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Master Thesis

INFLUENCE OF DIGITALIZATION ON BUYER-SUPPLIER RELATIONSHIPS IN CONSTRUCTION INDUSTRY

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Abbreviation

AEC	Architecture – Engineering - Construction
AR	Augmented Reality
ARA	Activity – Resources – Actor
BIM	Building Information Modelling
CEO	Chief Executive Officer
CPS	Cyber-Physical Systems
HCI	Human – Computer - Interaction
ICT	Information and Communication Technologies
IMP	International Marketing and Purchasing
INA	Industrial Network Approach
IoS	Internet of Services
IoT	Internet of Things
IT	Information Technologies
MR	Mixed Reality
TCE	Transaction cost of economies
VR	Virtual Reality

Summary

Digitalization is currently an emerging term used in every facet of the society. Investment in information technology has showed improvement in productivity (Fulford & Standing, 2014; Strauss & Samkharadze, 2011). Despite the observable benefits of digitalization on other industries, construction companies are still reluctant to invest in those innovative technologies (Moldof, 2015). Most of the research related to the impact of digitalization on the industry is still in formative years and focuses on operational level. BIM and web-based technology as well as other digital tools have showed their potential in improving the construction companies' perfomance. However, the startegic influence of the application of these tools on the business relationship within the industry remains unanswered. Concerning the typical characteristics of relationship: short-term and project-based, resulting from the fragmented and complex nature of the industry, we want to investigate the change in the dyadic relationship patterns between construction companies and their subcontractors under the influence of digitalization at higher level of administration: corporate-level and towards long-term partnership by using Industrial Network Appoach which describes the relationship in three dimensions: Actors – Resources – Activities (Hakansson & Johanson, 1992).

The first part of the paper contains the introduction about our area of interest: influence of digitalization on buyer-supplier relationships in the construction industry, our proposal research question and limitations and scope we consider when conducting the study. The second part is the preliminary literature review which gives us insight to construct the research methodology presented in the third part. The paper is concluded with the thesis execution plan.

Introduction

Background

Digitalization has become popular term describing the increase in using digital technology in all possible societal and human activities. In business context, digitalization entails a variety of technologies or ICT tools to enable the optimized, more profitable digital working environment (*Taming the digital dragon: the 2014 CIO Agenda*, 2014). Although there have been proved evidence of digitalization improving the product quality, decreasing time-to-market as well as enhancing enterprise performance in manufacturing sector (Brettel, Friederichsen, Keller, & Rosenberg, 2014), many construction companies are still reluctant to integrate these innovative technologies (Kraatz, Hampson, & Sanchez, 2014; Moldof, 2015). Despite the laggard in digitization adoption, many technologies within the industry have reached their market maturity and are currently available (Oesterreich & Teuteberg, 2016). BIM (Building Information Modelling) and web-based technologies are the most diffusing tools being applied (Adwan & Al-Soufi, 2016). Other tools such as Internet of Things, Big Data, Robotics, etc. are also major components to enable a digitized construction environment.

The research related to the impact of digitalization on the construction industry is still in its formative years (Oesterreich & Teuteberg, 2016) and tends to study on the operational level. The main focus of the research stream is on the relationship between IT investment and companies' performance and productivity (Linderoth & Elbanna, 2016; Rimmington, Dickens, & Pasquire, 2015). There are rare research working on the changes of relationship among the actors within the focal industry under the influence of digitalization. Some studies just touch upon the area of interest, working on the collaboration improvement at project management level (Fulford & Standing, 2014; Merschbrock & Munkvold, 2015). How digitalization is changing - or have already changed – the long-term, administrative-level interaction patterns or the relationships between a company and its customers, its suppliers or other actors after several projects is still unclear.

The relationships in construction industry are different and more complex to study compare to those in other industry in manufacturing sector. The first concern when studying the relationship is the project-based characteristic of construction industry. Each construction project goes through a system which provides firms with the

ability to compare prices and choose the lowest ones among identical suppliers (Holmen, Pedersen, & Torvatn, 2005). Other concerns include structural problems within the industry such as complexity, uncertainty, fragmented supply chain, short-term thinking and culture (Arayici & Coates, 2012; Dubois & Gadde, 2002; Kraatz et al., 2014). This leads to short-lived relationship between buyer and supplier and the discontinuity of construction activities.

The Industrial Network Approach (INA) developed by IMP scholars is chosen as our theoretical framework because it offers a rich set of concepts for business relationships (Håkansson, 1989; Håkansson & Snehota, 1995). INA offers a framework for understanding how companies interact, how this interaction develops over time, resulting in long-term relationships (Bygballe, Jahre, & Swärd, 2010; Håkansson & Snehota, 1995). To clearly understand the interaction patterns, we also deploy ARA model (Hakansson & Johanson, 1992) which describes the interaction process in terms of three layers: actor, resources and activity. How the introduction of digital tools influences these three layers of buyer – supplier relationship would be our main interest.

Research question

With the emerge of digitalization in construction industry and the industry's typical relationship related to short-term, complex and project-based characteristics, it is interesting for us to investigate more into the influence of the social phenomenon, digitalization, on the long-term, corporate-level relationship patterns in the focal industry. We proposed the following research question:

"How do digitalization influence the supplier-buyer relationships in the construction industry?"

With some sub-questions:

- How do the three layers of buyer-supplier relationships in the industry: Actor – Resource – Activities change under the influence of digitalization?
- What are the opportunities given by digitalization for construction companies to enhance their long-term relationship with their suppliers?
- What are the challenges companies meet in improving their relationship with the suppliers in the context of digitalization?
- Would digitalization foster more collaborative and longer relationships, or would it keep firms become at further/arm-length distance?

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Limitation

We mainly focus on the dyadic buyer-supplier relationship between construction companies and their one biggest subcontractor. However, our research could be extended to understand the network that firms are embedded in because the relationships between two actors is influenced by the actors' other relationships in its network, which are beyond the dyadic relationship.

The relationship will be investigated at corporate-level, which fosters more long-term and strategic characteristics

In the research, we just consider the top 10 most popular ICT tools which are being developed and adopted in the construction industry. The 10 technologies are defined regarding the work of Oesterreich and Teuteberg (2016) and Adwan and Al-Soufi (2016). Other less popular technologies have minimal influence on the performance of the companies at the time of research, thus, are assumed to not impact the long-term relationship within the sector.

Theoretical framework

1. Buyer-supplier relationship in construction: the view in literature

The construction industry has been characterized to be fragmented and dominated by small companies (Håkansson & Jahre, 2004) and that the industry is organized by projects which results in short-lived or arm – length relationships (Dubois & Gadde, 2002; Ingemansson, Elsebeth, Åse, & Ann-Charlott, 2017). The project – based character which fragmentizes the production activities together with the strong focus on bidding procedures in selecting partners "keep the industry's actors at a distance" (Ingemansson Havenvid, Håkansson, & Linné, 2016). Numerous researchers have highlighted the construction industry's poor productivity levels and assert that it lags behind other industries in terms of efficiency improvements (Bankvall, Bygballe, Dubois, & Jahre, 2010). Collaboration is considered as a mainstay of efficiency improvements as it enables integration and automation of processes (Yahia, 2009).

The market approach which deployed Transaction cost theory (TCE) was once interested by authors researching on construction industry (Håkansson & Jahre, 2004). The "typical" authors of this approach "view the market as a set of individual companies who relate to each other through contracts." TCE theory often disregards

relationships due to the concern of "opportunism", hence, firms choose how to transact basing on the criterion of minimizing the sum of production and transaction costs (Williamson, 1985). However, transaction cost theoretical framework was criticized as it ignored the continuing interactions to build up commitment and trust (Ring & Van De Ven, 1992).

In the construction industry, even though there have been numerous researches on the discontinuity of relationship (Håkansson & Ingemansson, 2013), some relationships are sustained over several projects (Holmen et al., 2005). Researchers have been increasingly interested in long-term relationship to improve the efficiency of construction industry through collaboration and innovation (Ingemansson et al., 2017). While long-term relationships and collaborative forms are common in other industries, partnering has recently been introduced into the construction industry (Bygballe et al., 2010; Ingemansson et al., 2017). Our paper contributes to this research stream by studying how the introduction of digital tools in construction influence the relationships between buyer – supplier in the industry. Would digitalization foster more collaborative and longer relationships, or would it keep firms at further/arm-length distance?

The Industrial Network Approach (INA) developed by IMP scholars is chosen as our theoretical framework because it offers a rich set of concepts for business relationships (Håkansson & Snehota, 1995). (Håkansson & Ingemansson, 2013) also pointed out two reasons to apply INA to the construction industry. One concerns the heavy use of a set of suppliers (around 60% - 70% of total volume); the other one concerns the product of construction, which are mainly done for corporate customers. The assumptions regarding how firms interact, and form business relationships presented in the INA make it a suitable framework for the analysis of our thesis.

IMP studies based on empirical evidence and observations from manufacturing and process type industries and emphasized on the interaction patterns between firms. According to the INA, companies do business with each other on a continuous basis in series of transactions and develop business relationships that connect their operations. The term "relationship" therefore refers to what is actually going on between business organizations, such as providers and sellers with users and buyers. Companies seldom have one or two transactions but repetitive transactions, then they could develop specific relationships with each other to increase efficiency,

build trust, and decrease opportunity cost (Snehota & Håkansson, 2017). According to IMP empirical studies, "such long-term relationships have been shown to contain numerous adaptations and "heavy" economic investments (Håkansson & Waluszewski, 2002).

The "ARA Model" (Hakansson & Johanson, 1992) provides a conceptual framework of the process and outcomes of interaction and suggests that business relationships developed between buyer and seller could result in different ways. The model suggests that the outcomes of an interaction process can be described in terms of the three layers: Actor (bonds), Activity (links) and Resource (ties) between the counterparts (Håkansson & Snehota, 1995). In general, the layers refer to how actors relate on a social level (bonds), how they combine technological and organizational solutions (ties), and how they are interrelated through the various activities they perform (links) (Ingemansson Havenvid et al., 2016).

Figure 1 ARA model
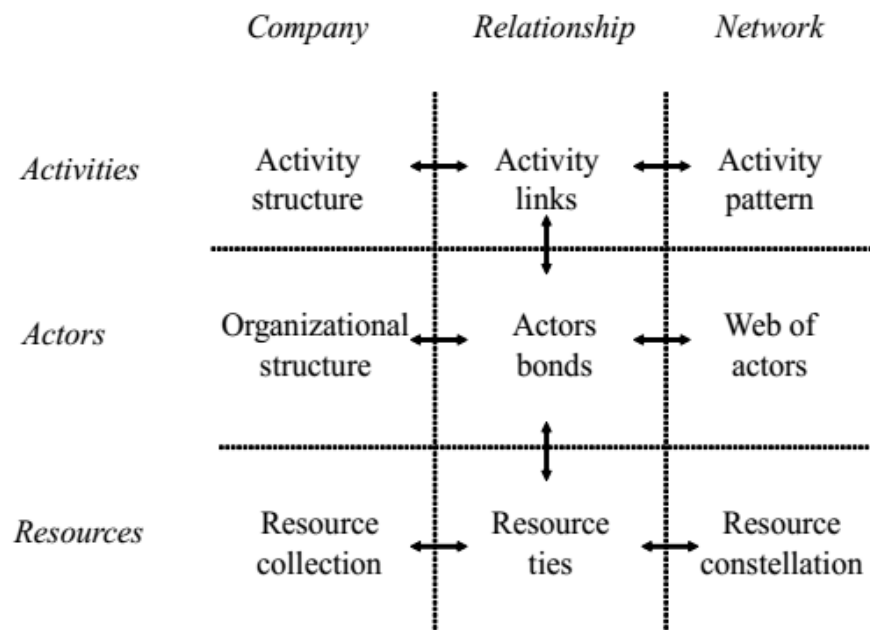
(Hakansson & Johanson, 1992)

These three layers, however, are not independent but inter-connected that each layer affects each other by the constellation of resources, pattern of activities and web of actors in the wider network which presents the development of relationships (Håkansson & Ingemansson, 2013).

The Activity layer: A business relationship grows when certain of their different technical, administrative or commercial activities link together (Håkansson & Snehota, 1995). Hence, activity is present in all business relationships and relationships affect the way two companies perform their activities, or in other words, activity structure.

The Actor Layer: Actors refer to companies, or organizations and/or individuals that individually control resources to execute certain activities (Ingemansson et al., 2017). The bonds between two actors may alter their way of seeing and interpreting situations, what they can exchange and how they trust, appreciate and become mutually committed (Håkansson & Snehota, 1995). Hence, actor bonds play an important role in the interaction behavior of business relationship because it influences how parties assume or identify the other parties.

The Resource Layer: When two companies build up a relationship, they can decide to combine several resource elements to utilize those resources. Different resources include both tangible assets (land, equipment, plant) as well as intangible ones (talent pool, knowledge, culture). New resource combinations are likely to change when the interaction between two companies change when it requires more mutual specific adaptations. Resource ties arise as the two parties in a relationship confront and mutually adapt their resources over time (Håkansson & Snehota, 1995).

Håkansson and Ingemansson (2013) argued that any innovation that changes the activities or resources of any of the two actors would also alter the relationship or the "renewal" of the relationship. Hence, we expect that the application of any ICT tools would also alter one or any layer of business interactions. As these three layers are interdependent that when one layer is influenced, the other two would also be influenced. When actor bonds are developed over time, the mutual commitment and trust also increase which may pave the way for more resources ties or activity links development (Ingemansson Havenvid et al., 2016). New resources combinations may hinder or foster more activity co-ordination and activity links may limit or facilitate resource adaptations and may develop the bonds between two actors (Håkansson & Snehota, 1995).

In this paper, we apply the ARA model to investigate the interaction of a buyer – supplier relationship with the application of ICT at the corporate level. Even though we will only focus on a buyer – supplier relationship, the ARA model can be

extended to understand broader context – the network that the companies are embedded in. An activity link is a link in a broader activity pattern over several companies, a resource tie is part of a resource constellation and an actor bond is a part of a web of actors.

2. Digitalization in construction industry

a. *Digitalization definition and nomenclature*

Digitalization has been used in several meanings in different context and there has not been clear definition regarding this phenomenon. Before going to definition of digitalization, we also go through the definition of one expression which has been sometimes used interchangeably with "digitalization" but having different meaning: "digitization." Some extant research in construction industry used "digitization" to indicate the process of converting information presented on physical material such as paper, photograph, etc. to that presented on computer in form of digital bits. (Fulford & Standing, 2014; Leviäkangas, Mok Paik, & Moon, 2017; Oesterreich & Teuteberg, 2016).

However, "digitalization" refers more to the restructuring of many areas in social life with digitized information and media infrastructure as a core (Brennen & Kreiss, 2014). In business context, the 2014 Gartner CIO Agenda Report mentioned "digitalization era" in which companies moves "from running IT like a business within a business, into a period characterized by deep innovation beyond process optimization, exploitation of a broader universe of digital technology and information, more-integrated business and IT innovation, and a need for much faster and more agile capability." There is another emerging term that researchers use to indicate digitalization: Industry 4.0, described as the increasing digitization and automation of the manufacturing environment as well as the creation of a digital value chain to enable the communication between products and their environment and business partners (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014; Schmidt et al., 2015). Therefore, when we mention "digitalization" in this research, we concern the digital working environment facilitated by information technology and digital platform and its utilization for better business performance.

To study the influence of digitalization on buyer-supplier relationships, we consider its tools whose application changes the way companies doing their business. In this research, we will frequently use the term ICT, which is defined as a combination of

automation, and information and communications technology (Perkinson & Ahmad, 2006). In construction context, ICT entailed the use of computer systems that are capable of capturing, organizing, storing, analyzing, exchanging, transmitting, and sharing information (Adwan & Al-Soufi, 2016).

b. *Current state of digitalization adoption in construction industry*

Globally, construction industry is lagging behind other manufacturing sectors in terms of applying digitalization into production and management. The overall picture in US and Europe is similar, construction is the least digitized sector. (Friedrich, Merle, Grone, & Koster, 2011; *Income Distribution Data Review*, 2012) Moldof (2015) argued that many construction contracting and subcontracting firm owners are reluctant to jump on the bandwagon and spend money on the latest technology fads and trends. Despite the benefits that have been showed in other industries, construction companies have not managed to integrate innovative technologies to keep up with their counterparts from the automotive or mechanical engineering sector (Kraatz et al., 2014). Also the maturity level of IT application varies along and within the construction's value chain."(Leviäkangas et al., 2017).

In their systematic literature review and case study analysis, Oesterreich and Teuteberg (2016) found out that several digitalization and automation technologies for construction have reached market maturity and are currently available. The most penetrating technology in the field is BIM, described as a digital environment that is used in the design and preconstruction stages of a building project and its components which retrieves information of a three-dimension (3D) entity model by multiple different project team members during the project (Davies & Harty, 2013). Major construction projects increasingly depend on BIM to be completed expeditiously, and many companies in the architecture, engineering, and construction (AEC) industry have used BIM as a catalyst for IT-based change processes in their operations (*The Business Value of BIM in North America: Multi-Year Trend Analysis and User Ratings (2007–2012)*, 2012). BIM enables a new way of working by providing a common environment for all information defining a building, facility or asset, together with its common parts and activities (Pittard, 2013).

Another powerful and widely used tools are web- based technologies, which provide a platform to manage and share construction information by getting rid of

paper documents, improving access to data, allowing common documents between agents in different locations, eliminating discrepancy and misunderstanding in the versions of documents, and recording data in a multimedia format (Martinez-Rojas, Marín, & Vila, 2015)

To enable a digitized construction environment, there are also many other digital tools that should be taken into consideration: The Internet of Things (IoT)/Internet of Services (IoS), Cloud Computing, Big Data, Smart Factory, 3D-Printing and the Cyber-Physical Systems (CPS) or Embedded systems; also, Augmented Reality (AR)/Virtual Reality (VR)/Mixed Reality (MR) and the Human-Computer-Interaction (HCI) (Oesterreich & Teuteberg, 2016).

c. Research on impact of digitalization on relationship within the industry

Even though ICT has been developed in construction industry for many years and reached maturity, research field related to digitalization and its effects on the industry are still in its formative years (Oesterreich & Teuteberg, 2016). The research stream tends to focus on the relationship between IT investment and companies' performance and productivity (Linderoth & Elbanna, 2016). It has been suggested that IT improves transparency, productivity, and product quality throughout construction supply chains (Bullinger, Bauer, Wenzel, & Blach, 2010; Čuš-Babič, Rebolj, Nekrep-Perc, & Podbreznik, 2014; Petri, Beach, Rezgui, Wilson, & Li, 2014). ICT technology such as BIM, web-based technology, mobile computing and wireless technology, etc. has provided the platform for more efficient collaboration among the actors in the industry (Fulford & Standing, 2014). However, the study about the enhance in collaboration and productivity by using technology has just bounded in project level. The largest percentage rate, 36% of the papers analyzed by Adwan and Al-Soufi (2016) concerns application of IT in project management. The implication of digitalization in sustaining the long-term relationships or the relationship continuity after the specific projects remains unanswered.

In other industries, there exists some research studying the role of IT in a strategic long-term buyer-supplier relationship (Baraldi & Nadin, 2006; Makkonen & Vuori, 2014). Their work can be a good reference for our research observing the changes in buyer-supplier relationship in construction industry at administrative and long-term level rather than project level in other extant research.

Research methodology

1. Research strategy

According to Bryman and Bell (2011), the meaning of a research strategy is to generalize and orientate the business research. Qualitative research tends to be concerned with words rather than numbers, and its three noteworthy features are fitted to our purpose of research:

- An inductive view of the relationship between theory and research: through analyzing the observations and positions of the experts within large companies in construction industry, we want to see how digitalization has changed the interaction of buyer - supplier relationship of construction companies.

- An epistemological position: in order to understand the influence of digitalization on the buyer - supplier relationships of construction companies, we scrutinize the interpretation of the industry's experts who has directly experienced and observed the change in their own interaction with other suppliers/buyers under the influence of digitalization.

- An ontological position: the properties of the buyer - supplier relationships after the intervention of digitalization are the consequences of continuous interactions among the participants over a period of time. Digitalization adoption is also an inevitable outcome of the needs of improving the industry's productivity.

2. Research design

We are about to conduct the research by using cross-sectional design, also called social survey design. As Bryman and Bell (2011) mentioned: "A cross-sectional design entails the collection of data on more than one case (usually quite a lot more than one) and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables (usually many more than two), which are then examined to detect patterns of association.", our research design meets most of the elements of the definition.

- More than one case: the research considers the perspective of the 10 biggest construction companies and of their three main subcontractors upon the impact of digitalization on their relationship with each other. The variation

in the opinions of the observed companies due to the differences in companies' size, profit, specific position in the supply chain, etc. is a fruitful source for us to derive the overall view of the influence of digitalization on the industry network through both suppliers and buyers point of view.

- At a single point in time, the research will be conducted in a short time (less than one month) to collect the data related to the understanding of the experts in the aimed companies about the effect of digitalization on the companies' relationships with the subcontractors and vice versa over long time. The construction industry is considered laggard in adopting innovations and the relationships also change slowly over time under the influence of any intervention, thus, it takes a long time for the companies to observe the clear trend in their relationships with others after applying digitalization. Therefore, the time of collecting data is considered a single point relative to the long time of actual impact of digitalization being observed.

- Quantitative or quantifiable data: the definition requires the data to be quantifiable by using questionnaire or structured interview. However, with the nature of qualitative research, we will conduct semi-structured interview to gain more insights into the reformation of the construction companies' network via different perspectives of different buyers and suppliers. To establish variation in the personal view requires more flexible data collection methods rather than the standardized survey which can omit some important characteristics that cannot be included in any uniform questionnaires.

3. Data collection

The 10 biggest construction companies are selected as they are some of the foremost organizations within the Norway construction industry and as such have adopted digitalization developed over many years. The organizations are also the main contractors for works. The selected companies provide construction projects to government or tender and manage all aspects of the construction project. After accessing to those companies, we will connect to one of their biggest direct upstream companies in the supply chain, known as main subcontractors. Because the main focus of this paper is long-term relationship between buyer and supplier, we would conduct semi-structured interviews with senior purchasing managers or CEO, rather than project managers to avoid the complexity and high variation. However, questions about construction project management would also be included

if the interviewed CEO/managers have valuable insights about the effect of digitalization/ICT tools on their projects. At the corporate level, areas of importance included information requirements, parties, current state of the organizations in using ICT tools to enhance communication, timescales and the decision of choosing supplier.

The interview guide has key questions and prompts for areas of interest that may not be covered in the initial answer. The interview guide will be derived from the literature review and focus upon the relationship patterns before, after and in the process of managing large construction projects. The interviews are fundamentally a walkthrough of the experts' experience and opinion about the change in interactions with other actors in the network under the influence of digitalization. The ARA model serves as a guide for our data collection. We expect to see how the use of ICT tools influences the 3 layers – Activity, Resource, Actors – of a business relationship as well as Activity links, Resource ties and Actor bonds.

Two of the organizations: one construction company and its one subcontractor will be selected as a pilot case to test the validity of the semi-structured interview guide. We estimate total of more than 20 interviews be conducted with senior managers and CEOs. The interviews will all be recorded, and the recordings will be transcribed. All interviews were conducted by the same investigator.

4. Data analysis

The data being analyzed with the Nvivo data indexing tool to the constructs derived from the literature and embedded in the interview guide. Also, the discourse has been transcribed to text and coded in Nvivo. The text has been carefully analyzed and conceptualized. The data has also been reconceptualized using cross case analysis.

5. Quality of research

5.1. Reliability

Reliability refers to whether a measure of a concept is stable or not (Bryman & Bell, 2011). It basically asks the researcher to make sure that if the study were to be repeated, it would yield the same results. In the survey, there are two important aspects to reliability; the use of a protocol and the development of a database

(Ellram, 1996). Data collection steps, questions asked in the procedure, assumptions taken, limitations made and challenges met, as well as detailed information about the sources used are all examples of information that will be provided. All of this will be presented in the thesis in a structured and detailed manner, in order for other researchers to be able to repeat the study.

The survey study protocol attached to our thesis will include an interview guide and the procedures that will be followed in this research. The study database will include completed interview guides, any additional notes taken outside the interview guide as well as a detailed summary write up. Furthermore, as a cross sectional design includes the use of multiple sources, all of the written documentation used as sources for the thesis will be included in the study database.

5.2. *Validity*

Mishler (1990) explains that "validity assessments are not assured by following procedures but by investigator's judgement". He has also pointed out that validation is often being applied to social science research in the same way as experimental research, with many studies being judged wrongly to lack academic rigour. He proposed that validation should be a theoretical rather than a technical problem. Therefore, in order to interpret the information gained from interviews objectively, we try to conduct intensive literature review on which we create the interview guidelines and metrics to assess all the dimensions of the relationships regarding Actors-Resources-Activities.

External validity is concerned with the degree to which a study is generalizable to other situations. The selection of people chosen to participate in the study, becomes crucial in this context (Bryman and Bell, 2011), and will therefore be described in great detail in the thesis.

Project plan

	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18
Define research area	█															
Literature review		█	█	█												
Define research questions					█											
Extensive literature review					█	█	█	█	█	█						
Decide on research methodology							█	█	█	█						
Hand-in preliminary									█							
Produce interview guidelines										█						
Pilot interview											█					
Revise interview guidelines												█				
Real interview												█				
Data analysis													█			
First draft												█	█	█		
Second draft															█	
Final submission																█

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