Digital Construction in Lithuania:

Public Policy vs. Implementation in Practice

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Resume: Dette speciale beskæftiger sig med implementering af det digitale byggeri i den Litauiske byggesektor. Indenfor dette felt er den historiske udvikling, de eksisterende forhold og den fremtidige strategiske udvikling analyseret. Det digitale byggeri anses for at være en niche innovation og analysen af fremtidig implementering er baseret på to mulige niche managers: den offentlige organisation og et lokalt firma. Der undersøges, hvad er den bedste strategi for udviklingen og udbredelsen af teknologien, og hvordan de to tiltag konvergerer og bidrage hertil. For at få dybere forståelse af, hvad er specifikt for implementeringen i Litauen, sammenlignes implementeringsforløb i Litauen med erfaringerne fra Danmark, hvor udviklingen er længere og mere udbredt.

En bred empirisk data er indsamlet via interviews, observationer og litteraturstudie med henblik på at analysere fænomenet i dets sammenhænge og tage fat på mange beslægtede aspekter.

Analysen er baseret på den teoretiske tilgang af Multi-level perspective (Geels, 2005) og Strategic niche management (Kemp, Schot, Hoogma, 1988).

Abstract (på dansk)

Dette speciale beskæftiger sig med implementering af det digitale byggeri i den Litauiske byggesektor. Indenfor dette felt er den historiske udvikling, de eksisterende forhold og den fremtidige strategiske udvikling analyseret. Det digitale byggeri anses for at være en niche innovation og analysen af fremtidig implementering er baseret på to mulige niche managers: den offentlige organisation og et lokalt firma. Der undersøges, hvad er den bedste strategi for udviklingen og udbredelsen af teknologien, og hvordan de to tiltag konvergerer og bidrage hertil. For at få dybere forståelse af, hvad er specifikt for implementeringen i Litauen, sammenlignes implementeringsforløb i Litauen med erfaringerne fra Danmark, hvor udviklingen er længere og mere udbredt.

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Analysen er baseret på den teoretiske tilgang af Multi-level perspective (Geels, 2005) og Strategic niche management (Kemp, Schot, Hoogma, 1988).

Summary (in English)

The thesis deals with the development of the Lithuanian construction sector towards digital construction. Within this field the historical development, the existing conditions and the future strategic development are analysed. The digital construction is considered to be a niche innovation and the analysis is based on two possible niche managers: the public body and a local consultancy company. These initiatives are analysed in order to distinguish the best way of organising development and ensure implementation. In order to understand, what is specific about implementation in Lithuania, the analysis compares the practices in Lithuania with experiences from Denmark, where the development started much earlier and has been active for many years.

A broad empirical data was collected via interviews, observations and literature study in order to analyse phenomenon in its contexts and address many related aspects.

The analysis is based on the theoretical approach of the Multi-level perspective (Geels, 2005) and the Strategic niche management (Kemp, Schot, & Hoogma, 1988).

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1. Introduction

The construction sector signifies an important factor for the economy and identity of every country. Construction projects not only contribute to GDP and offer employment, but also create buildings that are supposed to stand for decades, or even centuries. The way building projects are planned, designed and carried out is important for the quality and price of the buildings and, therefore, it is interesting to examine.

Over past decades, the world has witnessed increasing growth in the development of information and communication technology (ICT) solutions and the building sector was no exception. Many digital tools came to the market and were available from then on for all disciplines within design, construction and facilities management. Together with ICT technologies, a new niche technology appeared, in a particular report referred to as 'digital construction'. This is a complex phenomenon that integrates technology, information, people and processes. It is also sometimes referred to as BIM (building information modelling), although in the thesis, BIM is used as a narrow concept covering integrated processes in the project, whereas 'digital construction' is said to have been a wide concept operating on the national level addressing such matters as standards, classification and regulations. The idea behind this is the same: using digital technologies to collect and store information that would be continuously added, structured and available throughout the process of design, construction and operation of the building, to be used by collaborating parties.

This revolutionary technology should eliminate mistakes, redundancies and differentiation in construction projects and result in better, cheaper and quicker construction than it earlier offered. It is a way not only to rationalize the sector, but also to bring radical change in the way construction projects are organized today; hence, it is very challenging. It requires not only the implementation of the new technologies, but also reorganization of the work processes, changes in laws, creation of new standards, specifications, classification and, furthermore, the preparation of new specialists.

In Denmark, digital construction as a strategy to develop the construction sector appeared in 2001, when through initiative from the government, the work group 'digital construction' was established. Its aim was to develop requirements for using ICT in public construction projects, with the hope that the good experiences from the public sector will spread to the private sector as well. Since 2001, Denmark has gone a long way in nurturing, developing and implementing this strategy.

In Lithuania, the idea of rationalizing the construction sector by introducing digital construction came recently. Even though enthusiasts started talking about it a while ago inspired by experiences from abroad, it was officially included in the strategic development agenda only in the year 2014. As a main motor to drive the digitalization process in Lithuania, the public body 'Digital Construction' was established.

In this thesis, the strategy of digitalization of the construction sector in Lithuania will be analysed in relation to the experiences from Denmark. Not only the implementation of the digital construction, but also the historical setup of the countries, will be analysed in order to determent if the same criteria can be applied for strategic development. Even though the aim with digital construction as a new institutional logic is the same, implementation might unfold differently in strongly institutionalized Denmark and deinstitutionalized Lithuania.

The decision to select these countries is not accidental. The countries were chosen not only because they closely collaborate, but also because of authors Lithuanian background and experience of living in Denmark and working with construction for eight years, provides a good basis for this kind of analysis.

The transition from traditional (existing) construction to digital construction as a new dominant practice in the thesis is analysed using a theoretical framework of transition management and the multi-level perspective. In order to understand the transition, first of all, the existing setup has to be analysed. This part of the analysis will provide an understanding of the background for the emergence of the new initiative. It will also explain relative actors, possible potentials and barriers related to implementation. In the next part of the thesis, the possible scenarios of the future implementation of the digital construction will be speculated upon.

Out of many initiatives, the two examined scenarios are chosen to be the public body—called 'Digital Construction'—which unites many associations and specialists, and is established with the purpose of encouraging digitalization of construction broadly in the entire construction sector. This initiative is seen from the perspective of strategic sector development and defined as top-down approach. Another scenario involves a single construction consultancy company that is seeking to rationalize everyday work by implementing digital technologies, which provides a more practical, operational perspective. The second initiative is considered to be bottom-up. The aim of examining these two paths is to analyse two different approaches in order to understand their legitimacy and effect on a development towards a more rational construction process.

2. Problem

If digital construction should replace the existing dominant way of organizing the construction process, many changes need to take place. In the thesis, these changes will be analysed as a strategy for sector development in Lithuania. As the country is standing at the very beginning of this long journey, it is natural that it is looking for good examples abroad. Denmark is considered to be one of the best examples showing good practice in implementing digital construction.

This addresses the question of the practices in these two countries can be compared, as the political and historical set-up is very different from each other. Denmark is considered a strongly institutionalized country, characterized by longstanding traditions and development strategies. Lithuania's unfortunate history has led to many drastic changes in the political and institutional setups. Therefore, it can be characterized by the absence of continuity and stability in its socio-technical system and development strategies. The question is, how this affects resistance to change in the said countries' perspectives and which setup allows a less complicated transition.

In relation to this, the analysis will address questions of how stable the exiting socio-technical system is in order to understand how strongly it resists change. Furthermore, it will also analyse how the historical development of sectoral strategies affect the transformation. How powerful actors or social groups can be inducing or discouraging this change. How reinstitutionalization activities can be coordinated and governed. What threats and opportunities can be expected?

The main research question is

How can strategic development activities be organized in order to ensure the implementation of digital construction principles in the Lithuanian construction sector?

It will be addressed by dividing the analysis into two main parts of retrospective analysis of existing regime and prospective analysis of the development strategies by two different niche managers.

This will include necessary changes in the existing institutions, the emergence of new institutions and actors, and their relation to incumbent regime actors. Moreover it will also discuss how two selected niche managers will try to rationalise this process and who will gain the leading role.

3. Outline of the report's structure

The report is divided into ten chapters, starting with an introduction and the research question followed by a chapter on theory explaining the two main theoretical frameworks used and finally concentrating on research methodology. The most important chapters of analysis are those on retrospective and prospective analysis. In the first of these, the historical development and the existing conditions are described to give a full contextual overview for further analysis. The next chapter looks into the prospective development activities by speculating on two different scenarios. Afterwards follows a discussion on the analysis and, finally, the conclusion and perspective ends the thesis.

A significant part of empirical data is collected in Lithuanian. The translation into English is conducted by the author. In addition, the titles of reference texts are translated into English.

The direct quotes are typed in italics. References to information sources are structured according to APA standards. References to conducted interviews in relation to this analysis are also used as references.

4. Theory

Introduction

The theoretical framework based on F.W. Geels' interpretation is selected because it is considered to be best suited to analysis in bringing a major change in the socio-technical system and includes a broad spectrum of relevant aspects for understanding such a complex phenomenon.

Overall the thesis is about transition and transition management. The transition is a long-term and complex process, which includes major shifts in the dominant sociotechnical structure (Raven, van den Bosch, & Weterings, 2010). Good examples of transitions are 'the transition from sailing ships to steamships', or 'the transition from horse-down carriages to automobiles'. Both steamships and automobiles started as strange novelties, but afterwards were taken for granted as they came into everyday use. Together with the adoption of the new technology, elements in the broader context need to be changed to adapt to the new technology. For example, for using the fuel infrastructure of automobiles, maintenance network, traffic and parking rules as well as road infrastructure - i.e. other aspects - need to be established or changed in order for people to be able to use automobiles. All these interrelated aspects form the socio-technical system. The transition from one socio-technical system to another takes place, not when technology improves, but when all or most of the related factors such as user practices, regulation, industrial networks, infrastructure, symbolic meaning and culture change (Geels, 2005).

In this thesis, the analysed transition makes a major shift in the way in which the Lithuanian construction sector is organized. The transition from traditional construction to digital construction is thoroughly examined. To analyse this transition, two main analytical approaches are used: the multi-level perspective (MLP), and strategic niche management (SNM). Both approaches are closely related and were developed during the last three decades. They are multidisciplinary approaches that combine social and technology studies, system innovation and evolutionary economics (Geels, 2005). In order to explain social structures and behaviour in the approaches, it is important to look into broader contexts, such as the significance of rules, developments in society, culture and history (Scott, 2003).

Richard R. Nelson and Sidney G. Winter were amongst the first to acknowledge the importance of institutional complexity and variety for innovation in their work (Nelson & Winter, 1977). Later, Giovanni Dosi introduced technological paradigms, where the broad context of such interplaying factors as economy, institutions and established technological paths have subsequently influenced the innovation process. 'The market' was no longer seen as a main driver (Dosi, 1982). It served as a basis for further development of the theoretical framework by Johan Schot, Arie Rip and Rene Kemp in various studies. In this way, multidisciplinary perspectives on technological change were formed, stressing the importance of the external context (Elzen, Geels, & Green, 2004). On this basis, R. Kemp, J. Schot and R. Hoogma described the framework of SNM, which was further analysed by

Frank W. Geels in relation to distinguishing and describing the MLP in a way that is used in this report (Elzen, Geels, & Green, 2004).

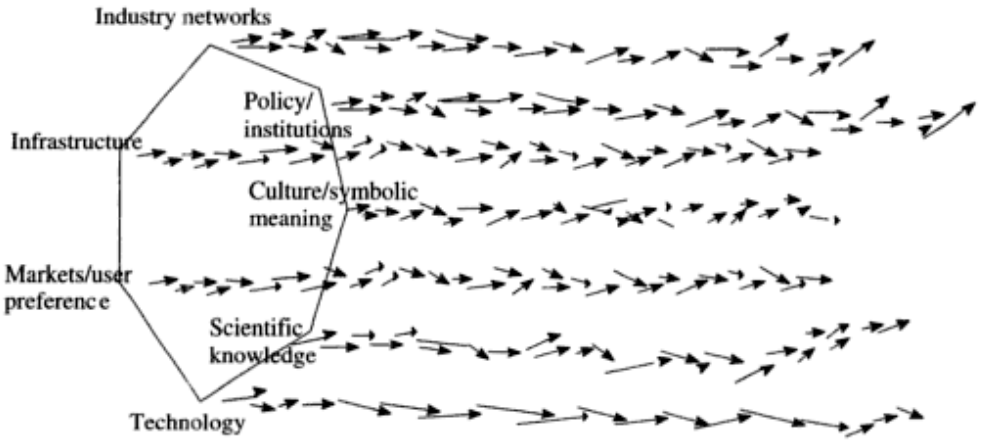
The main features of MLP and SNM are the three levels of heuristic, analytical concepts: the socio-technical regime, the socio-technical landscape and niche innovations (see figure nr. 2). In theory, interactions between developments on these levels can be used to explain the emergence of the new technology, and the cause of diffusion of this technology, which possibly results in the transition (Geels, 2005).

Sociotechnical landscape

The first level is that of the socio-technical landscape. It is a macro-level factor and acts as an external context. It is defined as a '*Set of deep structural trends'* (Elzen, Geels, & Green, 2004). It involves aspects that cannot be directly influenced by issues such as wars, rapidly increasing oil prices or political policy change. This level can either provide moderate pressure, which slowly initiates transformation at other levels, or shock, when it shakes up and destroys the existing system. For example, global warming is considered to be in the landscape level, as it creates moderate pressure and initiates new initiatives for CO2 saving on other levels. An example of a shock could be a war, which changes the existing system suddenly and deeply (Elzen, Geels, & Green, 2004).

Socio-technical regime

The meso-level is the socio-technical regime, which is described as '*patterns of artefacts, institutions, rules and norms assembled and maintained to perform economic and social activities'* (Elzen, Geels, & Green, 2004). It is further development of the technological regime described by Richard R. Nelson and Sidney G. Winter (Nielson & Winter, 1982). They described interrelated 'technological trajectories' in an engineering company. In MLP, the technological regime was widened to include the socio-technical regime by adding more social groups, such as scientists, policy makers, users, and special-interest groups. In this thesis eight domains of the regime are described: Technology; Market; Science; User practice; Policy/law; Socio-cultural; Organisations/Network; Infrastructure. These domains together with social groups are guided in a specific direction by establishing trajectories in the regime structure. They all develop separately but are closely interrelated—for example, changes in user preferences can lead to changes in technology, which can lead to changes in regulations; and these changes in regulations can affect technology development and so on (Geels, 2005). See the figure on the next page:



Figur 1: Alignment of trajectories in socio-technical regime (Elzen, Geels, & Green, 2004)

As long as the developments within these trajectories are aligned and oriented in the same direction, the system is stable (Elzen, Geels, & Green, 2004). This stability means that it is extremely difficult to introduce novelties, because regulations, economic practices, routines and infrastructures are built around the existing technology (Kemp, Schot, & Hoogma, 1988)

It is much more likely to succeed in the implementation of new technologies, when the regime is destabilized. It happens, for example, when internal technical problems or changes in market arise; it could also be caused by strategic games between firms, or external influence from the landscape level. Such instability leads some trajectories to develop different direction and it can create windows of opportunities for new technologies to break in and in the long run cause regime transformation. (Elzen, Geels, & Green, 2004)

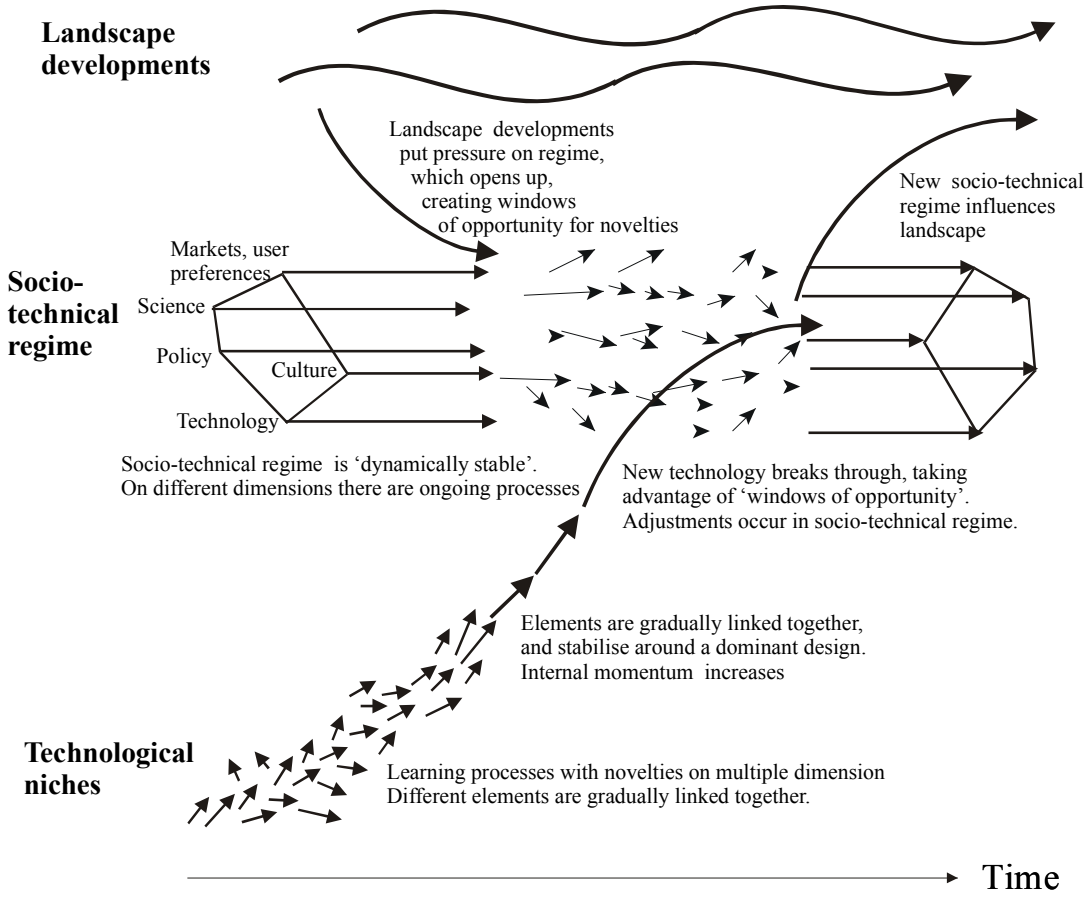
Niche

The described new technologies emerges form the niche level, where they are created and nurtured. This level is the most dynamic of the three. It acts as an incubation room, where novelties are born. In the niche level, the technology can be created independently for existing trajectories in the regime, which means that it is not constrained by regime rules. It can be completely radical. That is why to adopt these technologies in the regime; the regime rules have to be changed. This change is considered to be the transformation from one socio-technical system to another, which is analysed in the thesis. (Geels & Schot, 2007)

Multi-level perspective

The digital construction in the thesis is seen as niche technology, which does not fit in existing regime elements, such as user practice, regulations, and existing phase model etc. The transformation and adoption of technology in the regime is argued to be dependent on interaction between developments on all three levels, described previously. Only a specific combination can cause window of opportunity for new technology to break in and influence in the shift from one socio-technical system to another.

This is why the MLP approach will be used to analyse development on all three levels. It will serve as a strategy to outline multi-actor, multi-factor and multi-level aspects in one analysis of the existing system (Elzen, Geels, & Green, 2004). The following framework will be used:



Figur 2: Multi-level perspective on system innovation (Geels, 2002, s. 1263)

Each of he three layers will be described in the analysis. The top layer in the figure is landscape layer. It will be defined by the pressures it provides to the regime, and how that affects and shapes the regime developments. Regime is the middle level in the figure. It is initially resistant to fundamental changes as it is organized around old technologies, through the emergence of production routines, existence of infrastructures, the formation of skills and habits, and established consumption patterns (Kemp, Schot, & Hoogma, 1988). If the

system is destabilized, new opportunities will be created for technologies from the niche level to break through in the main markets and compete with existing technologies. The niche is the bottom level represented by many arrows, as technological novelties. Some of these novelties will be adopted by regime actors and will build around the support network, whereas others will be rejected (Geels & Schot, 2007).

Strategic niche management

In the thesis, the MLP approach is further complemented by the SNM approach, which is orientated towards actors who are supposed to try and shape the transition. It is a form of transition management, which also takes external context into consideration. It argues that even though the complex development in a regime is built around existing technologies, the actors can try to shape development towards the desired direction. They act on a niche level by nurturing the novelties to be ready when opportunity arrives. (Kemp, Schot, & Hoogma, 1988)

The SNM approach is oriented towards actors and social groups that are trying to shape the selection processes, by setting up special programs in R&D (Schot & Geels, 2008). Earlier, SNM described processes as 'bottom-up' where niches could actually initiate the regime shift (Schot & Geels, 2008). This theoretically ideal description was, however, argued to be more complicated and the SNM approach was accordingly corrected with greater focus on the interaction between the niche and external factors (Schot & Geels, 2008).

The late SNM approach is used in this thesis and it cannot be described as a top-down or bottom-up approach, but as a combination of the two through multiple interactions. The main point in SNM is that the development takes place through learning and the establishment of experiments, where technology is adjusted through broader social structure developments and where a support network is built around it (Schot & Geels, 2008).

Kemp, Schot and Hoogma described five steps of SNM that are used as a framework for analysing new technology creation and implementation. It starts with the choice of technology, and the selection and setup of experiments, followed by the scaling up of those experiments and the breaking down of protection. When choosing the technology for an experiment, it is important to consider technological opportunities, economic returns, compatibility with user needs and attractiveness. (Kemp, Schot, & Hoogma, 1988)

These steps are not to promote the new technology, but mainly to learn the following: What changes in the institutional structure and legislation are necessary? Which symbolic meaning should be given to technology? What are the consumer's needs and requirements? Who produces and markets the new technology? Does it require the development of infrastructure and complimentary products? What are their social effects on society (Kemp, Schot, & Hoogma, 1988)? The answers to these questions serve as the basis for niche managers in the creation and development of niche innovations in order to implement them in the regime and finally cause the transition.

This thesis examines two different niche managers, one from the public policy makers' perspective, and another from a specific company's perspective. It is chosen to look closer into these two niche managers, because they represent the development on two relevant levels – the global level, where the unified standards and regulations are developed and the local level, where experiences from real construction projects are generated. As developments on these levels take place simultaneously and they are closely interrelated and co-dependent, it is considered, that analysis of both of them can best cover the field of research. As these niche managers have slightly different focus areas, it will also be relevant to outline the technology they support. Technology in this context is understood as a broad context.

Rip and Kemp (1998) suggest that technology is a 'configuration that works' (Geels, 2005). This means that it involves heterogeneous elements that fulfil a function in a specific desirable context (Geels, 2005). That is why the technology used in SNM will be defined according to the context in which it will be used, and not as a separate artefact.

Discussion of Validity of Theory

This particular theoretical framework is chosen to illustrate the complexity of implementing the new technology in the wide socio-technical system. It proves that it is not enough just to implement new software, but that the work processes and the actors' understanding need to be changed. Furthermore, it is used to analyse multi-functional process, where development does not take place in an isolated way, but in the context. The chosen theoretical framework is considered to be suitable to answer the main research question and generate understanding, which niche managers could use, while developing a strategy for the implementation of chosen technology. SNM gives clear answers, but cannot be used alone without background knowledge, as using MLP entails a kind of detailed description of the regime.

An alternative choice of theory to analyse the phenomenon of digital construction could have been based on the theories propounded by J. White and E. Lobo (2010), who described the concept of boundary objects. It could have been used to analyse digital construction as a digital infrastructure on the micro level, which would give a more detailed understanding of the concept used in the particular practice. This would be interesting in order to look closer into using technology in practice and how it helps to coordinate as well as plan the building process. However, it is considered to limit analysis and describe the implementation strategies instead of going into detail while analysing the technology. (Whyte & Lobo, 2010)

The other choice, which also looks at implementing technology, could have been an innovation–diffusion view, which provides a clear-stage model and helps analyse the process of implementation. It could have given a wider understanding of the implementation process, but the problem is that the implementation of digital construction

in Lithuania is at the very first stage. Therefore, the Kwon and Zmud model cannot be used adequately. (Rajagopal, 2002)

Limitations

The MLP model has received some criticism, as it is sometimes difficult to distinguish how the conceptual levels should be applied empirically (Geels & Schot, 2007). From this thesis, it was determined that MLP considers the overall level of analysis. Furthermore, it is considered to be an 'appreciative' theory and, therefore, it was adjusted according to the interpretation by the author.

5. Method of Collecting and Analysing Data

This chapter outlines the methods used to collect data and analyse it in order to answer the research question.

The analysis is based on the case study out of desire to understand a complex phenomenon. It is a preferred method to answer 'how' questions, where an investigator has little control over the events and the focus is on the contemporary phenomenon within a real-life context. It helps to understand why the decisions that were taken, were taken, as in the thesis, why the decision to implement 'digital construction' was taken, how it is planned to be implemented, and what results can be expected (Yin, 2009).

In the thesis a multiple case study is carried out, as it concerns both public and private initiative, also both Lithuania´s and Denmark´s experience. Comparative case method gives the broader perspective for the analysis and shows that development does not happen isolated, but in the context. It also gives external validity and understanding wat is specific about particular case. (Yin, 2009).

It is chosen to use the abduction method and qualitative strategy in order to understand a real-life phenomenon in depth. This means that by collecting qualitative data, the aim is not only to describe but also to understand and explain the deeper meaning of the phenomenon by analysing socio-technical interpretation schemes (Olsen & Pedersen, 2003). This method is chosen because it provides a possibility to draw general conclusions out of the collected knowledge. It also means that the said analysis is based on information gathered from literature, interviews, and participation in meetings and conferences. It was aimed to collect data from different sources to give the thesis the highest possible construct validity (Yin, 2009).

Literature Study

In order to gather the empirical data, a wide variety of literature was studied. This includes books, scientific articles, publications, journals, published presentations and information on websites. The search was conducted in Aalborg University's library and the Lithuanian academic library on various Internet databases. The literature was first reviewed prior to the study in order to ascertain what is already known about phenomenon and later is used in the analysis.

Qualitative Interviews

To collect relevant empirical material about Lithuania several qualitative interviews were conducted. It was decided to carry out semi-structured and open interviews in order to understand how the chosen interviewees understand the phenomenon, what their experiences are as well as the inherent meaning of all this. None of these interviews were conducted to collect information about Denmark. This was considered unnecessary as the main focus of this thesis is Lithuania's journey to digital construction. Also all the relevant

information about Denmark was available in literature and in conference proceedings where the Danish model was presented.

The chosen interviewees represent different social groups and have different levels of experience working in digital construction. This gave the analysis various views and insights, which helped to draw a proper picture of the situation in this sector.

For analysis of the particular practice in the construction consultancy company Incorpus, the following interviews were conducted:

- With the CEO of the company, Darius Čepokas. It was relevant in order to understand strategic development and reflections from the strategic level.
- With the leading construction supervisor, Aurimas Dubonis, and the construction supervisor engineer, Justas Oleškevičius. It was relevant in order to understand everyday practices on the operational level.
- With the architect Andre Baldišiūtė and her colleagues. They are working in collaboration with the construction consultancy company and are often termed as project partners. It is relevant, as digital construction is not possible in an isolated company; it has to spread through the project participants.

Above all, the interviewed persons have an ambition to implement digital construction in their practice to help rationalize everyday work, but they lack significant knowledge about digital construction opportunities. The purpose of these interviews was to understand the company's interpretation of digital construction in general and in the context of their daily routine. Interviews were semi-structured and an interview process was divided into two parts. The first part had general questions on the person's understanding of the digital technology and situation in Lithuania. The other part contained specific questions about the daily work, problems and solutions.

The second part of interviews involved the interviewed persons who had significant knowledge and many years of practice related to digital construction.

- Dsc. Darius Migilinskas – An associate professor at Faculty of Civil Engineering, Department of Construction Technology and Management at Vilnius Gediminas Technical University; Profesional project manager, construction supervisor and engineer with 15 years of scientific practice in the field of construction/production also implementation of IT technologies. It was relevant in order to look at phenomenon from academic perspective.

- Ernestas Beranskis: Intelligent BIM solutions, providing consultancy supporting digital construction in practice. It is relevant in order to explore the existing practices in the projects using BIM methodology in Lithuania.

Open interviews with the above persons were conducted in order to understand and analyse their ideas about the phenomenon, because they are playing the leading roles in the development and implementation of the concept.

Participation in the Work Group of 'Digital Construction'

The public body called 'Digital Construction' united different associations and specialists from the construction sector and formed work groups with a specific direction or topic. In order to collect reliable data, the author participated in and observed group meetings, presentations and discussions at least twice a month. Extra meetings were arranged with group members and the head of the organization to further discuss the current situation in Lithuania. This provided good insights into the arrangement and activities of the organization.

Conference: 'BIM Regional Developments 2014 in Vilnius'

Participation in the conference was arranged by 'Digital Construction', with the purpose of strengthening cooperation between the countries, while also developing strategies and sharing common experiences. Besides many presentations by representatives from Lithuania, the UK, Finland, Poland, Estonia, Latvia and Belarus talking about the development of digital construction methodology in their countries, the most relevant was the presentation by Michael Schwartz about the development in Denmark. His participation provided wider knowledge about the development of digital construction in Europe and allowed direct comparisons of initiatives in Lithuania, Denmark and other countries.

Courses: ICT and Business Process Optimization Opportunities

Participation in one-day courses was organized by the 'Lithuanian construction technological platform' on software solutions suited for carrying out projects according to BIM methodology and, in general, on the possibilities to optimize construction projects with BIM. This provided us with better understanding of which software solutions are available in Lithuania, how widespread they are and what is the level of using them in practice.

Processing the Empirical Data

Many sources were provided with relevant and sufficient empirical data. The evidence is reported fairly, without altering or influencing it (Yin, 2009). Afterwards, the data was structured based on matching patterns, on statements that were repetitive or conflicting. Using the theoretical framework, the data was analysed, compared and discussed in order to draw relevant conclusions. The findings were considered to be valid based on multiple sources of evidence.

Limitations

The data was collected concerning mostly Lithuania's construction sector, with narrower comparison to the development in Denmark. Because of limitations in the time and scope of the projects, it was decided not to include more countries. Furthermore, the discussion includes the public body 'Digital Construction' and one construction consultancy company, although with more time it would have been relevant to study other types of actors in the sector. Digital construction is relevant to research, as it is considered to be the main driver for the digitalization of Lithuania's construction sector. The construction consultancy company is chosen because it is a relevant actor working closely with the client, who can have an influence on the management of construction projects and in convincing the client to use digital construction principles.

6. Retrospective Analysis

This chapter first describes historical development of the sector to give an understanding of the background in witch the existing regime was shaped. It will be followed by analysis of the existing conditions in the sector, based on Geels´ (2005) description of the regime describing different elements in detail.

Introduction to Historical Development

This chapter will introduce the historical development of Lithuania. It is relevant because, in order to understand the existing setup, it is necessary to look into the historical development that shaped the existing institutions. Every change on a political level affects the agency of regime actors, who need to react accordingly in order to maintain their role in the regime. In order to better understand Lithuania's socio-technical setup, the following chapter provides a brief introduction to the most dramatic changes that affected the construction sector during periods of independence and occupation.

Lithuania has a long and complicated history. It started as a great warrior state that, at the beginning of 15th century, reached the peak of its power and became the largest in Europe. In that glorious period, the commonwealth with Poland was created. The first constitution was established stating democratic principles at the end of the 18th century. The period of its power quickly ended as the Russian Empire rose, overran and annexed the state. Even though Lithuanians aggressively objected, the state remained under Russia until World War 1 (WW1). In the beginning of the WW1, Germans overran Russia and Lithuania´s territory was briefly taken over by Germany. After its fall, Lithuania regained independence in 1918. The state was re-established with a new constitution and institutions. By World War 2 (WW2), Lithuania came under Russia's oppression once again and was included in the Soviet Union. Russia destroyed the state again through political repression, collectivization, forbidden opposition and many killings, etc. But the Lithuanians held on to the hope to escape. Many local initiatives, underground political groups, and movements for independence combined with changes within the Soviet Union led to the country regaining independence in 1990, after which it has been strategically developed as an independent democratic republic (Eidintas, Bumblauskas, Kulakauskas, & Tamosaitis, 2012).

The brief introduction describes many developments on the landscape level, which has caused various kinds of pressure to the regime. Changes at the landscape level are considered to be those that Lithuanians could not affect directly, such as wars, the rise of the Russian Empire and of the Soviet Union, division of its territory by powerful actors and occupation. This resulted in the regime structure in Lithuania being shaped by different institutional logics that were completely different in their ideology: capitalism and communism or socialism. Even though Lithuania resisted pressure and managed to keep its identity together with its culture, traditions and language, the different occupations have left traces in its current set-up. The most significant and recent changes of sectoral development are introduced on the next page:

Between War Periods

After WW1, Lithuania became independent after many years of occupation. Strategic development of the country began and during those 19 years of independence it demonstrated significant achievements in many sectors (Stankevičiūtė, 2009). Successful strategic and sectoral development resulted in a fast-growing economy. Together with the economy the building industry also grew. It was recognized as a sector with a centralized organ in the form of a building inspection to plan and control it (Ministry of Environment).

After WW2

After WW2 and up to 1990, occupation by the Soviets destroyed the institutions of Lithuania again. All the property was collectivized and belonged to the state, which became an all-powerful actor. The Construction Committee planned and controlled both the private and the public construction, design, development and other related areas (Ministry of Environment). This huge bureaucratic system destroyed the construction market and urban planning strategies. It has left Lithuanians with not modern and low quality buildings, and it has also distorted their institutional logic (Lithuanian construction technology platform, 2007).

Since Independence

When Lithuania regained independence in 1990, a new chapter in Lithuania's history began. The rebirth period was complicated. As in the beginning, the Soviet Union did not want to admit Lithuania's independence; they blocked Lithuania's economy and there was no interest from the west in investing here (Lithuanian construction technology platform, 2007).

After the Soviet Union's collapse, everything that was owned by the state needed to be privatized. The process of privatization was difficult to control by newly established institutions on shaky foundations. Many controversial operations took place. Properties and companies were privatized in illegal ways. After such a long period of not being able to own anything, everyone wanted to get as much as possible and the system could not control the process. Families could not even regain the properties that they owned before collectivization. There was no continuity in property rights (Seibutis, 2002). Such an unfair privatization process led to many getting rich through cheating and the lack of control misbalanced the historical class division. At the time, all the power from the state was directed towards the fight for independence, and not towards economical development (Seibutis, 2002).

When independence was acknowledged, Lithuania started strategic development by creating institutions and shaping a new regime based on democratic principles. It was a complicated process. Many regulations and strategic planning organs needed to be reviewed since the existing ones were created in other political setups (Lithuanian construction technology platform, 2007).

Institutionalizing of the field has started by reorganizing ministries and changing laws. Control of the construction sector was given to the new Building and Urban Ministry established in 1993 (Seibutis, 2002). Development strategies were established. At the time many professional associations were formed. These included the following:

- Lithuanian Builders Association
- Lithuanian Roads Association
- Lithuanian Association of Consulting Companies
- Lithuanian Architects Chamber
- Lithuanian Association of Civil Engineers
- Lithuanian Electricity Association
- Lithuanian Association of Land Reclamation Enterprises
- National Passive House Association
- Project Expertise and Fire Safety Companies Association
- Association of Buildings Certification Experts
- Building Product Testing Laboratory Association
- 'Structural Engineers' Club
- Lithuanian EPS Association (red. Polystyrene Association)

The associations were eager to raise the level of the Lithuanian construction sector to be equal competitors with other western countries and eliminate the bureaucratic establishment left behind by the Soviets (Lithuanian construction technology platform, 2007).

The Lithuanian construction sector grew, together with its economy, surprisingly quickly. Furthermore, the country survived and managed the economy well through the crisis and is now getting ready to adopt Euro on the 1st of January 2015. (Åslund, 2011)

Summing up

The abovementioned historical events disturbed continuity in developing the building industry as a sector in Lithuania. It can be described as a deinstitutionalized field with a lack of historically stable institutions. The reestablishment of the sector started in the beginning of 90s with the regaining of independence, but many obstacles described in the following chapter led to an inability to achieve stabilization or, in other words, more coordinated sectoral development.

In general, the Lithuanian construction sector in its present design can be called 'young' in comparison with the historically continued initiatives in Denmark. The latter country has been aiming to develop its construction sector since 1947, when the Ministry of Housing was established. The dominance of the state in the development initiatives in Denmark characterizes development as a top-down. The state plays an important role and has been active in analysing the sector, finding problems and trying to rationalize processes through

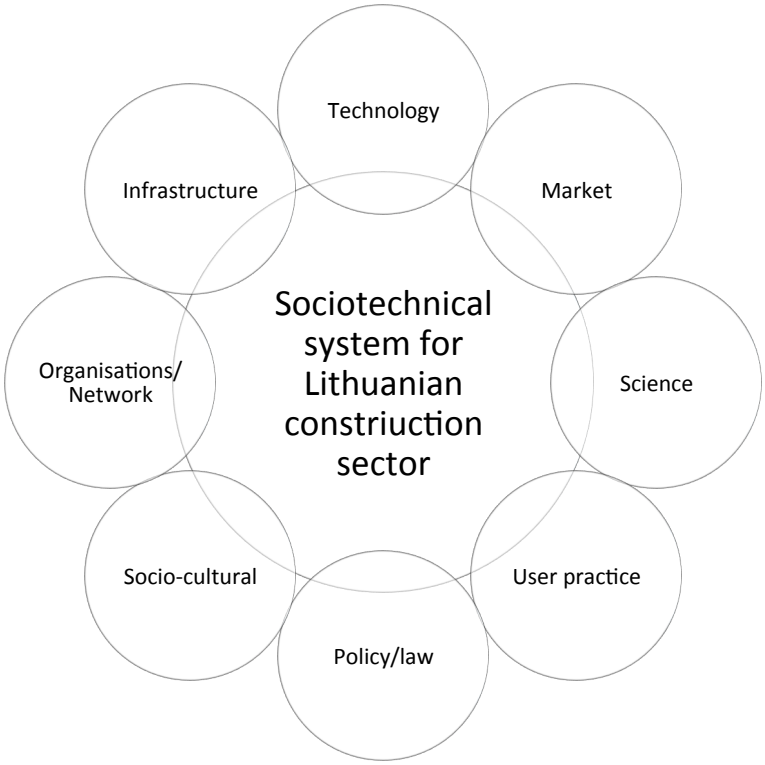
initiating many programs as well as forming regulations. The digital construction in Denmark is also a state initiative. (Jensen, 2011)

The state's role in Lithuania is not as active in sector development as in Denmark. Many initiatives emerge in the bottom-up manner. The public body called 'Digital Construction', which has the same intention as the Danish initiative, also emerged from enthusiasts within the sector and was not initiated by the state.

The following chapter will describe in detail the current situation in the Lithuanian construction sector in order to provide an understanding of the level of stability it has achieved through those 24 years. Furthermore, the barriers and potentials for the implementation of the initiative 'digital construction' will be discussed in relation with Denmark's experience. The question, 'Are the same conditions applicable in both countries, when power is distributed differently?', will be further discussed. The analysis of existing condition is based on the structure of regime described by Geels. (2005)

Regime

This chapter outlines the regime and represents the existing conditions of the Lithuanian construction sector. The description is based on Geels' description of the regime system and is divided into eight elements as shown on he figure below.



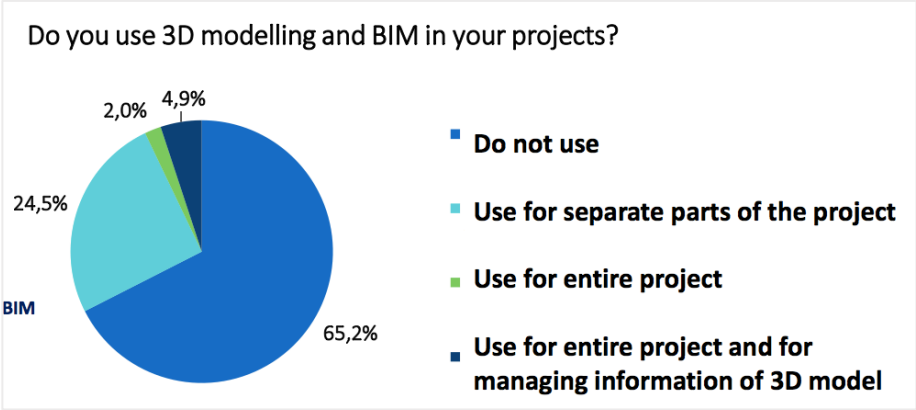
Figur 3: Sociotechnical Regime 'Lithuanian construction sector' elements

Each element is described below. Attention is paid to the on-going processes - for example, the emergence of new markets, policy dynamics, and new technologies (Geels, 2005). Furthermore this detailed description will give a better understanding of the potential barriers standing in the way of implementing fully functional digital construction, as this chapter gives the basis understanding of the setting, which the new technology is approaching. In order to speculate the possible diffusion of the new technology, which is analysed in the next chapter, it is relevant to assess the resistance to change in the existing system. This is determined by discussing stability of regime system and every element. It is considered that the more stable system is, the more it resists changing. (Geels, 2005)

Analysis of the existing regime elements:

Technology

This chapter describes the use of technology in construction projects. It mostly concerns the use of ICT software, but also discusses the BIM concept. BIM as it is described on the 'digital construction' website, is *'Building information modelling, which is a process where creation of united information building model integrating all project parts and life cycles from the design to demolition takes place'*. There are a few ways of describing the concept, but this description is chosen as the organization is considered to be the most influential factor in the development of this concept. It has also carried out a survey of 204 respondents on the use of BIM in the construction projects. Only around 7% answered positively in favour of using BIM in the entire project. However, it is difficult to determine what the respondents meant by answering that they use BIM, as 24.5 % answered that they 'use it for separate parts of the project'. It can be discussed if it is still BIM when it is not integrated and used by one part, but it is assumed that this option meant that the use of the ICT technology would be compatible with BIM. (Gedvilas, 2014)



Figur 4: Use of BIM in construction projects in Lithuania (Gedvilas, 2014)

Out of the 7% who use BIM, 2% 'use it for the entire project' and 4.9 % 'use it for the entire project and the 3D model for management information'. It is unclear how these two answers are different as, according to the BIM description, managing the information of 3D models is implicit in the use of BIM. This shows the uncertainty in understanding BIM and, therefore, it is still considered to be a kind of technology on the niche level.

Furthermore, this survey is based on the project level, where companies on the project level decide on the use of BIM, exchange formats, specifications, etc. and it varies from project to project. It is not based on nationally recognized standards.

The rest of the sector, more than 65%, uses 2D and paper drawings in construction projects, where changes are not coordinated and building information is unreliable. Even though 3D is used in the design phase, the model is not integrated and does not contain relevant information about objects, which is the main condition in working with BIM technology.

Architects use 3D for making visualizations, sometimes for extracting quantities. 3D is also used in some construction drawings, but only for own calculations (Migilinskas, 2012). During the interviews, the leading construction supervisor and the construction supervisor engineer were speculating on why 3D processes are not taken to the next level, where the model is supplied with data and used for sharing information. The possible reasons that are considered are related to price, or people who are not convinced that it can add value, or perhaps they do not even know about the possibilities. It is their opinion that model has to be integrated and used more actively, since a lot still happens on paper (Dubonis & Oleškevičius, 2014).

As the model in the design phase is not supplied with information, it cannot be used further in the process for generating reliable quantities, time plans and budgets. Almost everything is calculated manually and information is gathered from the drawings. There is no database with versions of drawings. The interviews revealed that the leading construction supervisor and the construction supervisor engineer create their own systems together concerning how they keep up with changes. Furthermore, they carry around physical folders with drawings and specifications when on site (Dubonis & Oleškevičius, 2014).

The construction managers and technical managers are often not even equipped with computers or relevant software. According to a research conducted in 2010–2012, out of 708 construction and technical managers, 68% had PCs at work, 37% had CAD programmes installed, 24% had budgeting tools and 16% planning graphical tools (Migilinskas, Skaitmene statyba, 2012).

Planning and budgeting software used in the consultancy company is primitive and not suited especially for construction, which eliminates the possibility of integrating with drawings/models (Čepokas, 2014).

The use of integrated technologies in Lithuanian projects is remarkably lower than in Denmark. As Michael Schwartz mentioned in his presentation on BIM development in Denmark, over 95% of projects in Denmark (both public and private) have BIM requirements (Schwartz, 2014).

There are many reasons behind the fact that in Denmark the technologies are used more actively, which are discussed in following chapters but, in general, Denmark is one of the leading countries in Europe in its use of ICT:

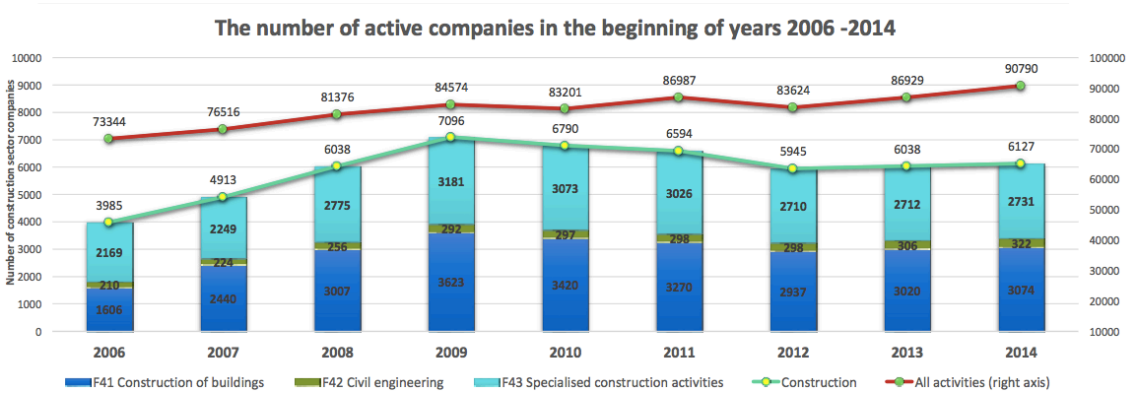
'Denmark ranks at the top of the IDI (red. ICT development index) 2013. This small technology-driven country with a highly skilled population has been quick to adapt to new technologies. According to data from the European Union (EU), 85 per cent of Danes have some level of computer skills (compared to the EU average of 67 per cent) and 42 per cent of the population have "high" computer skills (...). Having regard to the general economic downturn, Denmark's government sees ICTs as a major driver for growth, innovation and economic development (Government of Denmark, 2012)' (International Telecommunication Union , 2014).

Moreover owing to the generally higher economic standards, expensive software solutions are considered also more accessible for Danish firms.

To sum up, the current level of use of smart technologies in the construction sector in Lithuania is low. The main possible barriers are the price of software and lack of knowledge about software solutions and potentials. But the frustration caused by many manual processes resulting in many mistakes shows that the regime element is not stable and settled. There is a potential for change as regime actors are not satisfied and are looking for better solutions. Any approachable solution has an opportunity to be adopted.

Market

The Lithuanian construction market is much smaller than the Danish one. As the graph below shows, in the beginning of 2014, out of 90.790 enterprises, 6,127 were construction enterprises, which represents up to 6.7 % of all enterprises. In total, in year 2013, 64,700 employees were working in the construction market. (Gedvilas, 2014)



Figur 5: Lithuanian construction market (Gedvilas, 2014)

		2008	2009	2010	2011	2012	2013
Av. number of employees in construction	thousand	110,5	82,8	58,1	65,7	80,4	64,7
Relative weight of construction sector in GDP	%	11,3	6,4	5,7	6,51	5,9	6,5

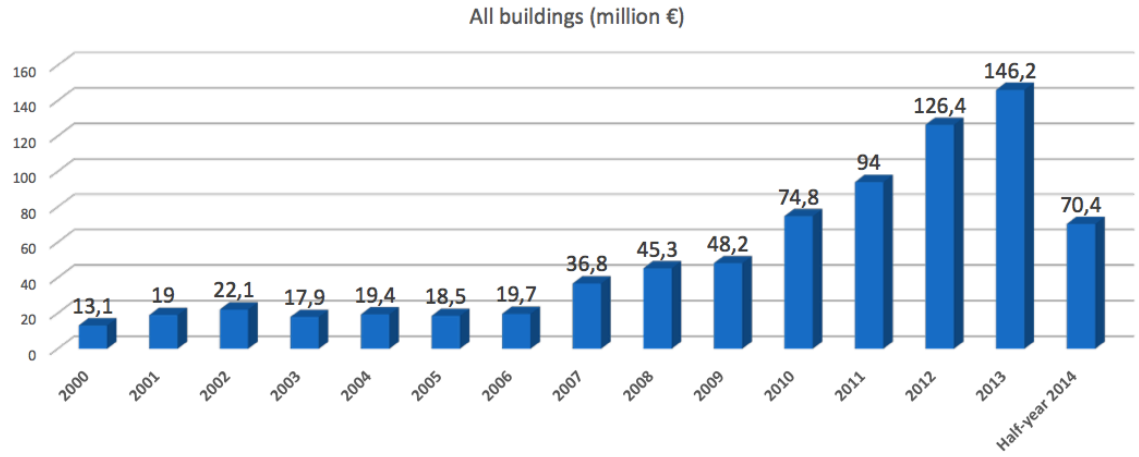
Figur 6: Lithuanian construction market 2 (Gedvilas, 2014)

In comparison to Denmark, according to the Danish statistics, in 2011 and 2012 there were around 31,000 enterprises were registered in the construction sector with 1,20,000 employees. (Danmarks statistik, 2012)

This shows that the number of enterprises in Denmark is significantly higher than that in Lithuania, but the number of employees is only double. As Lithuania has five times fewer enterprises, it could be easier to spread the word about digitalization.

In 2008–2010, all construction projects in Lithuania amounted to 1,500–3,500 million Euro, while public procurement for construction projects amounted to 1,000–1,500 million Euro, which corresponds to a half (Lithuanian Builders Association, 2012). In Denmark in year 2013, construction projects carried out amounted to almost 8,000 million Euro, and nearly half were public procurement projects. (CRM-Byggefakta A/S, 2014)

Denmark's exports of construction services are remarkably higher than that of Lithuania. Every quarter, Denmark's exports amount to around 600 million Euro, which corresponds to around 2,400 million Euro per year (Denmark statistics). Meanwhile, Lithuania's exports in year 2013 were valued at only 146.2 million Euro.



Figur 7: Export in Lithuanian construction sector (Gedvilas, 2014)

The implementation of digital construction in Lithuania could open up new export opportunities and attract new investors from abroad. As the CEO of the construction consultancy company explained, the Lithuanian construction sector is presently unattractive to investors from abroad because projects are relatively expensive. It seems that they should be cheaper than in western countries because salaries and materials are cheaper here, but projects are still quite expensive because of low productivity (Čepokas, 2014).

Science

There has been a noticeable increase in the amount of research and publications related to digital construction in the past few years in Lithuania. Professional scientists, who have special knowledge about digital construction and its potentials, criticize the current regime setup and propose alternative courses of direction (Geels & Schot, 2007). Already, four conferences related to digital construction and BIM have been organized within the last couple of years. Various free courses promoting digital construction have taken place (Šarka, 2013).

The Lithuanian construction technology platform started work in order to support research and experimental development in civil engineering including ICT. It is a part of the EU

initiative Europe Construction Technological Platform (ECTP). (Lithuanian construction technology platform)

In Denmark, the initiative of digitalizing the sector arose much earlier. Over many years, the amount of research work in the field has become remarkably larger. Furthermore, in Denmark, a big part of the research is initiated and financed by the government, even as many powerful associations and organizations collaborate with the government on their research projects. But in Lithuania, low financing in the field and lack of government support result in the fact that it is mostly enthusiasts carrying out test projects and learning from them through their own initiative. (Migilinskas, Digital Construction, 2014)

Thus, in Lithuania, the activities are not coordinated by one powerful actor. Therefore, there is a risk that knowledge about digital construction is coming from various and not always trustworthy sources. (Structum, 2014)

Furthermore, Denmark's universities offer programmes reviewing the problems and potentials of digital construction and the correct integration of projects, whereas in Lithuania the existing programmes are mostly related to the use of software tools for the design phase.

For example, the following courses are currently taught in Lithuania's technical universities. Technological courses in construction technology and management department (Migilinskas, 2012):

- Bachelor's programme from 2011: 'Digitalized construction design'
- Master's programme from 2008: 'Computer-based design'

Construction courses, which are offered in the concrete and brick construction, and construction mechanics departments are:

- Master's programme from 2005: 'Space modelling systems'
- Master's programme from 2005: 'Integrated design systems'
- Master's programme from 2011: 'Computer-based design II'

Approximately 150 students are introduced to BIM every year (Migilinskas, 2012).

This shows that knowledge about integrated projects on the BIM concept is gained by self-taught specialists or by specialists who have studied abroad. This means that there is a lack of qualified specialists with sufficient knowledge about the phenomenon in order to create strategies or determine the development directions.

On the other hand, Lithuania's construction sector is smaller in comparison to the Danish construction sector. Therefore, it needs fewer specialists on the strategic level and more on the operational level.

To sum up, there is a barrier in the form of a lack of knowledge about digital construction in Lithuania and the lack of specialists with sufficient knowledge for making decisions on the national level regarding national standards, classification systems, etc. Even though new

study programmes are being introduced next year, it will take at least four years to prepare the specialists, even as the important decisions need to be weighed and carefully considered now.

User Practice

Many interviewees stated that communication in construction projects is complicated, as information does not flow in the process, but disappears, and is poorly recreated by separate actors. Furthermore, the design and construction phases in Lithuanian construction projects are often separated. The designers design the building and handover the project to the builders without any further participation in it. Since information in the project is not structured, it often disappears. There is no infrastructure to collect and send over the information to the other phases and parts of the project (Dubonis & Oleškevičius, 2014).

Introducing digital construction principles could partially solve this problem, because then all the relevant information would be collected in the model during the design phase and be easily accessible to everyone, but this would also mean that the design phase would become longer, more complex and would cost more than it did earlier. In theory, there should be fewer mistakes and smoother construction phases, but this requires understanding from the client and correct task and budget division in the project.

In general, the idea behind digital construction involves close collaboration between project participants including the exchange and coordination of information. The potential barrier here is the lack of interest in sharing information (Čepokas, 2014). Many companies think about their own profit rather than on how to execute a good construction project in totality. Limited information sharing leads to redundancies in the work process, where, for example, the calculation of quantities is carried out manually by many departments at many times (Dubonis & Oleškevičius, 2014). The digital construction model could partly solve this problem by providing a possibility to generate automatic quantity take-off. But here the question of responsibilities arises. Who will take responsibility for the model's correctness when quantities are generated from it automatically?

Another problem in today's construction projects is that the project material is not situated in the structured database and, therefore, changes in the project material are poorly coordinated. Changes in the drawing are not always coordinated with potential changes in other drawings. There is no unified version control system. Introducing a digital project platform could potentially solve this issue, where consequences caused by any change are instantly visible and can be coordinated in the model. It can also be used to coordinate different disciplines, as a united model makes clashes visible. This thought would create an extra role in the projects of a coordinator of the platform, wherein the information is aptly provided.

But the biggest problem today, as mentioned by almost all of the interviewees and described in most of the literature, is tender procedures based on the lowest price in the public projects. More than half of all construction projects are public projects. In today's public

procurement of construction projects, the main selection criteria depend always on price. Thus, for a company to win the tender, it needs to set the price very low. Projects based on unrealistic low prices commonly contain (willingly or unwillingly) a lot of mistakes. It also means that many changes are made compared to the original project material and the quality of the project is often affected (Markevičienė, 2012). Almantas Stankūnas ('COWI Lithuania', construction department director) also confirms that the lowest price competition is the reason for the quality of building projects being extremely low (Markevičienė, 2012).

There is potential that by introducing digital tools, the process would become more transparent. All information collected in the model would make it more complicated to use elements other than those specified. The required and used elements would be identified more easily and would make the quality assurance procedure easier than expected. Furthermore, using digital models would make it possible to arrange tenders based on quantities generated from the model. This would provide transparency and give the same basis for every contractor offering the price.

But digitalization of the processes will come with additional costs in the beginning. The client, who is the head of the projects, is normally not interested in the ways that construction projects are carried out, as long as the price and quality is acceptable. If digital construction costs more than usual it will be a significant barrier for implementation, because there will not be any investors who are willing to pay extra for it (Čepokas, 2014). This implies that implementation of digital construction needs to add value by optimizing construction processes in order to offer better quality for the same price, or a lower price for the same quality.

Another big barrier is that introducing digital construction in projects provides value only if all the participants contribute generously to it. It is only the client who can formulate requirements for the projects, but clients in Lithuania presently do not have sufficient knowledge about which requirements regarding digital construction they should demand. (Digital construction, 2014)

To sum up, the way in which construction projects are organized is chaotic and there is no information flow, coordination of changes, or a centralized project platform containing project information. The quality assurance procedures are complicated. Decisions are often taken at the construction site (Digital construction, 2014). Furthermore, there is no common unified classification system in the construction sector. This shows instability and the absence of unified as well as accepted norms and procedures.

Policy/Law

STR or construction technical regulations are the laws applied to all construction projects in Lithuania (The Ministry of Environment, 2014). It includes wider spectrum of regulations and laws than 'Building Regulations' of Denmark. STR can be seen as unified laws governing not only requirements for buildings but also, for example, procedures for quality

assurance, planning of resources, qualification of specialists and companies required to carry out curtain works, and the rules for graphical representation of the drawings. The last of these is not suited for digital construction using models, as there are certain requirements for drawing, text layouts on the drawings and mark-ups, which are made to suit 2D working methods, where relevant information is shown on the drawings. Even though any modelling software programme can generate 2D drawings, it is missing standardized requirements for carrying out object-based models containing relevant information. This means that designers are constrained by laws carrying out the standardized 2D drawings and if this is what needs to be delivered, the motivation for doing 3D models is low. While there will be an absence of clear guidelines about carrying out construction projects based on digital models, the resistance to change will remain.

The other widely discussed law standing in the way of digital construction is the law about the physical construction work journal. This journal needs to be filled by the site manager with the work being carried out every day and signed by the quality assurance manager. The system considerably came from Soviet times when bureaucracy was deeply entrenched in the law system. It requires signatures, stamps of all important and unimportant works, which in some cases does not make sense. For example, the site manager writes that he has built scaffolding for the windows montage. This means that the quality assurance office needs to sign that he checked that work, even though it has nothing to do with the building (Dubonis & Oleškevičius, 2014).

The other problem with this journal is that it is a physical book, where it is difficult to find or afterwards use information. In order to find a specific work to be carried out, a person needs to read whole book and, in the big projects, it can be more than 60 books. Information from the books is not related to plans or budgeting; it cannot be used in other contexts. The need for digitalization of this particular aspect is considered of high relevance (Dubonis & Oleškevičius, 2014). In this context, digitalization does not mean making the same journal digital, but rationalizing procedures, developing systems related to plans and budgeting, digital acceptance function prompted by relative parties, etc.

The implementation of digital construction requires preparation of specifications, standards and a unified qualification system. These works are included in the 'Development strategy of construction sector in Lithuania until 2015. Part 2: Vision, mission, strategic goals and actions of implementation of strategic objectives' (Zavadskas, Kaklauskas, & Banaitis, 2010). This means that development of the sector is moving in the right direction, but success will depend on results of the work regarding choosing/developing classification, standards, etc. The developing of laws in Lithuania is characterized by lack of continuity. Plans change together with politicians and heads of municipalities, which is why it is important to ensure that digitalization does not die with newly elected governments and officials (Lithuanian construction technology platform, 2007).

But according to European Union Public Procurement Directive, all EU countries have to form special requirements for using digital construction in public projects from 2016

(Lithuanian construction technology platform, 2007). This means that Lithuania will also need to develop these requirements and the law will change.

In Denmark, such requirements came into force in year 2007. But Denmark was well-prepared, as the state financed a group of specialists working on developing the requirements from year 2001 (Michael Schwartz). Much analysis and research work was carried out and the implementation strategies were created. This means that Denmark was better prepared with support of government, whereas Lithuania still does not have governmental support. Moreover, even though Denmark invested a lot of work in preparation, the requirements were revised several times with the last revision valid from 2013.

Socio-cultural

According to the Gallup International Association, the construction sector is the most corrupt sector in the world. The level of corruption is higher than in the gun and oil industries (Lithuanian construction technology platform, 2007). In the interviews, it is also mentioned that some level of corruption exists and this could be one of the barriers for implementing digital technologies, because in that case the process would become more transparent (Čepokas, 2014).

Another barrier is the older generation, which today has high positions in various organizations in the construction sector. It is considered that the older generation could possibly resist innovative digital tools, as they have worked in other ways for many years (Čepokas, 2014). Because of deinstitutionalized system, they have developed and adjusted own working routines and methods and found the way that works for them. This means that the willingness for upgrading qualifications needs to be examined.

But there are many, especially in the younger generation, who are generally interested in innovation. Since Soviet times, where there was absolutely no selection, but only standard goods, Lithuanian society has been growing. For the young generation after independence everything was new, life was modernized every year. Novelties have been adopted with big enthusiasm. Every aspect has become better and more modern throughout the years of independance. From finding nothing in the shops in near past, the country now has huge supermarkets. This ongoing development continues every year and has not yet to slow down. Even though Lithuania has already eliminated the retardation left behind by the Soviets and reached a level equalling other western countries, innovation continues to take place. This could be one reason why digitalization of the construction sector might be easier in Lithuania, than in Denmark, as the former has not developed deep traditions or trends, everything is still developing. It is also considered to be a good time for change, as the regime structure is not totally settled.

Organizations/Network

So far, technological innovation comes mostly from the single companies that are interested in improving their work in Lithuania (Lithuanian construction technology platform, 2007). The centralized approach of 'Digital Construction', which should involve all the participants, is just beginning and has not shown any results yet. But it is clear that the advantage of digital construction is possible only if all the parties in the project collaborate.

It is not certain that the 'Digital Construction' as a niche actor is powerful enough to push implementation through the whole sector. It is based on many collaborating associations, but associations in Lithuania are not considered to be as influential as, for example, in Denmark. For example the Builders' Association in Lithuania is portrayed as having more of the social character, than one that can influence quality of the construction projects and qualifications of the members (Čepokas, 2014). So far there is no equivalent organization to the Bips in Denmark, which is highly influential, spread over whole construction sector and working towards solutions for raising quality in the sector by involving the best specialists in the field. (Bips, 2014)

Infrastructure

To ensure the digital exchange it is important to develop a unified classification system and standards in order to ensure the smooth exchange of information between parties. It is possible to work according to BIM methodology determining the classification and standards for each project, agreeing internally about what and how they will be used, but accepting unified classification and standards on a national level would simplify the process. Furthermore, it would give the possibility for manufacturers, inspection institutions and others to contribute to the automation of some processes. There is no such system in Lithuania at the moment (Lithuanian construction technology platform, 2007).

Denmark is in the last phase of creation of its own classification system of CCS suited to the digital construction concept (Cuneco, 2014). The effect of the system is difficult to evaluate, since it is not fully developed yet and did not win the full acceptance in the regime. The system is discussed in Lithuania as a possible option that could be adopted in the future. This shows instability of regime element, as it is stated that Lithuania needs a unified qualification system, but which one to choose or whether to create a brand new one is still a highly discussed question (Digital construction, 2014).

Denmark is also part of the Building Smart alliance, which develops standardized exchange formats. It is also a Lithuanian ambition to join this alliance in the near future (Digital construction, 2014).

In general, the development towards digital infrastructure in Lithuania has begun, as the state registry centre, tax administration, customs and other government agencies became digital. The building permissions can also be issued digitally. At the moment, Lithuania is ranked in the 40th position out of 166 world countries by the IDI index, which '*is a*

composite index combining 11 indicators into one benchmark measure that serves to monitor and compare developments in information and communication technology (ICT) across countries' (International Telecommunication Union , 2014).

Regime: Summing up

To sum up, the Lithuanian construction sector is quite small compared to other countries, but contributes with a big part of GDP in Lithuania. It could be characterized by its wide use of primitive technologies, constrained by outdated regulations, and ineffective project organisation, there is also a lack of specialists in the digitalization field and lack of financing for the sectoral development strategies. The regime is not stable; therefore, there are possibilities for change. But, on the other hand, the country has survived so many changes that the possibility of successful reinstitutionalizing can be discussed.

The wider changes and instabilities in regime are not only caused by internal factors, but also by external influences from landscape level. It acts as an external context, which still has influence in the direction of the development in regime by providing certain pressures described in the following chapter.

Landscape

The elements described above belong to the regime structure. The developments in the regime are not isolated and can be influenced by development on the landscape level.

The economic crisis is one of the external factors strongly affecting the construction sector. Up to the crisis in 2009, the economy together with the construction sector was growing very fast. Together with the favourable bank loan system in Lithuania, purchases of real estate property were higher than ever, which led to many construction projects, with the main concern of how to build fast. During the crisis the bank loan system changed, people started saving, construction remarkably slow down and many construction companies did not survive. Hence, after the crisis, priorities changed. The construction projects are not running on a tight schedule, but more and more attention is paid to quality. The potential for rationalization of building processes arose and one of the initiatives for this is digital construction. As the economical situation is now about to stabilize, there is no more need for very strict saving and there is a move in the direction of development towards innovation.

Furthermore, developments in Europe resulted in a new European Union Public Procurement Directive, which states that, from 2016, all EU countries have to form special requirements for using digital construction in the public projects. This directive puts big pressure on the regime to develop strategies for implementing digital construction. It also opens up possibilities to get financing for organizing activities related to development and implementation of digital construction principles, which is vital for development in Lithuania, where financing from the state is very limited (Digital construction, 2014).

The other direction for developing is set by decreasing natural resources and increasing attention paid to energy performance of buildings. In Lithuania, the building mass uses 50 % of all the country's energy. Considering the buildings' lifespan it adds up to significant numbers. Increasing energy prices encourages the planning of the entire building lifetime including design and materials, construction operation and facility management (Lithuanian construction technology platform, 2007). This encourages the search for alternative ways to increase building performance. The good planning and wise selection of construction elements in the design phase can save on many exploitation costs. Digital technologies provide tools that allow the simulation of buildings' performance and can encourage the digitalization of the construction sector.

Furthermore the general development in IT and spread of Internet accessibility resulted in increased use of smartphones and tablet computers, which are available for competitive prices. As it allows people to be more mobile it resulted into change in user preferences. When more and more information is available on mobile devices, actors are less willing to walk around with cases of paper drawings and seek for Internet based solutions. Moreover as more and more manufacturers provide possibility to simulate goods in 3D environment on the Internet it becomes more natural to work with 3D models and quickly access the relevant information.

The above-described developments pressure regime from the top, which leads to the search for better solutions in some areas. But if the alternatives are not available or articulated, the transition process is not possible. The alternatives are often developed as niche innovations and are described in the following chapter of prospective analysis (Geels & Schot, 2007).

Sum up Retrospective Analysis

Landscape pressures and rapid changes in the regime system have caused destabilization of the system. Internal problems, such as loss and redundancies of information in the process, a lot of manual work and ineffective organization as well as low export qualities cannot be met by available technology. This encourages regime actors to search for alternative ways. Moreover, pressures from landscape in the form of EU laws, changing user preferences, demanding higher quality of the processes and economic considerations, creates circumstances that result in the possibility for transition to take place.

One of the possible ways for reinstitutionalizing this sector is adopting digital construction technology and methodology (Geels & Schot, 2007). In the description of regime elements many potentials and barriers were mentioned. The next chapter is analysing how niche innovation can be implemented in the existing regime, and therefor a quick summary of the most important barriers for implementation, which needs to be eliminated, is provided:

- Lack of understanding of the technology and its potential by regime actors
- Lack of clear guidelines about how it works in practice and what new roles would emerge in the projects
- Lack of investment in innovations in the companies
- Expensive software, insecurity about choosing the right software (problem of compatibility with other software)
- Very big change to go from paper or 2D to the intelligent software solutions, considering that some participants in the projects are not even equipped with computers
- Differentiated construction process and lack of interest in sharing information
- Lack of understanding about technology and process by the client, who sets the project demands
- No unified classification system, no standards
- Lowest price competition
- Regulations not suited for model-based work

The next chapter will provide a closer look into the development strategies and how they can eliminate above-mentioned barriers. Also it will describe current development on niche.

7. Prospective Analysis

The previous chapter discussed the current situation in the sector. In the following chapter, we will take a closer look at the development and diffusion of the niche technology.

Niche

Niche acts as an incubation room for the technologies to be developed. In the case of a window of opportunity in the regime, the innovation can break from the niche level into the regime level. It is not always adapted to regime level, but either way it generates learning process through experiences and can be transformed into other different innovations, which are better nurtured and levelled with developments in the regime. (Schot & Geels, 2008)

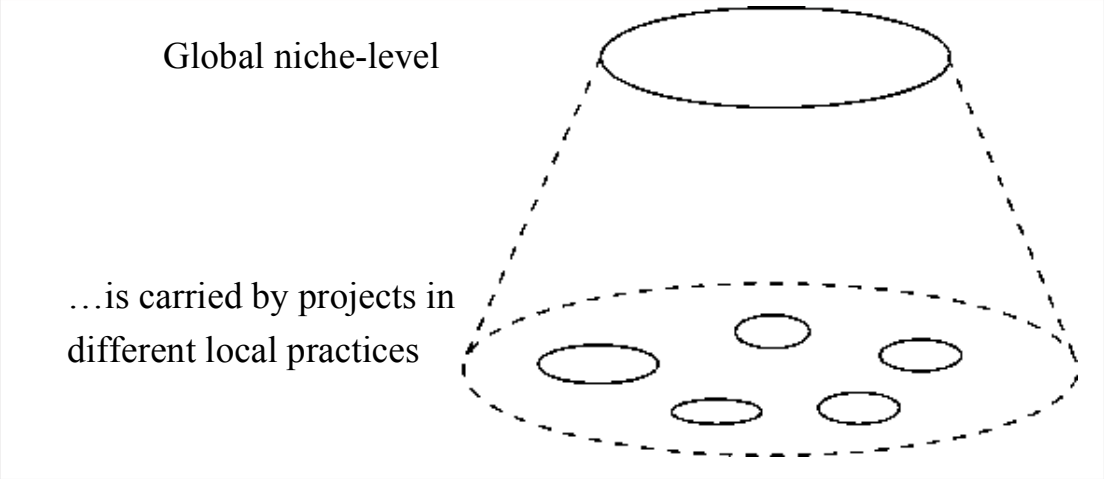
In this thesis the technology is centred on digital construction and could also be referred to as BIM. It is a way of organizing and carrying out construction projects.

BIM as described by Building Smart alliance is

'is a digital representation of physical and functional characteristics of a facility. A building information model is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.' (Building Smart Alliance, 2014)

Basically, it is a process of designing and managing design, construction and exploitation using digital models containing the information shared and coordinated among and accessible to the relevant actors. BIM is used as a narrower concept, acting on the project level. This means that in case of the collaborative project team, which can internally agree on terms of using BIM in particular projects it is possible to carry out projects based on BIM methodology without the nationally accepted classification systems and standards, but then it will be limited to only exchange of information between project parts and will every time result in significant amount of coordination work. This is considered a local project or a local niche as the initiative is not coordinated in a wider context. The digital construction concept in this thesis is used as a wider concept operating on national level, which means developing a unified classification and standards in order for everyone to have a clear understanding of how to use it. This is referred to a global level or a global niche in the projects, as it tries to cover all the sector.

The development of the niche technology is progressing at local and global levels simultaneously.



Figur 8: Local projects and global niche-level (Geels & Raven, 2006)

As shown in the figure above local level consists of projects in local practices described as single projects and uncoordinated initiatives taken by single firms, associations or activists. In Lithuania there are several of such activities as for example:

- DaromBIM.lt (red. Let's do BIM): This is a social project organized by Autodesk software providers in Lithuania AGA-CAD. It has a character of a forum with the purpose of spreading the word about BIM. It also organizes seminars. (AGA-CAD, 2014)
- Intelligent BIM Solutions: This is a private BIM consultancy company actively participating in teaching based on their own practice with BIM. Actively supporting open BIM concept and Building Smart alliance. (Intelligent BIM Solutions, 2014)
- IN RE: This is a private company providing consulting regarding BIM, along with software solutions based on Bentley and Nemetschek software and other smart solutions. (IN RE, 2014)

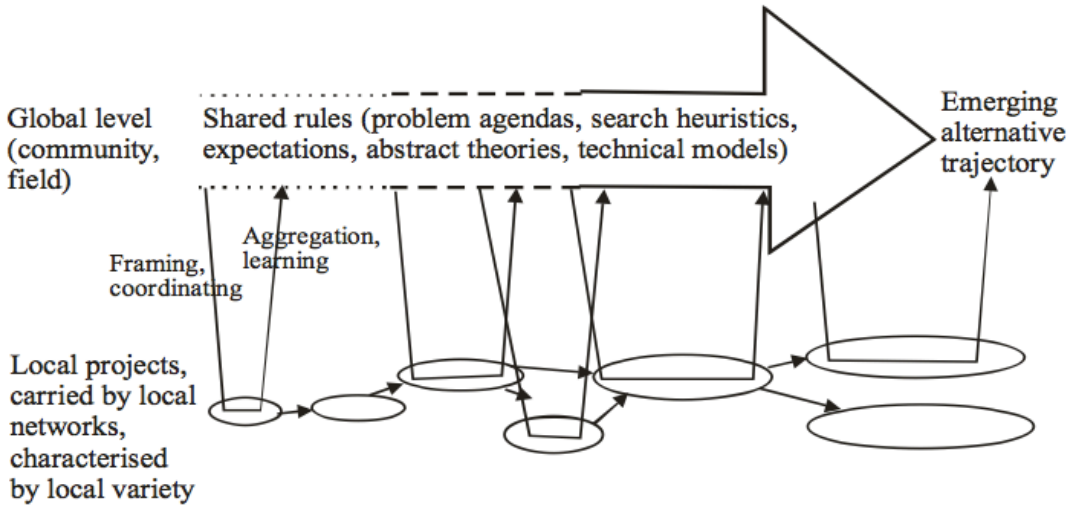
Furthermore, ten big construction projects were carried out by enthusiasts applying digital tools. (Digital Construction, 2014) First one was carried out already in 2002 where established group of specialists started using BIM as they described it in real construction project, where interest in BIM technology came from abroad. They used 3D models where they gathered information for generating time schedules and price sheets. The group developed classification by defining typical elements and their typical combinations. It was also collected in the database (Migilinskas, 2012).

Furthermore there are some big regime actors that, because of the deinstitutionalized regime, have changed orientation and started using BIM methodology in order to achieve better results. For example, we can cite the name of YIT Kausta—a Finnish capital construction company. It carries out private projects using a building information modelling and digital platform. All the construction processes are modelled using documents on the digital platform and shared for design, construction and Facilities Management (Aglinskas, 2014).

In theory, local socio-technical projects can add up in an emerging community that shares cognitive, formal and normative rules (Schot & Geels, 2008) This community is described as a global niche and should align the initiatives from local actors. In the thesis, the global niche manager is the public body 'Digital Construction'. This is a unified initiative that includes not only actors immediately involved in local projects, but also policy makers and professional societies. Furthermore, it seeks financial and political support. (Raven & Geels, 2010). It aims to coordinate development and act as a centralized driver of the digitalization process.

As a representative for the local level, the construction consultancy company 'Incorpus' was selected. Even though it would have been interesting to examine a wider range of local initiatives, including the successes and the failures, only one is analysed considering the limited time and scope of the thesis.

The simultaneous development on the global and the local levels can gradually add up to new trajectories and become more articulated in the regime before finally forming the transition as shown in the figure bellow (Raven, van den Bosch, & Weterings, 2010).



Figur 9: Global and local levels (Geels & Raven, 2006)

The two following chapters will discuss these two niche managers on two levels described and their possibilities for managing the transition and eliminating the discussed barriers. Furthermore, the question of how they can induce the implementation of the niche technology into the regime system in order to cause the transition will be addressed.

Both, the analysis of the public body 'Digital Construction' and of the construction consultancy company is arranged based on the SNM principles through experiments. This will help articulate how these niche managers could initiate changes in the existing regime system in order to promote the selected technology. Attention will be directed towards building up a support network and involving the regime actors, the power distribution and learning processes.

Public Body 'Digital Construction'

This chapter describes in detail the initiative on global level carried out by public body 'Digital Construction'.

The initiative started from the Builders' Association, which is one of the most influential associations in Lithuania. It was a result of the first big international conference organized by the association, of which the Ministry of Economy and the Danish embassy were also partners. It was organized on 13 April 2012 as a presentation of digital construction initiatives. The Danish model was also presented and the possibility to adopt it in Lithuania discussed. After the conference, the idea of establishing a public body such as 'Digital Construction' was discussed. It was decided that it should be an NGO organization uniting many specialists. Today, it is driven by members of the following associations:

- Lithuanian Builders Association
- Lithuanian Roads Association
- Lithuanian Association of Consulting Companies
- Lithuanian Architects Chamber
- Lithuanian Association of Civil Engineers
- Lithuanian Electricity Association
- Lithuanian Association of Land Reclamation Enterprises
- National Passive House Association
- Project Expertise and Fire Safety Companies Association
- Association of Buildings Certification Experts
- Building Product Testing Laboratory Association
- Structural Engineers' Club
- Lithuanian EPS Association

And have following partners:

- Universities
    - Vilnius Gediminas Technical University
    - Kaunas University of Technology
- Lithuanian Real Estate Development Association
- INFOBALT
- Lithuanian Association of surveyors
- Center of Registers
- JSC 'Lithuanian Railways'
- Lithuanian Road Administration
- Klaipeda state seaport authority
- LESTO (red. Lithuanian distribution network operator)
- Litgrid (red. Lithuanian electricity transmission system operator)

- Lithuania Energy
- And other enthusiasts (Gedvilas, 2014)

The organization is trying to implement several fundamental changes, which could be described as the formation of a totally new regime. The work directions of the initiatives cover changes in every element of the regime, starting from the implementation of BIM technology, changing user practice, project organization, laws, policy, education and infrastructure. It is an enthusiastically driven revolutionary initiative of reinstitutionalization of the sector.

The vision of the organisation is the following:

'To form a single digital infrastructure for developing ICT solutions in construction targeted at the development of the Lithuanian construction sector of sustainable environment and to encourage all market participants to use it.' (Gedvilas, 2014)

Their mission is:

'To contribute to the development of a sustainable environment of the Lithuanian construction sector, both public and private, for cooperation and partnership by developing innovative solutions for rational exchange and dissemination of information in the construction sector, development of ICT systems and services in the construction sector; to educate and organise training.' (Gedvilas, 2014)

It is noted that it should be supported financially by the state. But up to this point financing has not been granted. Furthermore, the members are working towards applying for finance from the EU. (Lithuanian Builders Association, 2012)

The technology promoted by the public body could be described as a building process based on objectivity, which entails information containing models that were developed using the unified classification as well as exchanged as per unified and nationally accepted standards, ensuring '*that the whole information used in construction projects throughout the life-cycle of the construction object, from idea to demolition, would be created systematically by avoiding the overlap of activities, where the information is only supplemented in each construction stage or changed in the centralised database connected to various databases associated with the construction object concerned'* (Digital construction, 2014). The technology is used not only to create digital models, but also to generate time plans, budgets, simulate energy performance, organize the facility management, etc.

Assessment of technology

In order to analyse the possible implementation of the technology, it needs to be assessed according to its technical opportunities, economic advantages, consistency with the organizations and attractiveness in the market (Kemp, Schot, & Hoogma, 1988).

Technological opportunities embedded in the promoted technology are considered to be of high relevance. The digital models provided with structured information offer the

possibility of easy access and share information in order to use it in all the construction processes in order to optimize it, and avoid redundancies, manual calculations and mistakes. It is a precondition for achieving the mentioned results, that all (or, at least, most of) the construction project parts use digital infrastructure and share information via digital tools. If the models according to the BIM methodology are only created for design and are not used for construction or facilities management, they will lose their value. Furthermore, the description is based on an ideal model, but it is not yet described how exactly it would work in practice.

In relation to the economic impact, the digital construction website states that with the correct use of technology it is possible to achieve '*as much as 30% lower price of construction project during its life-cycle; lower number of changes; higher number of projects completed within deadlines; higher quality, etc.'* (Digital Construtions, 2014)

However, it is not specified what the 30% lower cost is based on and whether it is assumed to be advantageous for the client, but the economic returns need to be calculated also for each company, assessing the price of the implementation of technologies (software and learning) and their possible positive results.

Regarding consistency with the organization – the technology is not entirely consistent with the existing organization of the projects. The idea of sharing information and collaborating is presently hardly possible in today's differentiated project organization.

But it is attractive for use in big projects, where the quantity of information is too high to be managed without clear structure. The advantages of easily generated and accessible information would also lead to coordinated changes, which would be valued higher than the disadvantages caused by the longer design process of modelling than in the information-rich models.

To sum up, it is an attractive technology in theory, but it requires many adjustments such as the revision of budgeting, different work division, willingness of collaboration by parties etc. The possibility to implement these changes is further discussed by establishing an experiment in the following chapter.

The experiment

It is further analysed according to the five steps of SNM in order to assess its possibilities. (Kemp, Schot, & Hoogma, 1988)

The Selection of Experiment

The selection of the experiment relates to finding the setting, where the advantages of technology are valued highly (Kemp, Schot, & Hoogma, 1988). It is basically any construction project, but high priority is considered to be public sector projects including the tender procedure based on digital construction principles. The advantages are relevant as it has the potential to save taxpayers' money and contribute to the countries' GDP. Furthermore, the amount of public procurement projects increases every year and now represents more than half of all construction projects (Digital Construction, 2014). This also includes digital tender procedures based on digital models. As described by digital construction it should:

'increase the transparency, accuracy and evaluation of public procurements, reduce public procurement costs, create more new jobs, encourage innovations, increase competitiveness, ensure "greener" construction, possibilities of new businesses for new and existing construction sector and related enterprises, etc.' (Digital Constrution, 2014)

Furthermore establishing requirements for public procurement projects would in a way force the participants to use the technology, which will generate valuable experiences for further development and adjustment of technology.

The Set-up of the Experiment

In order to implement digital construction principles, digital construction is working towards:

- Developing the strategy of building project design, construction and operation based on computer-aided modelling technologies
- Ensuring the integrated management of graphical and information data flows
- Transforming individual executors into teams, integrating individual tasks into processes (Digital Constrution, 2014)

In order to achieve these goals, the short-term road map was confirmed by establishing a series of the objectives. There were formed into work groups with the articulated tasks. The members of these work groups are working on a voluntary basis in order to form project specifications for raising funds. After these activities are carried out and the budget is formed, the long-term goals will be achieved in order to carry out projects such as requirements for BIM models, classification and coding systems, process and data exchange, public procurement regulations and sample contracts, BIM guidelines, templates and libraries of BIM elements, research studies and BIM maturity assessment, regulation infrastructure, training and certification, and pilot projects (Gedvilas, 2014).

But in order to raise financing for carrying out the projects, the nine work groups are working on the following areas (Gedvilas, 2014):

1. The first group is *preparing BIM requirements and standards (preparing guides and adapting IFC in Lithuania)*. The successful completion of this task has the potential to eliminate the barriers, such as the lack of clear guides regarding how BIM technology is applied in practice. Furthermore, the requirements for public procurement projects would force the implementation of technology and encourage the client to set requirements regarding the use of ICT.

2. *Defining the statistical index of development of digital construction and describing the monitoring index of the BIM environment.* This refers to research and evaluation of the development work by digital construction and should ensure the match of the development direction along with its user requirements.

3. *Adapting and analysing the adjustment of methodology of digital construction and integration with the current system of law and regulation in Lithuania.* Successful work by this group would eliminate the barrier of outdated laws suited only to 2D work methodology.

4. *Forming and developing the structure of national classification and systems of coding; compatibility and integration with EU.* This should also eliminate the barriers of incompatible technologies and troubles related to the exchange of data. But it is a tremendous task. The reality is that there is no existing fully integrated classification system without any of the disadvantages. To develop one's own system is too big a task for Lithuania and adopting one from abroad needs careful assessment.

5. *Forming, developing, administrating and describing the order of usage of information and communication technologies concerning the infrastructure of digital construction.* The successful work of this group would eliminate the biggest issues involving lack of knowledge in the field. Furthermore, a clear guide about information sharing could solve the problem of willingness of sharing between parts. But, in this case, it needs to draw a clear scheme of who is responsible for what information in which stages, as it also describes new roles in the projects, such as that of IVT coordinator or one with similar competence.

6. *Publicity, dissemination of the results of good practice, creating image of the public body.* It again eliminates lack of understanding of potentials with technology and increases interest, but it would also be good to share not only good practice, but also know the bad practices and analyse the lessons learnt from them.

7. *Regional cooperation for developing BIM*. It would possibly open up new export possibilities through learning from other countries, which would also attract investors.

8. *Introduction and certification of BIM study programmes, organizing of studies in high schools and informal training, validation of qualification, preparing of certification methods, organizing of certification of participants of construction process, BIM project*

managers. This is one of the most important works towards understanding and managing the processes. Education and specialized courses would eliminate lack of special knowledge in the field. It would raise the qualification of the existing regime actors. The question of willingness could be solved by the required certification of the knowledge level.

9. *Preparing of legal regulation of organizing public procurement in accordance with BIM.* This could eliminate the biggest barrier as was described earlier, along with the problems related to the lowest-price competition. If the tender were to take place on the digital platform, utilizing data from the digital models, it would give everyone the same background data to prepare bids. It raises though the question of the division of responsibilities. In this case the designer would be responsible for the quantities in the price sheets, and it would take away responsibility from the contractors to recalculate their bids.

These developments in the groups address many of the discussed barriers and their success depends on the work results of the groups and the successful involvement of all the actors. Until now the groups are working in the protected environment and the results are not available to broader public. Too much protection can result into that the decisions are not coordinated with the other actors and therefore are not adjusted accordingly. This can cause a major frustration in the sector, when the requirements for using technologies suddenly appear. To adjust the expectations and decisions the contact to the sector needs to be ensured. The public body is organising conferences, but broader discussion forums, external specialists etc. are of high relevance.

The aim is build up a centralised organ with rich knowledge, attract specialists in the field and gain and power in driving innovation in the sector. This is difficult to achieve in Lithuania, where trust in institutions is extremely low because of the country's recent history. Research in 2011 showed that 86% of citizens do not trust the Lithuanian parliament and 76% do not trust the government (ELTA, 2011).

The most important task is also to address the incumbent actors, who are still working on paper. For them to start using the smart technologies very basic and applicable solutions need to be available, together with courses and free of charge simple software tools. This can be difficult to achieve, as the lack of knowledge in the field does not provide a solid background to choose the best software and can give software sellers the advantage of engaging companies into the most expensive/incompatible solutions. Moreover, the willingness of companies to invest in new technology is law and therefore the financial support in form of subsidies or other needs to be considered, as price of technology is considered to be high in Lithuania, where the average salary is only around 620 Euro before tax (Statistics Lithuania, 2013).

Finally, the actual plan of reorganizing the construction process from differentiated to cooperative needs to be detailed and specified in the approachable manner.

Scaling up the Experiment

In order to scale up the experiment there is a clear need for support from the government. In order to coordinate the action and strategies, financial support is required along with a change in laws and recognition of standards. The interest from the government should be an expectation that the initiative will become important for increasing economic benefits in the future (Schot & Geels, 2008).

The support of the government is confirmed through its approval of the programme of experimental development and innovation in the future, including digital construction as a point in its agenda (Zavadskas, Kaklauskas, & Banaitis, 2010).

But the more active part of government would help scale up the experiment and involve the actors by, for example, offering subsidies for new technologies, free of charge nationally developed contractual basis or the facilities of e-infrastructure. The government could also finance the pilot projects and offer free courses in order to educate regime actors and expand the network.

The Breakdown of Protection

So far as the development work is carried out in closed groups, it entails nurturing, discussing, and analysing the possibilities of, for example, the requirements, classification system, standards, guides, education system, etc. The breakdown of protection would be the announcement of the requirements of the public procurement, which is planned in 2016. It is a very tight deadline for a significant amount of work and, therefore, there is a risk for publishing not completely polished decisions. In Denmark, the support of the government was granted to the group of highly qualified specialists divided into six groups with the sole aim of developing the requirements. This took six years and the result has been adjusted a few times since then.

But the most important is that the publishing of the requirements would not be the only goal, which would make the regime actors to use the technology. Sudden new requirements would most likely cause the frustration and would encourage finding solutions to 'work around' the requirements by still using old routines. As the task here is to change the way projects are organised, the mind-set of the participants need to change, the thinking of 'me' needs to change into thinking of 'us carrying out a complete project'. It is a tremendous task, which will require convincing and teaching many actors.

Summing up: Public Body 'Digital Construction'

In order for the technology to be recognized the support network needs to be build around it and stimulate learning processes. The meetings of specialists discussing the issues align different interests (as groups are formed by specialists from many disciplines) to a single goal. As the actor is operating in the global level, it needs to ensure the coordination of the activities on local level to ensure that simultaneous development processes target the same

direction. It can be done by establishing rules, classification and standards, but in order to convince and involve other actors the promises needs to be articulated. The public body is promising to:

'*Increase the transparency, accuracy and evaluation of public procurements, reduce costs, create more new jobs, encourage innovations, increase competitiveness, ensure "greener" construction, ensure more reliable investment planning, lower number of changes, higher number of projects completed within deadlines, higher quality, faster design, fewer error, more profit, more accurate estimates, better life quality.'* (Digital Constrution, 2014)

Even though achieving this is not realistic in the near future, the articulated benefits can attract the interest of other actors and engage them in development or convince them to try again. Trying would build up the knowledge required to initiate further development of the technology and adjustment to the real practice. This means that the promises need to be spread via publications, conferences, discussions and most importantly the real project positive results. Only if other regime actors will associate and the social network will grow larger, the learning process take place, rules become more stable and constraining and the niche innovation will have the possibility to grow into regime construction (Geels & Schot, 2007).

Construction Consultancy Company

The following chapter provides similar analyses as before, but now with focus on a local niche initiative by a construction consultancy company as a niche manager. The experiment described below provides site-specific knowledge as hands-on experience, where actors make sense of the technology in the real projects, whereas before discussed experiment generated global, abstract and generic knowledge (Raven & Geels, 2010).

It is an attempt to rationalize a single construction project by applying the BIM methodology in order to achieve tangible results. The aim with the experiment is to add value by optimizing construction processes in order to offer better quality for the same price, or lower price for the same quality. In other words the success is measured by direct profit for the company, or by possibility to attract clients.

The company acting as niche manager is a young one but possesses a competitive team of specialists working on relatively big projects, acting mostly as client consultants through the construction projects. The idea of searching for alternatives stemmed from the frustration associated with ineffective processes. Digital construction principles are considered to have the potentials to solve real-life problems, as for example manual procedures, ineffective work organisation etc.

Assessment of technology

The technology is basically applying a centralized database and building model with information applied for the design, management of the construction and the exploitation of the building. It is again assessed according to the technological opportunities, economic returns, and consistency with the organization and its current attractiveness (Kemp, Schot, & Hoogma, 1988).

The major technological opportunities can raise the levels of information flow, which can help in avoiding mistakes, coordinate changes, plan the works, manage budgets and carry out quality assurance.

The economic impact should lead to a better quality of execution of the projects. The direct economic impact on the construction consultancy company would lead to savings in the resources that carry out manual operations.

It is not directly consistent with actual forms of organization, but in this particular project the engagement of all the participants would be granted by special agreements. Furthermore, the company is already working with FIDIC contractual basis, which is supporting BIM methodology and developing the contracts accordingly.

It is already attractive to use, as it is eliminating the big issues discussed during interviews with the employees in the organization such as manual procedures, unstructured data, and the chaotic implementation of changes. It would add value to their processes and possibly cause higher value for projects, than the difficulties and costs implementing new technology

as the employees are characterized as innovation-driven young enthusiasts, capable of using technology accordingly (Čepokas, 2014).

Further the technology is assessed in a context by establishing an experiment.

The Selection of the Experiment

An appropriate setting to try out the technology and learn about it would be to select and carry out a pilot project. It is important to select a project, where the other parties of the project would be willing to collaborate, as the technology loses value if it is not applied throughout the process. Because of the absence of standards and specifications on national level, the team needs to work out the exchange procedures on the project basis. Furthermore, the company would not be able to use the advantages of the technology in the absence of the model containing relative information provided by the designers, which is why the involvement of architects and engineers is essential.

The Setting-up of the Experiment

First, the company needs to help the client to understand the concept as the technology changes budget and phase division, but possible advantages of less mistakes, higher quality and digital data with possibility of using it for facility management, might convince the client to form the right requirements for the projects. Second, the team (including architects, engineers, project managers and consultants) needs to sit down and discuss the responsibilities, ways of collaboration and defined roles, and agree on how and when they will exchange information, what collaborative technologies they will use as well as delegate responsibilities in the BIM environment. Furthermore they need to appoint a responsible BIM person for coordination and references.

In order for the whole concept to work, the information-rich model is essential. The interviewed architects work mostly with 2D, but there are possibilities to carry out projects in ArchiCAD and Revit software. Both of these software solutions support BIM methodology and the designs used in this software can serve as a basis for the BIM model. It would add extra work for an architect to develop a good model, but easy coordination of changes and automatically generated documents should add value afterwords. The engineering part needs to be coordinated and included as well. This would also cause the coordination of work and software. Furthermore, the common project database needs to be set. It is possible to place the models from the architects and engineers on the server where the participants can have access to them; and the quality assurance can take place. These models can be used in the planning and budgeting software, automatically generating plans, following up and searching for visualizations. This would add value mostly to the consultancy company, but in order to involve others the advantages need to be clearly articulated. For construction management and quality assurance, there are many software solutions that allow planning, budgeting, checking and coordinating projects based on virtual models—for example, Vico office could be an affordable and suitable solution.

Furthermore, the free tool from Tekla BIMsight entails can also add value by providing access to all the information digitally to all participants without any specific software and offer the possibility of communicating via an integrated messenger.

The above procedure would generate experiences and enhance knowledge about working with BIM; it would help to develop the model where the technology works. It does not require big investment in the software as it is now, but requires the new role of a coordinator for solving technical exchange and coordination problems. In this case, all the parties are interested in developing the concept; therefore, the barrier of lack of willingness to share information disappears. Furthermore, it necessitates more work to develop the clear coding system on the project, as it is not available on national level, but it is possible and is not considered of high relevance by the interviewed actors. The barrier that this method does not resolve is of the outdated laws and regulations. It is possible to 'go around' the requirements using software—generate 2D drawings, print out the quality assurance journal—but it is not an optimal solution.

This is not an ideal model, where everyone can utilize every activity, where, for example, the site manager can order materials form the model, etc. But it would optimize the process without very big adjustments and would allow picking the low-hanging fruit.

The collaborating team is central to this experiment. Furthermore, for the actors to engage all the team members, the technology has to be easily understandable and simple. This would require some work in the beginning to set up the system and teach the participants. Therefore, the first project would likely not generate much profit, but would provide experience with which subsequent projects would become easier. The problem is that different teams work on different projects, but good experiences between actors would carry the concept to other projects and spread like ripples in water.

Scaling up the Experiment

The scaling up of the experiment would be closely related to the work of the public body described previously. Experiences from the local projects, carried out by construction consultancy company should be collected and made available to the public body in order to develop solutions that are adjusted to real practices and solve problems on the project level, by introducing rules on national level. This would help to develop system which works in practice, but by support from government make it available for everyone.

The Breakdown of Protection

The breakdown of protection would in this case be helping others to implement the technology, by consulting and sharing the good practices; the construction consultancy company could spread the word and attract interest from other companies. By carrying projects with different teams the experiences would spread, which means that every time the processes would become more articulated and smooth. It would also be easier to

convince the client proving the added value by demonstrating results of other projects. This would increase demand and general quality level of the projects witch in long run other regime actors should live up to.

Summing up: Construction Consultancy Company

This management does not introduce the revolutionary change across all the regime elements. It is more likely to develop a model that is suitable for adoption by the regime actors in order to solve local problems. It does not directly cause, but still triggers further adjustments, which can accumulate into a regime shift in the long run.

The experiment is formed according to the articulated needs of the company as accessible, structured information is necessary in every respect, while the digital plans and budgets connected to the models lead to more coordinated changes than experienced earlier.

This development of the niche level requires developing the network in the form of a project team that is willing to collaborate and try out the technology in a different way.

While single local projects can be carried out by establishing special agreements between parts, the wider diffusion of the technology needs to be coordinated on a national level through, for example, the creation of infrastructure, support programmes, new regulations, etc. The local niche manager is not powerful enough to carry out these tasks and, therefore, needs support from the global niche. But knowledge about the content of the change is generated on the local level, where the actors try out the technology in real projects (Geels & Raven, 2006). These experiences need to be articulated and translated into lessons for the global level in order to draw the right decisions and form the trajectory of development, which again will affect local projects by guiding them in a particular direction. This shows how closely interrelated these two initiatives are.

8. Discussion

The preceding analysis provided an opportunity to understand the phenomenon of digital construction in its empirical complexity (Geels, 2005). Thus, it outlined a wide variety of aspects that plays a role in the process of implementation of the technology.

This process is seen as a *wide transformation*, as described by Geels (2005). The existing regime, which is described as the Lithuanian construction sector, suffers from such internal problems as low productivity, expensive construction projects, multiple mistakes, chaotic organization of the projects, lack of information flows, outdated regulations, controversial procedures, and lack of control. There is noticeable dissatisfaction among regime actors and they seem unable to solve the mentioned problems since construction projects are expensive and have quality assurance issues.

These problems together with pressure from the landscape level in the form of EU requirements, the experiences of other countries, the development of smart technology in other domains, and the emergence of new actors like BIM consultants forced the regime to open up and create windows of opportunities.

The above-described conditions provided legitimization for niche actors to develop alternative technologies and led to the creation of new niche actors. In the analysis, the public body 'Digital Construction' and local initiatives by enthusiasts to adopt new technologies on selected project are discussed.

This is not a completely new initiative in Lithuania, as some experimental projects were already carried out in 2002 inspired by experiences from abroad. But it is only now that development is reaching a momentum, as many conditions—such as requirements from the EU, the end of the economic crisis, and the general development and dissemination of smartphones, tablets and the internet—have emerged and are leading to accumulation.

Global niche vs. local niche

In the thesis, the two niche managers discussed are equally important although operating on different levels.

The first niche manager—the public body 'Digital Construction'—brings together different specialists from private firms, universities and institutes to work on the existing problems and develop solutions. Being a broad network of specialists, it has more experiences and a broader view on the existing regime than the second niche manager. But this can also mean that the members may be blinded by the established cognitive routines, which can interrupt the innovative development process. This initiative has an agenda to change the regime completely, including the cognitive, normative and regulative rules, and, therefore, shares a competitive relationship with the existing regime (Geels & Schot, 2007).

The second niche manager represents outsiders—young people forming small company driven by their own enthusiasm and innovation. This promotes technology that has a

symbiotic relationship with the existing regime, because it initially has no ambition for fundamental change. The aim is to promote technology, which can be easily adopted without comprehensive changes in order to rationalize construction processes. Successful adoption would trigger change in other elements and, finally, result in the transition (Geels & Schot, 2007).

The public body is the driver behind the implementation of the requirements for using digital construction principles in public procurement projects. The release of requirements would force a breakthrough in technology and cause rapid change, which would be difficult for regime actors to adopt.

The second niche manager—the consultancy company—is practicing a less drastic method for the implementation of technology. This can be described as 'fit-stretch'. The technology has a close fit with the existing interpretation of functionalities from the start and does not drastically change the process. But as users build up experiences with the technology, new functionalities can be explored and adoption widened and spread, thereby stretching the regime's development in the direction of new functions and possibly leading to the gradual replacement of the established regime (Geels, 2005). This model does not create competition between old and new technology, but acts as symbioses of both. In comparison, the first initiative creates competition between technologies, as the old one needs to be suddenly replaced with the new. This competition is more likely to result in frustration, as the actors are used to the old technology and a quick change is never easy.

Furthermore, according to the theory, the second initiative is more likely to succeed because the landscape pressure is moderate. The sudden replacement of an existing regime as in the first initiative is more likely to happen if the landscape provides the shock, where the whole regime structure falls apart and needs to be recreated from the foundation. Notably, the regime system is unstable and can be considered as deinstitutionalized, which actually requires a wide range of solutions on the national level as provided by the first initiative.

In practice, however, these two initiatives are closely related, and can link up with and reinforce one another. The local activities need to be aligned by ensuring development in the same direction by establishing common cognitive rules on the global level. But in order to establish these, the global level needs the experiences and knowledge generated on local projects. Therefore, the interaction of these levels is important for ensuring that learning from the local level is fed back to the global level, which again will affect and guide the local-level project in the specific direction. (Raven & Geels, 2010)

The interaction and alignments between these two levels is important, but not the only factor causing successful implementation. External factors such as development in the regime structure are also of high relevance. The involvement of regime actors in building a support network is crucial. Their involvement can be ensured by establishing expectations for solving existing problems in order to attract attention and resources. The expectations would attract interest and encourage the actors to join the support network. This would

affect development in the regime level, which would again grant support for the projects on a niche level and further induce the development. (Raven & Geels, 2010)

The experiences generated through local projects are valuable, but need to be discussed, adjusted, compared and interpreted. This transformation of local practices into more global rules is a task of aggregation, formalization and codification, which can only be carried out by the actor on the global level, as in this case, by the public body 'Digital Construction' (Raven & Geels, 2010). The global niche manager also has the power to establish the regulations, which would force the regime actors to adopt the new technology, but this does not make the global niche manager more powerful than the local one. As described earlier, in Lithuania, only a low number of actors trust the institutions. Therefore, both initiatives are equally important in order to develop solutions that cause a transformation in the dominant way of organizing the construction sector.

Furthermore, the articulated expectations of how niche innovation will solve regime problems on the two levels are slightly different. The public body's promises can be considered too theoretical and lacking in the understanding of practical implementation, as many actors are more interested in their own gains than in improving whole sector.

The second initiative can be easier to relate to while demonstrating the actual results of the real projects. But it is also discussed mostly from an economic perspective. The increasing return to adoption plays an important role in local practice. However, the implementation of technology not only concerns economic, but also many other socio-technical aspects such as project organization, the involvement of other actors in building up the network, changing practices and the role of regulations.

Lithuania vs. Denmark

Since the regime system in Lithuania is deinstitutionalized, re-institutionalization is inevitable. The regime actors are willing to try novelties as they are seeking better solutions. It is not stated that digital construction is the solution or that it can rationalize the sector and create a sustainable environment for carrying out construction projects, but its possibilities are discussed in the thesis.

The difference in Denmark was that the regime, at the time of the emergence of digital construction, was much more stable; the actors were more satisfied with the conditions and did not seek rationalization. The sector was characterized by deep traditions and trends, a clear contractual basis formed during many years of continuous development without as many drastic changes as in Lithuania.

The change in Denmark was initiated and financed by the government and was implemented through the announcement of requirements that forced the regime to change. The changes were not coordinated with incumbent actors, as in Lithuania, where the specialists voluntarily joined the development process.

But in Denmark, the processes of organizing the construction projects were coordinated up to the digital construction initiative. It only needed further adjustments, rationalization of the information exchange and better coordination. In Lithuania, processes are chaotic and need to be rationalized from the very foundation, which gives rise to a much bigger task for Lithuanian niche managers.

Furthermore, in Denmark's construction sector, associations and organizations are considered to be powerful actors that have an influence in raising the qualifications of specialists. These have existed and built up the support network over many years. In Lithuania, such influential organizations as, for example, 'Bips', do not exist and general trust in institutions is low because of the country's many disappointments in recent history. Therefore, many initiatives come from marked actors. Furthermore, financial support from the government is much lower in Lithuania than can be expected in Denmark.

In Denmark, automation and digitalization have been part of an overall development strategy for many years. This also contributes to savings, as salaries are very high. In Lithuania, the workforce was considered as low-cost for many years and there was not the same demand for digitalization. Only recent economic growth has brought the salary level up to the European average, and the automation of processes has become more relevant.

Besides, when Denmark started to develop the digital construction idea, there was much less experience in the world and many things were new. Since Lithuania is only just starting out, when many countries are much further into the development process, it can learn from others' experiences. For example, it needs carefully developed and clear solutions that are broadly applicable because, in Denmark, after the release of the requirements, it was recognized that digital construction was more of '*a development challenge rather than an implementation challenge*' (Jensen, 2011).

9. Conclusion

In the thesis, the possibility to implement digital construction in Lithuania's construction sector as a way to re-institutionalize the sector is discussed.

First, the question of how stable the existing socio-technical system was addressed in order to determine the possible resistance to change. The analysis showed that the existing Lithuanian construction sector is suffering from ineffective organization as well as from the lack of stable and continuous development and of authoritative institutions. This condition proves the instability in the regime system, where regime actors are seeking re-institutionalization of the sector.

Comparing Lithuania to Denmark, the preconditions for when the digital construction initiative appeared are different. In the latter, the sector was settled, stable and strongly institutionalized. The idea of digital construction in Denmark was initiated by the state as a way to rationalize the process and increase GDP, which caused strong resistance by incumbent actors.

This means that the transformation towards digital construction in Lithuania can actually be smoother than in Denmark since the sector is unstable and the transformation is driven by sector actors and enthusiasts, who see potential in this way of rationalization, whereas the regime in Denmark was stable and the change was forced by the state.

On the other hand, Denmark had more time and better financing for developing a strategy, than does Lithuania, which could be a possible threat to success in the latter country.

The main research question was

How can strategic development activities be organized in order to ensure the implementation of digital construction principles in the Lithuanian construction sector?

By analysing development on the local and global levels, it can be concluded that in order to ensure the implementation of digital construction principles in the Lithuanian construction sector, the collaboration of the two is necessary.

The local initiatives add a lot value due to the presence of actors trying out and learning about the technology while also developing and adjusting it. These actors develop new routines, roles and responsibilities, but also risk going separate ways. The united and coordinated initiative is necessary for setting a stable base for ongoing development and distinguishing among the unified classification system, standard guides, and changes in laws to guide development in the desired direction. But the development on the global level most importantly has to be adjusted to the local experiences to ensure that solutions are applicable and advantageous in practice, because only if the technology is promising the actors will see the potential and be willing to try out the technology.

The niche manager on the local level by experimenting with real projects find problems, which needs to be addressed on the global level, where the solutions are developed refined

and embedded into norms and regulations. In this way, the global level could provide solutions to real life problems, which would ensure recourses for projects from the clients, who are convinced and willing to try out the new technology. Adjustments of expectations on both levels and involving clients, would increase resources and result in more experiences and better learning process, where an articulation of the rules will gradually transform the regime system.

In order to achieve the above-described process, it is also necessary to ensure mutual communication and interaction between the two levels by open discussions, pilot projects and benchmarking. Furthermore, clear, simple and attractive solutions need to be developed in order to be attractive and possibly adopted by the broad spectrum of regime actors.

Successful implementation will also depend on the ability to attract and use specialist knowledge in order to take the right strategic decisions from the early stages, as the choice of the national classification system and standards will set the foundation and will direct whole further development towards digital construction in Lithuania.

10. Perspective/Recommendations

The main question is if public body 'Digital Construction' will be able to adopt the knowledge from local projects and transform it into right decisions on national level considering low financing, lack of specialists and tight schedule, as the Lithuanian construction sector needs rationalization on all levels, which includes investing tremendous effort in preparing the clear and operational model and definition of the requirements need to be prepared as early as by year 2016.

In order to answer the above described concern, it would be interesting to take a closer look into every single work group of the public body 'Digital Construction' in order to understand how background knowledge is collected in order to make decisions on a national level as well as determine who influences them and how.

Furthermore the analysis describes only one local project. Hence, future research in the field could examine more local projects in order to compare different experiences and cover a broader field by analysing both success and failure.

And finally following a pilot project would give deeper understanding of the actual potential for the phenomenon to be adopted in the broader context.

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