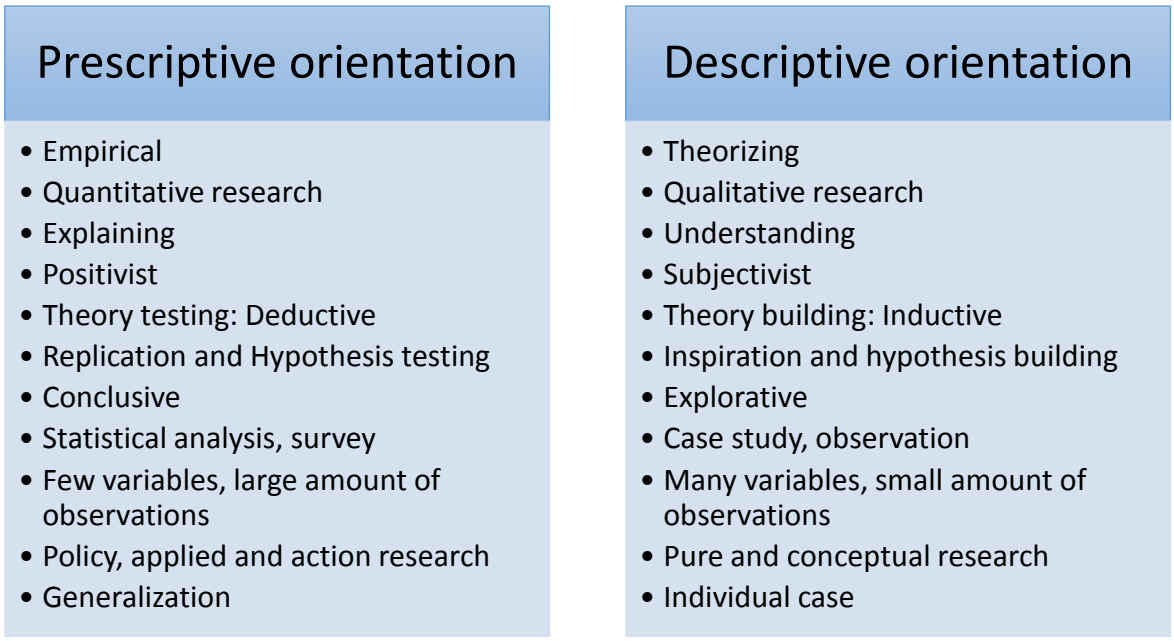

Figure 3. Research orientations
Source: von Tulder (2007, 45 Figure A.7), adapted by the author

Current research question is aiming to explore the phenomenon of the need for ICT alignment to Business strategy in AEC industry. It has descriptive orientation and is characterized by the nature of qualitative research question. Based on the aim of the researched topic it is suitable to choose qualitative research methodology which enables to discover new approaches and trends.

The intention of selected interview technique is to ask open-ended questions in order to receive the opinions and perspectives of the participants. The limited number of questions for this research allow free conversation and have unstructured form. As the research is exploring the strategic level which is available for high-level managers, in-person interviews are used. It is assumed that the other types of interviews (focus group interviews, interviews via e-mail or telephone) do not open the participants as much.

The personal interviews enable to discover historical information and to control the course of the interview. As direct observations are not possible, it is noted that the information can be influenced by subjective views of the participants. The selected unstructured interviews with open-ended questions may lead to additional information which is hard to interpret. Therefore the conversation is taped (which all the participants allowed). In addition a questionnaire regarding the company is filled before the interview (Appendix 1).

The data analysis is separated into two phases. The procedures are visually organized in Figure 4. Phase one is more general and concentrates to single interview result, while the second phase is more specific. The general analyze is conducted after each interview in order to organize the structure of final report and emphasize useful information from the conversation. After the recorded data is collected, the interview is typed in. The collected data is structured in specific themes in order to focus the results. The list of topics are written down and clustered after each interview.

The second detailed data analysis and comprehensive data structure is conducted after all interviews are finished. The whole material is worked through again in order to get holistic overview. The results are assembled and the coding is rechecked. The created themes are represented in a narrative discussion and comparable data is presented in tabular form. After the themes are arranged, the interpretation is linked with the results from the literature and suggestions are composed. The data analysis procedures of current study are basing on the work by Creswell (2014).

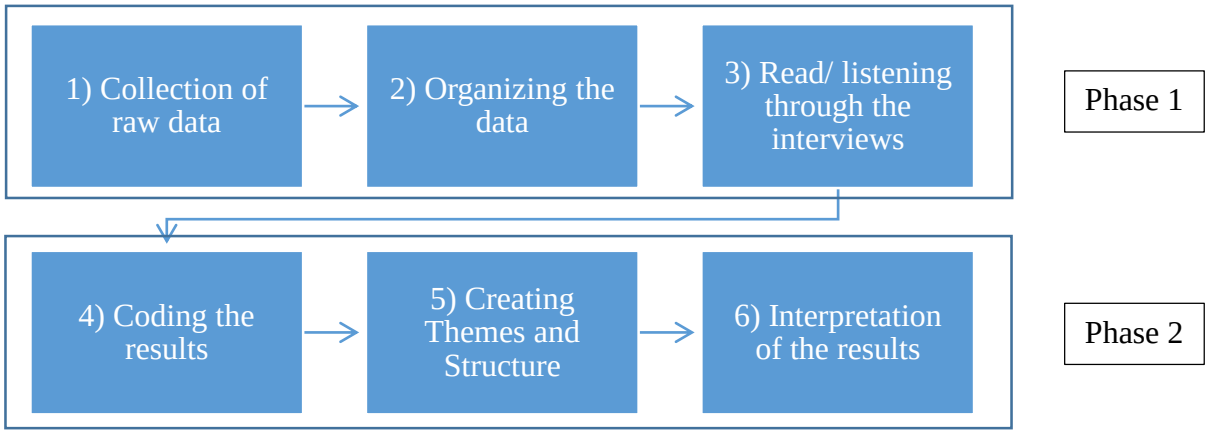

Figure 4. Data analysis procedures
Source: Creswell (2014, 197 Figure 9.1), extended by the author

In order to check the preliminary outcomes and clearness of the interview questions a pre-test is conducted. After the feedback and adjustment of the queries final questions were composed. The pretesting is conducted during May 2015 and the final interview period is two months beginning from June 2015.

5.2. Interview design and participant selection

The questions are composed as open-ended queries in order to get new perspectives to the topic. If needed during the personal interviews additional explanation is provided in order to avoid misunderstanding. At the same time the need for objectivity is taken into account. All questions presented in Appendix 2 are asked from every participant.

Topic 1 is aiming to collect the participant's point of view to the current innovation situation in Construction Industry in general. The topic addresses the insight of managers weather there is a need to adapt new technologies, are the long-term benefits and which main obstacles are present in the industry and firm level. It is argued whether innovation introduction changes the way business is done. With this topic it is aimed to understand the participant's point of view to ICT management in general.

Topic 2 identifies the current level of actual ICT implementation on firm level. The aim is to evaluate current ICT usage in accordance to ICT performance levels (Figure 2) introduced by Papastathopoulos & Beneki (2010). The discussion is also covering whether the ICT usage is internal or external and how have the company already benefited from new technologies. Second focus in this topic is to collect information regarding current ICT strategy of the company. It might occur that the ICT usage is already supporting business strategy, but it is not formulated separately. It is important to understand the perspective of the participant how could ICT provide competitive advantage in the future in the firm and in the industry.

Topic 3 is focusing on the current Business Strategy. The aim is to identify the presence of the strategy and their main competitive advantage in the near future. The second part of this topic is aiming to understand the thoughts regarding the need to align ICT to Business Strategy in the firm, which benefits or limitations are to be seen and how to evaluate ICT developments.

Selected topics cover a wide range of themes and the outcomes of the study can be interpreted differently. In order to get enough data, the selection of participants is discussed. Current business research involves individuals, who have different views and intentions. Therefore all individuals are treated equally and mental stress situations are prevented. Participants have respect to privacy and their anonymity is guaranteed. During the interviews self-confidence and self-determination of the participants are not influenced and the information regarding the research is revealed before the interview and the results are available to participants.

For the study five individuals for different companies are selected. One company is large, three medium-sized and one with the size of micro. They cover the areas of development, consultancy, design and construction. The overview of the participants' companies, which was provided on filled questionnaires is shown in Table 3. As the interviews have revealed sensitive information regarding the strategic positioning, the main results are presented anonymously and the interviews are randomly numbered.

Table 3. Overview of participants' companies

Participant No	**Field of activity**	**Size of the company**	**ICT usage**	**Existence of ICT Strategy**	**Managerial level of participant**
Participant #1	Development, Construction	Large	High	Yes	Mid-level
Participant #2	Construction	Medium	Medium	No	Mid-level
Participant #3	Development, Construction	Small	Medium	No	Top-level
Participant #4	Consultancy, Engineering	Small	Medium	No	Top-level
Participant #5	Architecture, Engineering	Micro	Medium	No	Top-level

Individuals who have enough information are selected and persuasion to participate is avoided. It is understood that the background of the participants influences the outcomes dramatically. Therefore the participants and the companies in which they are involved need to hold enough know-how regarding the technical innovation and have some experience with it. Similar approaches are suggested by Creswell (2014, 186) and von Tulder (2007, 157). In order to evaluate the importance of ICT in the company, the selected participant are at higher level in the structure and have access to the business strategy. The companies are active firms in AEC industry. As the general aim of the interviews is to discover new perspectives there is no need to involve large number of participants. In order to get new insights from the industry, the companies differ in size and activity area.

The participants evaluated the ICT usage rate in comparison to other companies by the experience of participant. All SME's stated, that they have medium-level ICT usage although they have no specific ICT strategy, while large company implements ICT by clear strategy. The experience of the participants is similar and their managerial position enables them to have an industry-wide overview.

6. ANALYSIS OF THE RESULTS AND FINDINGS

The following chapter presents and analyses the collected qualitative data. The analysis is divided into three main topics which are analyzed and presented in the sub-sections. The current situation in participants' companies is revealed in Topic 1. It discusses which ICT solutions are currently available and their interaction to users. The company level discussion is widened into a sight to the ICT introduction in the industry in general in Topic 2. Estonian and European ICT introduction level is evaluated by the participants. Topic 1 (company Level) and Topic 2 (industry level) lead the discussion to strategic ICT introduction in Topic 3. The most relevant quotes by the participants are presented by each sub-chapter separately.

6.1. Topic 1: ICT usage in the company

The aim of Topic 1 is to reveal which processes have been impacted by digitalization already in the company in order to reveal current situation. The introduction of ICT is separated into internal (Sub-section 6.1.1.) and external (Sub-section 6.1.2.) usage, depending from the users involved.

6.1.1. Internal ICT usage

Construction Industry has many partners in the supply chain and there is a need for collaboration. Therefore the internal ICT solutions are company specific and help to improve efficiency between departments or disciplines. The tools are oriented to provide in-house benefits.

Bookkeeping software is very commonly used. Projects managers insert invoices to the system, which links the expenses to specific project based categories. This enables to keep track

of synchronized budget and simplifies the transactions for financial department. (#1, #2, #3, #4).

Construction data management software is implemented in most of design companies and used in some companies during on-site construction. In design phase it is seen as normal working method (#3). Participant mentioned that more advanced construction companies create and adapt 3D design in order to implement it to their BIM software (#1). The usage remains mainly in company and does not have a collaborative approach with other partners.

The relevant quotes from participants regarding bookkeeping software and construction data are summarized in Table 4.

Table 4. Research results: Bookkeeping software and Construction Data management

Participant No.	**Quotes**
Participant #1:	*"The bookkeeping is digital as all bills are signed and approved in the system and linked to specific project."* *"BIM increases added value to our clients for more complex buildings"* *"Today we need to check the capability of the data and this is extra work for us."*
Participant #2:	*"Bookkeeping is needed in order to have good relations with our partners and to have better overview. So the internal quality is important."*
Participant #3:	*"Bookkeeping system is used daily. "* *"BIM is definitely a trend. Most of the designers use the software and we benefit from 3D views they provide."* *"Then we have design databases. Quality check is project based and not unified in company level."*
Participant #4:	*"Bookkeeping software is also used."*
Participant #5:	-

Internal documents are stored in digital space. They consist of general quality management, safety procedures, official mail database, contract management, employee database, archive and personal space for employees to be accessed on-line (#1, #2). The space is available in cloud based storage rooms like *Dropbox*[20], *OneDrive*[21] or similar (#4, #5). Useful are also continuous analysis of tendering details and results over many years. In some cases this enables to evaluate incoming biddings faster and get positive emotions from client (#2). The main contractor has also stated that the unit prices change in the economy rather fast and it is difficult to use these analysis in the long term. However the data can still be used as indicators

[20] File hosting tool (Dropbox, Inc.). Offers personal cloud, file synchronization and cloud storage.

[21] OneDrive is a file hosting tool (Microsoft). Offers personal cloud, file synchronization and cloud storage.

for quick reviews. Data collection is more beneficial in the area of infrastructure construction because of high quantities of the same category of work.

Project management software is used in order to store and evaluate mainly financial results and the data is linked to bookkeeping software in one case (#1, #3). The data holder is project manager and it enables to give an overview for top and medium level managers to evaluate financial results of the company (#1). Often the software enables to manage also the contracts in the system (#3).

The relevant quotes from the participants for regarding project management are presented in Table 5.

Table 5. Research results: Project Management

Participant No.	**Quotes**
Participant #1:	*"Project management is internal, as it is not possible to manage the schedule if everybody would change it. We need the overview and accept changes if necessary and I think it is not possible to change it in a way that 100% digital solutions are used. Construction is complicated. The sub-contractors might not have the needed know-how so it wouldn't work".* *"Project management software could be linked to time schedule, but today we use it to get an overview of the financial status of the project."* *"We use different solutions today to track project budget, use servers for design and internal documents like quality, etc."*
Participant #2:	*"Internal database is for every project. It holds also managerial documents, human resource database, tendering results, analysis."* *"Project database for digital design is in use daily for more than a decade."*
Participant #3:	*"We use software to control the budget of the project which is comparing today's results with target cost. Also contracts are integrated to the system. It is needed to have an overview of the financial status of the company in the coming periods."*
Participant #4:	*"OneDrive is used in order to share internally."*
Participant #5:	*"We use design database. This is internal. The external database is owned mainly by main designer. If needed Dropbox helps to share documents."*

6.1.2. External ICT usage

The level of external ICT usage depends from the company size. The participants declare that larger companies use self-developed on-line quality management and reporting tools which contain problems to be dealt with (#1, #4). It is described that for larger projects ICT based reporting tool is the only possible way to keep track of the remarks during construction process. All of the notes will be inserted to the system by various participating

people. The usage rate of the system by external partners depends from the management of the project and company. In the case of prohibited access to the client, the remarks are used to provide internal quality. There is a new software in a development phase which links the remarks to the 3D designs areas to give a faster overview and added value to the client (#1).

External virtual space for design document exchange is existing for more than 10 years and is used for every project (#1, #2, and #5). There might be different holders for specific project and the usage level depends from the partners in every case. It simplifies many processes throughout the life-cycle of project as modifications of design are inevitable. During the design process it enables to collaborate more easily as updates on implemented. In the early phases the cost and time reduction is remarkable. As the expenses for this digital space have marginal impact to the budget, it is not seen as investment (#2). Cloud based storage rooms could be used for small and medium sized companies and no self-developed software is needed.

On-site digital presentation tools like tablet PC's and widescreen LCDs are present at on-site offices as they enable access to all updated design documents. Even if the design is in 2D it reduces time to move the documents to the on-site office, while improves efficiency for all partners (#1).

It is mentioned that time schedule software which can be linked on-line to project management software could be used, but it is not done in any of the cases. No suitable and affordable solution is found for that. Mainly the time schedule is created by the main contractor and specified by sub-contractors manually. Participants have noted that higher level of collaboration could improve efficiency (#3). On the negative side it is seen that most probably it will get too complex to manage as the continuous corrections are impacted by weekly decisions (#1).

On-line meetings via Skype are used in order to reduce time for transportation (#2). This enables to invite participants who do not locate on site at the time. As construction projects are most often far from main offices, it is seen as useful tool for projects with many stakeholders.

The relevant quotes from the participants for this sub-section are presented in Table 6.

Table 6. Research results: External ICT usage

Participant No.	Quotes
Participant #1:	*"Quality system is externally used and can link to specific areas of the building."* *"The quality system is running for a long time in order to track the complaints."* *"Common file sharing is used in case of bigger projects. Also the 3D modelling enables to manage the project on-site with tablets. "* *"We need the overview and accept changes if necessary and I think it is not possible to change it to 100% digital as construction is complicated. The sub-contractors might not have the needed know-how so it would work."*
Participant #2:	*"Project design database is external."* *"Project database increases efficiency and decreases design costs. It is important that everybody has access. This improves efficiency, quality and speed."* *"Skype video calls make it easier to have meetings with multiple participants on great distances."* *Most of the ICT solutions are our daily habits and it is hard to work without them. At the same time the costs have low price in comparison to construction cost*
Participant #3:	*"There are clients who have their system to manage the invoices and the declared work results with partners. It is good as it is shared with partners of the client as efficiency improves."*
Participant #4:	*"We have quality system and design database for our partners. Also a more massive system to manage documents in the company is available but we are not using it."*
Participant #5:	*"We share externally only specific design documents. I think the external usage should be driven by the main contractor."* *"The external database is owned mainly by main designer. If needed, then Dropbox helps to share documents."*

6.2. Topic 2: Current situation in Construction Industry

Topic 2 explores the opinions of current ICT adaption rate in Construction Industry in general. As international competitiveness has important effect to Estonian economy, the situation in European and Estonian market is discussed (Sub-Section 6.2.1). Near future developments in the field is argued in Sub-Section 6.2.2.

6.2.1. ICT adaption at local and international level

The results of the interviews have discovered that the level of European ICT integration is not as high as it might seem to the outsider (#1). Central-Europe has habits and rules which are hard to change and even if new technologies are adopted, the on-site reality is still different (#2). Finnish companies use in comparison to Estonian firms more advanced solution during the whole construction process (#4, #5). One of the reason is that they see tendering process

differently. Their advantage is that the main contractor is also responsible for the whole cost of the project. This means that every partner needs to optimize the value for client (#5).

Latvia and Lithuania have not yet establishes the needed infrastructure for collaborative ICT solutions. There are signs for improvements in Lithuanian Construction Industry (#4) and in Latvia the digital signature is beginning to become more common (#2). In the south-east Europe Estonia is seen as more advanced (#5). Although it must be noted that the client in these markets is not yet ready for ICT based work methods (#5). South-East Europe has rather low ICT introduction level (#2, #5).

Some related quotes are presented in Table 7.

Table 7. Research results: International introduction level

Participant No.	**Quotes**
Participant #1:	"*No personal experience with central Europe, but the level it is not as high as it looks like*."
Participant #2:	*"Central Europe has long traditions and habits which are hard to change. In Finland the actual implementation depends very much from the stakeholders of the projects."* *"In Latvia and in Lithuania the improvements in digital infrastructure can be seen."* *"In the south-east it is more complicated and no ICT introduction is noted from our experience"*
Participant #3:	*"I am not aware how it is exactly in Europe so it is hard to compare. "*
Participant #4:	*"Finnish culture is ahead of Estonian, Swedes are at the same level. We can say it from our experience. Lithuanians are moving to introduce BIM to the industry."*
Participant #5:	*"In the south-east of Europe the client is not aware that there could be more advanced ICT solutions in the industry. ICT does not provide solutions for them."* *"In Finland, and also the Nordic countries, more advanced solutions are used. The high quality planning enables for them to reduce construction costs and they see it as a holistic approach."*

The overall introduction rate could be higher among the client in Estonia (#1). On the positive side it is noticed that sub-contractor are starting to use tablet PC's on construction sites (#4). In comparison to the neighboring countries the level of ICT adaption in the industry is rather good because of the existing infrastructure. As there are less complex projects, the overall usage in the industry has not increased as rapidly (#3). The national digital X-Road and digital signature as a habit opens the possibility to work digitally more often. For example in the cases where there is a need to apply for different permits with digital documents. As the younger generation is adapting quite good to new possibilities, the situation is getting constantly better

and the digital applications are already preferred. Another positive argument is that there is an easy access to internet and the possibility to sign digitally with mobile phone (#2).

Some informative quotes from the participants are presented in Table 8.

Table 8. Research results: National introduction level

Participant No.	**Quotes**
Participant #1:	"In *Estonia our main public client wants to introduce new working methods, but the level of introduction could be better*."
Participant #2:	*"In Estonia the digital infrastructure is very good in comparison to neighboring states. Beginning from construction permits and to general management of the company. Everything can be done digitally. Also easy access to the internet is a benefit."*
Participant #3:	*"As we have rather less complex specific buildings like hospitals, new design ICT software is not used as much as in larger economies."*
Participant #4:	*"In Estonia it is moving quite good. Even the sub-contractors are using tablet PC's to view design, so do we."*
Participant #5:	*"In Estonia the designers are using better ICT tools in comparison to other stakeholders."*

6.2.2. Near-future developments

The usage of ICT is not as high as technology would allow. Mostly *AutoCAD*[22] is introduced in the universities and used later on, but the technology does not meet new requirements. There is a know-how what are new possibilities with more advantaged technologies (for example *Building Information Modelling*), but it is hard to find suitable solution in small Estonian market for these applications, especially in SMEs (#3). In large companies the collaborative software is self-developed or bought-in software is adapted to the needs (#4). Self-developed software can be a threat as it is hard to predict changes in the digital era (#1, #2). Today the virtual reality is used more often and digital project integration to on-site activities has begun with the help of rapid evolution of smartphones and tablets (#1). The usage of 3D is definitely a new way of working and makes it easier and faster for all stakeholders to work through the project (#3).

Different integrated databases and development of digital infrastructure have changed the way of working during the last decade. It is seen that the wider or better usage of the same information creates new possibilities to manage the information flow and provide benefits for

[22] AutoCAD is a software 2D and 3D application for computer-aided design (CAD).

all stakeholders. For example the connections with governmental institutions are evolving and have enormous possibilities to replace paper-based documents to automated digital information. At the same time common everyday procedures could be digital and accessible to all participants. An idea of general digital system to exchange and archive documents for higher collaboration is presented by the participant (#2).

Some relevant quotes from the participants for this sub-section are presented in Table 9.

Table 9. Research results: National introduction level

Participant No.	**Quotes**
Participant #1:	*"The technology is developing rapidly. 3-4 years ago it was not even thought that we have 3D projects in tablet PC's, like we have today."*
Participant #2:	*"Hard to predict [the changes]. In my point of view the official databases are improving quite fast. There is a high potential for collaborative approach. We could decrease the duplication of documents on paper and have a digital database for that."*
Participant #3:	*"In Estonia AutoCAD is mostly used as it implemented to higher education institutions. We use it."* *"Some companies use integrated project management software, we have not found a suitable for us."*
Participant #4:	*"The developments are fast as more applications are coming which are also with low or no cost. So it is questionable if it is reasonable to build massive systems by ourselves at all."*
Participant #5:	*"There are light developments as the client becomes more aware of the possibilities. It might direct the industry."*

6.3. Topic 3: Business and ICT Strategy

A company can be successful if they have an advantage in the market. As ICT opens new solutions, there could be possibilities how to achieve strategic goals with the help of ICT. The following section presents the main values and advantages seen by participants. Sub-section 6.3.1 discusses challenges and motivational factors while introducing new ICT Solutions. Sub-section 6.3.2 describes the link between business strategy and ICT introduction.

6.3.1. Challenges and advantages to adapt new ICT solutions

A decision to introduce new software to the company is a long-term commitment and needs direct and indirect investments (#4). High direct costs, like price of the software, can lead to a negative investment decision as direct return on investment is difficult to foresee. This is the reason why new ICT solutions are excluded if the companies are not large or successful enough (#1, #3). It is mentioned that as the indirect and direct costs have a long-term effect and involve small sub-contractors. Most of the subcontractors use the same work methods they did decades ago and they are not interested in new technologies. More often they find new practical on-site tools to be useful (#3). Investment rate is rather low in small companies.

Large and medium-sized companies do not emphasize the direct impact of the cost. Participating large company has IT-department which improves new ideas continuously (#1). The medium sized companies see that the investments are done only once and new tools can be used afterwards without additional costs (#2). Although indirect cost rise as introduction takes time (#4).

It is estimated that there are paybacks which influence many internal and external partners as they address with a minor influence many processes inside of the company and have therefore many in-direct benefits (#2). It noted that the efficiency will rise if the critical mass uses ICT solutions and smart data management in a collaborative way (#1). Direct evaluation of introduced ICT solutions is not done in any of the cases as it is difficult to establish suitable methodology. In one case the measurement is combined to the client satisfaction analysis. It is assumed by management that if ICT improves satisfaction or any other process in the company then it is seen as positive influence (#1). Some related quotes for the topic are presented in Table 10.

It is seen that structure of the company has impact to the ICT developments, as flat hierarchy enables to make changes faster. At the same time in participating micro and small company there is no need for complex ICT solutions as the amount of information is comprehensible (#2, #5). The more data the company has, the more complex it is to investigate (#2). For example results and analysis of previous projects can give an advantage for specific clients where there is no time to work through the project and a bid is needed.

Table 10. Research results: Investment decisions and collaboration

Participant No.	**Quotes**
Participant #1:	*"Directly it is difficult to measure. We measure client satisfaction."* *"The sub-contractors do not have enough resources."* *"ICT is more like a support system to us."* *"There needs to be a critical mass in order to gain more effect from new digital solutions."*
Participant #2:	*"Until now the investments are done only once. After some use we have developed them further as we need what we want. But they don't need continuous developments."* *"ICT developments lower the costs in different departments and also for other partners."* *"We are not measuring the benefits. Most of the ICT solutions are our daily habits and it is hard to work without them. At the same time the costs have low price in comparison to construction cost."*
Participant #3:	*"Sub-contractors do not use new solutions as they see that they need only mechanical tools to get the work done. Of course there are exceptions but they are hard to find with lowest price."* *"As the winner of a contract is the lowest price, then the sub-contractors do not have enough qualified staff to use more advanced ICT solutions."* *"We have not measured [benefits]. In the beginning of introduction the usage took more time."*
Participant #4:	*"Hard to measure the results as we have no comparison. Every project is different."* *"Capital and man-hours are needed to introduce new tools"* *"The technology is changing rapidly and if we develop one system then it is most likely be outdated by the time we can gain the benefits from it."*
Participant #5:	*"Generally we don't measure [benefits]. Also there is a threat if we control too much the activities of our staff the motivation reduces."*

All of the participants agreed that management needs to take part of ICT related developments, but the ideas should be gathered from different participants. It should be noted that the interaction depends form the structure of the organization and the tasks inside of the companies can be very different. In the case of an existing IT-department, it evaluates the possibilities and implement them continuously (#1). In medium and small-sized companies the employees have multiple roles and the management works on ICT inputs as they need better overview. In this case it is used to organize a working-group to develop ideas further (#2).

The participants revealed that there are no suitable project management software used for construction companies (#1 and #3) and there is a need for additional security for on-line documents (#5). One of the limitation for ICT adaption is a missing link between financial, contractual and workflow process integration. Different software providers that exist in Estonia try to be suitable for a wide variety of companies in order to gather enough clients in the small market. Without specialization they do not meet the requirements for specific needs of local industry (#3).

Collaborative ICT technologies are limiting personal and emotional contact (#2). As there are many partners in the construction process, the need for personal meeting cannot be underestimated in order to have positive long-term cooperation and to solve critical issues. It is noted that already e-mails and even video calls can create falsely interpreted communications. Therefore it is not possible that ICT solutions can replace personal contacts in the long term.

The relevant quotes from the participants for this sub-section are presented in Table 11.

Table 11. Research results: ICT introduction and software suitability

Participant No.	**Quotes**
Participant #1:	*"The input [to ICT developments] should be a combination - board and departments."* *"We have not found a suitable and affordable project management software. The best ones are too massive and expensive for us."* *"Out IT department deals with the developments daily."*
Participant #2:	*"I see no specific strategic value if we had more advanced solutions implemented. If the company has more data to manage then more advanced solutions are needed."* *"[ICT development] Depends from the company's structure. We have formed a cross company team to work with the development ideas."* *"Digital solutions minor the need for personal communication. This is an important aspect of everyday life and without that the motivations will decrease."*
Participant #3:	*"ICT Strategy should be directed from board as we know the status of the company."* *"The most problematic is that there is no low cost project management software for small and medium sized companies. The more complex ones are not suitable for us."*
Participant #4:	*"The board and also other staff [should be involved to ICT development]."*
Participant #5:	*"In our small company we have discussed developments on board level."* *"There is low awareness of the possibilities. Also the risk of security is an important topic which has not been addressed enough."* *"... as we are a micro designer company, there is not much data to handle"*

6.3.2. ICT alignment to Business Strategy

Development of digitalization and needs of the client have impact to organization's strategic directions. Therefore digitalization is more important to professional client who has the know-how how to benefit from data management.

ICT is mainly seen as a support system to achieve company goals (#1, #2, #3, and #5). There is an existing knowledge of possibilities and companies are examining ways how to match new technologies to their needs. Therefore the motivation to invest is more driven from the need to improve efficiency of the organization. Although in the long-term it leads in to reduced construction costs and added value to the client (#1), it is more likely that ICT improves

data flow, quality of internal processes and reduces time usage of employees (#2, #4, #5). As a result it is seen that the efficiency improves and the staff can focus on their main tasks. It is estimated that already project management software saves around 5% of project manager's time. If the sub-contractors could be implemented to the system, another 5% might be saved (#3). Most often competitors and similar companies are observed in order to identify process improving tools and ICT solutions are introduced from the positive cases from the industry (#2). The relevant quotes from the participants for this sub-section are presented in Table 12.

Table 12. Research results: ICT usage as strategic tool

Participant No.	**Quotes**
Participant #1:	*"Some developments are seen as strategic goals. The rest are supporting systems of everyday processes."* *"BIM increases added value to our clients for more complex buildings"*
Participant #2:	*"Directly ICT is not part of our strategy. They are rather a support for evert-day life."* *"Project database increases efficiency and decreases design costs. It is important that everybody has access. This improves efficiency, quality and speed."* *"We have not been the first in the market, rather adapted solutions from others in order to work better."*
Participant #3:	*"ICT supports in-directly our efficiency and through that our strategic goals."* *"The ICT does not affect the cost of our work directly. I see it that it enables to focus on main activities as there is more data to handle. The efficiency is affected."* *"As we have rather less large projects there is no need for BIM. Our client is mainly a citizen who needs an apartment. Therefore there is no added value to them if more advanced ICT were used."* *"Overall it is difficult to distinguish from others in the AEC Industry. The first-time clients do not have the know-how to compare companies."* *"If the client is professional, then it would be beneficial. Today our client can't find the added value from ICT. Most of the clients are first-time non-professionals (ca 90%)."* *"For project managers the management system saves 2 hours of project manager's time in a week. If the sub-contractors could be integrated another 2 hours could be saved."*
Participant #4:	*"ICT systems should focus on a collaborative approach with other partners to gain the effect."*
Participant #5:	*"The software we use improves our efficiency in a way."*

The segmentation of clients set limits for strategic goals. The developers who focus on apartment buildings have tried to implement and provide new technologies for private clients. More often non-professional customers are not interested in these solutions and the ICT support is therefore not that beneficial (#3). The private-client based strategy is not linked to external ICT developments or usage. Although the visible identity of the company improves when more advanced skills are presented, it does not have noticeable effect to business outcomes (#2, #3).

In Estonian market roughly 90% of the clients are first-time clients (#3) and they don't get these additional values and the price is the main indicator. The ICT developments support in this segment a way that the company could be more effective internally (#3). In the participating large company some internal process improvements are linked to the strategy more specifically (#1).

The technology push and increase on the demand side has led to the need for the participating large companies to have a formulated long-term ICT strategies which support business strategy (#1). In some cases it is seen that in the Construction Industry ICT strategy is not necessary and it still does not provide additional benefits (#2). For medium sized company there is no revealed, as they are putting their effort to follow their Business Strategy and ICT developments is not part of it (#3). They see that ICT is more a tool which can be implemented if the need arises.

The awareness of BIM is increasing, specifically in Estonian public real estate company, as it is finding ways how to implement it to the tenders. Companies "don't want to be strangers" to these developments anymore and risk to lose important client. The internal development of the system enables to be on the picture if a client demands the usage of it (#2). Another positive side is the commercial aspect. It enables to show the company from a better and technologically more advanced perspective to the society. These investments are for the participating large construction company continuous and part of every-day processes for larger companies as the technology improves rapidly (#1).

The profile of the client influences ICT adaption. To the company whose strategic goal is to sell or present services to the professional real estate developer (#3), ICT is an advantage. Therefore the improvement of external digitalization, specifically BIM capability, is one of the strategic approaches of participating large company. It is mentioned that it increases added value to the client, improves the processes and enable to design and build more complex solutions with more qualitative manner (#1). Company whose main client is AEC industry professional sees that ICT tools could decrease the final costs during the construction phase if the client is oriented to that (#3, #5). For developer, whose main turnover is related with sales to non-professional one-time client ICT does not provide any external advantage.

The relevant quotes from the participants for this section are presented in Table 13.

Table 13. Research results: ICT introduction

Participant No.	**Quotes**
Participant #1:	*"Development of BIM is aiming to add value to the client."* *"BIM increases added value to our clients for more complex buildings."* *"Out IT department deals with the developments daily"*
Participant #2:	*"ICT Strategy should be existing in some economic areas, but not in Construction Industry. I see no advantage in this."* *"If the clients demands new methods to be used, then it is necessary to be on the picture. This is also the case of BIM introduction in Estonia as the client becomes more aware."*
Participant #3:	*"ICT supports in-directly our efficiency and through that our strategic goals."* *"If the client is professional then it would be beneficial. Today our client can't find the added value from ICT. Most of the clients are first-time non-professionals (ca 90%)* *"As we have rather less large projects there is no need for BIM."* *"The Designers most often do not think of the construction cost. ICT could help to improve that. If we have highly skilled staff we can distinguish from others in quality."*
Participant #4:	*"The lower cost public tendering has reduced the motivation to add value to our services. For private clients we can provide additional value as we have high experiences*."
Participant #5:	"*As our client is a professional designer or developer, then we see that if we focus on optimizing the final costs, we could provide additional benefits to our clients."* *"In AEC Industry I don't see collaboration between ICT strategy and Business Strategy. If it reduces working hours then it is beneficial, but it probably does not need an ICT strategy."* *"Our client has not asked for more advanced BIM usage. We have done it for our own to reduce mistakes."* *"Depends from the client. If they want quality or price."*

7. DISCUSSION

Construction Industry involves a large number of participants along the supply chain. Easy access and low exit barriers with the need to customize products have created a highly fragmented industry as discussed in Section 3.1. As more than 90% of companies in the industry are SMEs with local market, the knowledge remains limited and is unique in the specific culture. Similar tendencies have been noted in many European countries. As the amount of data is increasing, new business models have been created as new opportunities arise. The common factor is horizontal data exchange between different industries as discussed in Section 2.2. New technology based paradigms create opportunities. Construction Industry will benefit from ICT usage if a critical mass of users is present.

Participating companies use internally and externally directed ICT tools. Most common in-house tools are book keeping software, internally shared digital space, project management tools and in some cases construction data modelling software. With external partners data is mainly exchanged via project database which enables to present updated data during on-site construction process. In one case video calls are used to improve communications. External and internal usage of ICT is similar in large and medium-sized companies. Smaller companies align to methodologies used by their client. The difference of ICT introduction level originates from the practical need to manage information not from investment amount. The amount of data need to be processed in the company is dependent from the complexity of the organization and is aimed to have control over information. If the productivity increases due to ICT usage in the single company, then also indirect benefits are noted by different participants. The external and internal need coincides with the discussion of ICT essentials and the necessity for collaborative approach discussed in Section 3.2.

The participants of current study have positioned Estonian Construction Industry's ICT readiness above south-eastern Europe and below Scandinavian countries. The improvement has occurred because of general adaptive mindset of the society created by other innovative industries and governmental activities. New tools are mainly introduced because of

competitors' successful implementation. The need to develop and improve efficiency is not the first stimulus. In contrary to general mindset of willingness to adapt new solutions in AEC Industry is mediocre.

It is realized that Estonia has relatively good geographical position, neighboring the innovative Scandinavian countries as the know-how from abroad is boosting Estonian management skills and combining new knowledge with Estonian work methods. The ideas match the statements of Kajewski (2010), as ICT enables to expand more easily to foreign markets while reducing barriers (discussed in Section 1.2). Estonian AEC market can be described with the characteristics which are related to the maturity phase of an industry (discussed in Section 2.3): customers are price sensitive, pursuit for technical improvements is emerging, attempts to differentiate by quality occur and price competition increases.

The stated arguments regarding BIM adoption in Sub-Section 6.3.2 prove that there is an existing technology push and market pull for a small client group in Estonian market. According to Hosseini et al. (2012) the existence of both effects create a good ground for technology introduction (Section 3.2). Sabol et al. (2013) argue the stated aspects with maturing of an industry might describe a beginning of paradigm shift.

The traditions and habits are preventing to adapt new solutions in Central and Western Europe more than in young and dynamic Estonian economy. At the same time if the client is foreign, they demand similar process flow as they are used to in their home country. This means that the usage of digital data flow is hampered. The similar effect where deeply rooted behavioral models prevent to establish new collaborative approaches is discussed in Section 3.1. If the client is not aware or is not able to adapt new possible digital solutions, new technologies cannot be used. This can also be the case if the documents and procedures need to follow foreign cultural habits or the process is not seen holistically.

ICT introduction could solve the advanced needs of modern client and innovate the market. Energy consumption demands are getting higher in the society, the main structures and non-structural components (heating, ventilation and air conditioning systems) need to be fitted into building invisibly in tight conditions. ICT and construction data management enable to provide solutions. The developments are faster in larger countries, because of increased needs and complexity of projects. Based on a subjective evaluation, only up to 10% of the clients might benefit from advanced ICT developments today in Estonia.

In Construction Industry there is rather limited collaboration in process management and ICT would need higher overall adaption level in order to gain more effect. And even in the case of adapting new digital solutions, all stakeholders should use the same work methods. The revealed necessity for collaboration match with the essential symptoms of the in the industry as discussed in Chapter 3. It is noted by the participants, that today additional work is needed in order to implement new systems to the company processes. The reason lay in different work methods and habits of sub-contractors. With general higher ICT adaption level in the industry the unified basic standards could and should be agreed on. A counter-argument to a need for one overwhelming system is that the start-up community is publishing new low cost solutions daily. Therefore it is a question how much should a company invest as there is a risk that the system will be outdated soon.

In Estonian Construction Industry two separate strategic foresights can be distinguished among participants. One group of managers are directed to the mindset that ICT improves internal processes and the developments stay in the company. ICT tools enable to manage data and improve efficiency as the amount of information increases. The second strategic direction is driven from the need to meet the client's demands with the benefit of improving company's visual identity. The additional value provided to the client is externally directed and it is believed that collaborative developments create the added value. This conclusion sets Estonian Construction industry's development phase between Turkish' and United Kingdom's argued in Section 3.3. It means that as new collaborative mindset becomes more common, new ICT solutions will be accepted more enthusiastically.

The participants have noted that the internal values which are influenced by ICT introduction are the organizational culture, process efficiency and the quality of work. Participants have understood that the core value of the company are employees. The indirect investments to improve new skills are valued more often among managers. It is one of the recognized success factor described in Section 1.2 and matches with the developments of UK's Construction Industry (Section 3.3). Participants have distinguished that highly advanced external ICT solutions alone do not provide any additional value in the Estonian market. The new developed skills are essential in order to be able to fill the demands of the clients in the near future and the internal values are at least as important as external brand and visual identity.

It is difficult to measure the benefits and none of the participating company does it directly. Only one company associates client satisfaction with specific ICT solutions and indirectly sees it as the return on investment. The results back up the research of Iskidag et al. (2008), where less than half of the companies have tried to measure ICT benefits because of lack of appropriate method (discussed in Section 3.1).

The participating large company and two medium-sized firms invest continuously into ICT development. The others see that ICT is only one-time investment. ICT performance categorization by Papastathopoulos & Beneki (2010) discussed in Section 1.2 is applicable also in Estonian market. The companies with higher ICT implementation rate invest more in this field. The lack of resources directed to ICT developments lead to the attitude that ICT introduction is not seen as a strategic goal.

ICT alignment to Business Strategy is related to the main client of the company. New solutions are implemented if it enables to meet requested requirements of the client or additional value can be provided. If the client is not related to AEC Industry, does not have the know-how to use additional tools and invests only once over a long period of time to real estate, then ICT does not provide additional advantages in the market. This is the case for participating medium-sized company, which develops and builds apartment buildings. In this case internal ICT development is advisable as advanced ICT solutions do not provide benefits to the client.

The companies whose client is a professional the situation is different. As client becomes more aware of the possibilities, they invest into the research and development to manage data more efficiently. This gives a signal to the market that external ICT introduction can lead to competitive advantage in near future as they provide additional value to the professional client. Companies which have noted such signals, have started to invest into ICT introduction and align it to their Business Strategy.

SME's have the lowest resources to innovate. In order to improve collaborative work methods, it is necessary to involve them into the developments as much as possible. The usage and creating habits with a smaller group of sub-contractors improves the efficiency. As the client is the main driver, it can direct the usage rate directly. Although it might increase investment costs, ICT will most probably impact in-directly the efficiency of the overall construction process.

With the revealed recent developments in Estonian Construction Industry and based on researches and developments in other countries, it can be concluded that Estonian Construction Industry is in beginning to adapt ICT on a strategic level and it has a collaborative approach. The developments are directed by the client and early adapters are companies whose client is a professional. The trend opens new perspective markets in south-eastern Europe and offers the opportunity to stand out from local companies.

8. CONCLUSIONS AND RECOMMENDATIONS

The conducted qualitative research has provided insights of the Construction Industry's current situations, revealing that ICT innovation is most likely going to accelerate in the near future in Estonia. Because of well-developed digital infrastructure there are possibilities to develop highly collaborative working methods if a critical mass of users in the industry is exceeded.

The participating companies use internal and external ICT solutions as both are needed for different purposes. Internal ICT tools improve in-house efficiency and processes. Externally used ICT tools enable to exchange data in a more efficient way between the supply chain members and increase productivity in a collaborative manner. Today external tools are mainly project based and the information change with business partners in this industry is one of the major challenges to improve productivity.

Companies which are more oriented to productivity increase through collaboration are more common in developed societies and express a more innovative mindset. The decision whether to invest into advanced ICT solutions are linked to Business Strategy mainly in an indirect way. The reason lies in the chosen client segmentation. Business whose client is a non-professional have not introduced ICT in an external manner and do not see the strategic value from it. In contrast, the companies whose main client is a professional, understand that it is possible to grow competitive advantage if ICT is developed and introduced continuously.

Although only participating large company has a clear ICT strategy, the features are also by other companies present. ICT is a tool which supports the achievement of business goals. The companies have not yet stated clear goals regarding ICT implementation. The investments for that have direct and indirect influences to the whole company and also to external partners. There is no methodology to calculate the return on investment as project turnover and profit depends from different factors each time.

The neighboring more advanced Scandinavian countries provide the know-how to Estonian companies. This enables to learn and introduce already proven solutions to their

company's culture. As Estonia in general, and including Construction Industry, is seen as more advanced in south-eastern European countries, innovative ICT adaption provides opportunities to enter to new markets and distinguish from local companies. As it is possible to provide internal and external benefits to the processes in Construction Industry, ICT usage creates competitive advantage in these markets.

This study does not base on general opinion and therefore gives no weighted average opinion of the industry. Rather it shows the trend for the near future. Based on the literature and conducted research it can be said that digitalization will have higher impact to the Construction Industry as data and process management complexity increases. There are existing solutions which could and should be implemented to firm's culture in order improve. It is recommended to understand the needs of the client in the near future and start to be one step ahead from the market. The costs of ICT innovation is not seen as limitation. Moreover the industry is waiting to exceed the critical mass of users to gain the benefits.

It is recommended for companies to identify the main client in order to decide whether ICT could provide new strategic benefits in the market. In case of a professional client and/or foreign markets are targeted, ICT introduction is beneficial. The management and also employees should in this case implement new culture in a structured way in order avoid increased losses in the early stage.

For further research it is recommended to isolate the strategic directions of companies and research specific software solutions in order to align them to each other. There are most probably ICT possibilities, which are unknown to the AEC market. This could decreases the development costs for a single medium or small sized company and increase the speed of receiving the benefits.

SUMMARY

Architectural, Engineering and Construction Industry is one of the economic sectors which is characterized as low innovation adapter. Low entry barriers, high fragmentation and short-term strategies have created the situation where rapidly evolving technology and innovation is not implemented in a structured collaborative way. At the same time there is potential to increase value to the client, to the supply chain and to society in general. The paradigm shift of Information and Communications Technology (ICT) has created new opportunities and changed the way of working and will change the processes of Construction Industry in the near future.

To research the ICT interaction to Business Strategy a qualitative research methodology is developed. The selected participants of the interviews were medium or high level manager from different companies, who hold extensive knowledge and experience in Estonian AEC Industry. The arisen questions were assembled into three topics: the usage of ICT in selected companies, current ICT adaption level in the Estonian Construction Industry and the need to implement ICT to Business Strategy.

It is possible to divide ICT developments into internally and externally oriented tools. Internal effect is seen as a process improvement in the company. External tools provide benefits through collaboration for different stakeholders. It is noted that large and medium sized firms are shifting their focus from cost reduction at an operational level to the organizational level.

The usage of ICT solutions indicate that all companies use tools which increase internal efficiency. Information management tools enable the user to reduce working hours of employees on trivial tasks and focus on their main activities. The companies use book keeping software, digital storage space for documents, project management software and more advanced companies 3D and Building Information Modelling tools for internal use. The quality of work and communication exchange among external partners has improved with ICT software which is implemented in the same manner in the supply chain. The externally oriented software is used for quality management, data exchange through virtual space and on-line meetings.

International competitiveness has important effect to Estonian economy, the situation regarding ICT adoption level in European AEC market is seen as more advanced, but not substantially. European "old" markets have large economies with habits that are hard to change. This means that new collaborative developments can't be introduced to the market as easily. Estonia has geographically good location to benefit from. The innovative Nordic countries have opened the possibility to learn and adapt new technologies and Estonian young and dynamic economy enables to implement the habits quite fast. Therefore there could be business potential for highly-skilled companies in south-east of Europe, where Estonia is perceived as technologically more advanced and has well-balanced digital infrastructure. The advanced ICT usage creates the possibility to distinguish from local businesses.

ICT introduction level in the company is influenced by client segmentation. Companies which are directed to non-professional client believe that the external ICT solutions do not provide additional benefit to achieve strategic goals. The customer does not know how to benefit from the technology and they focus on the "façade" of construction process. In these cases the firms use internal ICT developments which enable to improve in-house processes.

Companies who have professional clients in their portfolio develop internal and external ICT capability simultaneously. Although the number of clients with advanced ICT knowledge is limited, the trend shows that clients' awareness is increasing in the field. This means that the long-term strategies of companies from Construction Industry should implement ICT in order to meet new requirements. The developments are driven by client and contractors do not want to lose their market share. Increased value can be provided to professional client as more efficient data exchange will help the client to achieve their strategic goals. It is estimated that the collaborative approach challenges the whole industry as it is seen in United Kingdom.

It can be concluded that digitalization is an important topic in Estonian Construction Industry and new developments are recognized. Participating large company develops ICT capabilities continuously and has long-term plans. Medium and small-sized enterprises have no direct reference of ICT in Business Strategy, the strategic processes are impacted from internal developments indirectly.

RÉSUMÉ

IKT OLULISUS EHITUSSEKTORI ÄRISTRATEEGIATES

Virgo Sulakatko

Ehitussektor on üks suuremaid majandusharusid, mis on samaaegselt madala innovatsiooni tasemega. Madalad sisenemisbarjäärid, suur killustatus ja lühiajalised strateegiad on loonud keskkonna, kus kiirelt arenevat tehnoloogiat ja innovatsiooni potentsiaali ei kasutata maksimaalsel võimalikul määral. Samaaegselt saaksid uued tehnoloogiad luua oluliselt suuremat lisandväärtust kliendile ja tarneahelale. Informatsiooni- ja kommunikatsioonitehnoloogia (IKT) paradigma on võimaldanud muuta arusaamist tööprotsessidest ja suure tõenäosusega jõuavad selle mõjutused lähiajal ka ehitussektorisse.

Käesoleva magistritöö eesmärk on uurida IKT võimalustega arvestamise olulisust ehitussektori ettevõtete äristrateegiates. Väljatöötatud kvalitatiivne uurimismetoodika kaasab intervjuudesse kesk- ja tipptaseme juhid erineva suurusega ettevõtetest, kes omavad ülevaadet Eesti ehitusvaldkonna viimastest arengutest. Töö uurib IKT kasutust ettevõtetes, tehnoloogia kasutuse taset sektoris tervikuna ning võimlust saavutada läbi IKT strateegilisi eesmärke.

IKT kasutust on võimalik jaotada sisemisetele ja välimistele protsessidele orienteeritud vahenditeks. Sisemise protsessi arendamine suurendab efektiivsust ettevõtte sees. Väljapoole orienteeritud rakendamine suurendab erinevatele osapooltele pakutavat väärtust. Juhtide mõtteviisid on muutunud kulude vähendamisest operatsiooni tasandilt organisatsiooni tasandile.

Info ja kommunikatsioonitehnoloogia mõjutab kõiki tarneahelas osalevaid ettevõtteid tõstes sisemiste protsesside efektiivsust ja kvaliteeti. Andmete juhtimise tööriistad võimaldavad vähendada töötajate ajakasutust triviaalsetele tegevustele ning suunata energia põhitööle. Ettevõtted kasutavad raamatupidamistarkvara, sisemist andmekogu dokumentide säilitamiseks, projektijuhtimistarkvara ning arenenumad ettevõtted ehitusinformatsiooni modelleerimise

võimalusi. Töö kvaliteeti, andmete korrektsust ja kommunikatsioonist tingitud ebakõlasid parendataks tarneahelas ühtselt kasutusele võetud väljapoole suunatud tööriistadega.

Sektori rahvusvahelist konkurentsivõime kasvu soodustab Eesti hea infotehnoloogia kuvand. Samas hindavad uuringus osalejad Euroopa üldist ehitussektori innovaatilisuse taset paremaks. Takistavaks teguriks on „vanade“ Euroopa riikide harjumused ja tavad, mis pärisvad uute protsesside juurutamist. Seega uudseid koostööle põhinevad protsesse ei ole võimalik läbi tarneahela ilma kultuuri muutuseta nendes riikides kasutusele võtta. Eestile geograafiliselt lähedal olevates innovaatilistes Põhjamaades kasutusel olevaid IKT lahendusi on Eesti ettevõtetel võimalik suhteliselt kiirelt üle võtta, katsetada ning Eesti dünaamiline majandus võimaldab neid oluliselt efektiivsemalt rakendada. Kagu-Euroopa tehnoloogiliselt vähemarenenud majandused, kus Eestit tajutakse kui arenenumat riiki, avavad võimaluse pakkuda parema tehnoloogiaga saavutavat kõrgema lisandväärtusega teenuseid ning eristuda sealsetest kohalikest ettevõtetest. IKT teadlik kasutamine avab võimaluse kergemalt siseneda sealsele turule.

IKT teadlik rakendamine on otseselt seotud ettevõtte strateegilise kliendi segmendist. Ettevõtted, kelle peamine klient ei ole teadlik ehitusvaldkonnas eripäradest, ei saa väljapoole suunatud tehnoloogilistest tööriistadest strateegilist lisandväärtust. Sellisel juhul tajub klient ainult ehitusprotsessi „fassaadi“ ning täiendavad andmed ei leia rakendust. Vastava kliendi segmendiga ettevõtetel on mõistlik suunata investeeringud ettevõtete sisemiste protsesside arendamiseks.

Ettevõtted, kelle peamine klient omab valdkonnast häid teadmisi ja puutub teemadega pidevalt kokku, arendavad nii sisemisi kui välimisi IKT tööriistu samaaegselt. Kuigi Eesti turul on suurema teadlikkusega limiteeritud hulk kliente, näitab trend kasvu märke. Ettevõtete pikaajalised strateegiad peaksid hindama kliendi tulevasi nõudmisi ning eelisarendama väljapoole suunatud tööriistu. Läbi selle on võimalik pakkuda täiendavat lisaväärtust kliendile läbi efektiivse andmekvaliteedi ja –vahetuse. Ühendkuningriikide näitel saab eeldada, et koostööd ja ühist lisandväärtust suurendavad strateegilised valikud mõjutavad sektori arenguid oluliselt. Digitaliseerimine ehitussektoris on oluline valdkond. Täna arendavad IKT võimekust järjepidevalt pigem suured ettevõtted. Keskmistes ja väikestes firmades on strateegilised protsessid IKT võimalustest kaudselt mõjutatud, kuid ei ole otseselt ja pikaajaliselt planeeritud.

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APPENDICES

Appendix 1. Questionnaire for Interview

Questionnaire for the academic research

This research is conducted in academic purposes and the results are presented anonymously. In order to evaluate the discussion it is asked to provide general information regarding Your preferences and company details.

1) Is it allowed to record this interview?
   a) Yes b) No
2) Please mark the activities of Your company.

a) Development	
b) Consultancy	
c) Architecture	
d) Engineering	
e) Construction	
f) Maintenance	

3) Size of Your company:
   a) large: 250+ employees
   b) medium-sized: 50 to 249 employees
   c) small: 10 to 49 employees
   d) micro: Less than 10 employees.
4) How is the ICT usage level in Your company?
   a) High b) Medium c) Low
5) Is an ICT strategy formulated in Your company?
   a) Yes b) No

Time of the interview:_____
Interview technique:
   a) Video conversation b) telephone c) in person

Thank you for participation!

Virgo Sulakatko

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Appendix 2. Interview introduction

Dear participant of the research, in the following list you can find the main topics of the interview. The research is conducted with the aim to discover new approaches and to understand the perspectives of the participants. The audio is recorded only if participants have allowed it. The gathered information is presented anonymously and used in academic purposes only.

Interview Focus Points:

a) Current innovation adaption situation in Construction Industry

How do You evaluate the level of ICT introduction in AEC Industry (Local and EU)?
What are the main near-future trends and needs (Client & Technology)?
Which are the main limitations and challenges in the industry and firm level?

b) ICT usage in the company

Which ICT solutions are used in Your Company?
Which departments/operations create most benefit from them? Can they be measured?
Are the ICT developments done once or continuously?
Should ICT be implemented internally and/or externally?
Is the motivation related more with lowering costs or creating new value to the client?

c) Business and ICT Strategy

What are Your main competitive advantages and who is the main client?
Are the ICT solutions supporting Business Strategy?
Is there an existing ICT Strategy or is there a need for one?
Who should give an input to the ICT Strategy?

Thank you in advance,

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