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The use of taxonomies and metadata: facilitating University - Industry Interaction by visually showcasing professionals' profile data

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Master Thesis

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Thesis by
Brigita Perchutkaite

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Summary

In this thesis, the phenomenon of University - Industry Interaction (UII) is explored, specifically, from the perceptive of large enterprises. The motivation for addressing the phenomenon originated within society, the Government - University - Industry Research Round table, together with Committee on Science, Engineering and Policy, had organized a workshop, where overcoming UII related challenges have been discussed. Likewise, the number of studies, discussing the importance of solving challenges for UII, have grown significantly in the past two decades. However, there are lack of studies that would address UII phenomenon in a narrow context. Therefore, in this study I am to answer RQ1: How can we visually/graphically present researchers' profile data to the enterprises with the purpose to facilitate University – Industry Interaction? RQ2: How can we design metadata scheme and taxonomy so that it supports graphical visualizations of researchers' profile data?

The study is a based on the methodological perspectives of interpretive phenomenology, and aims to understand phenomenon of UII by conducting a literature review. Elsevier's Pure Portal is a Research Information Management System and is used as a typical case of the thesis, because it showcases researcher profile data visually, with the purpose to facilitate collaboration. Using convenience/purposive sampling method, three different informants from three large engineering companies, based in Northern Jutland, have been sampled for the interview study, where the prototype have been explored. The interview study has been planned using seven stages on an interview inquiry. Semi-structured interviews were transcribed and analyzed using NVivo software tool for qualitative data analysis. For the analysis, thematic meaning condensation process has been used to answer RQs.

The primary findings of the study suggest, that graphic visualizations are important and useful, because they provide quick information interpretation. However, they must be informative, efficient and present the context of use, in order to support UII. In order to support visualizations, metadata should provide meta-communication to provide description of the context and how visualizations have been generated. It has been found that useful metadata for identifying experts is the 'title', 'department', 'leader'. The multidisciplinarity is important, therefore, high-level granularity and specificity taxonomy is useful tool to support visualizations. It has been found, that the 'publications', 'subject', 'topic' is important

descriptions for identifying relevant publications and thereafter authors of the publications. Study found, that the important information is to see information about 'international collaborations' between universities, also further information about external researchers, who are not the users of Pure Portal. Moreover, labels should be used to support the intended meaning of the visualization, this would support visualization.

Findings have contributed with an understanding about UII from perspective of large enterprises, in relation to graphic exposure, taxonomies and metadata on RIMS. Study findings suggest, that in order to facilitate UII, graphic visualizations must be informative. Informativeness can be supported by descriptive metadata and high-level granularity and specificity taxonomy. It is known, that RIMS are perceived as expensive and complex to start with, but a could be useful tool for the industry. However, RIMS are not used to search for experts, because strong channel for establishing UII are the personal connections. It is a part of organizational culture and considered to be sufficient form of interaction. Thesis have contributed with new findings and nuances to UII field from perspective of large enterprises, in the narrow context that point to new directions for future research.

Further work could explore UII from management perspective. The interesting finding, according to the thesis LR, suggest, that enterprise managers found it difficult to 'identify skills, their firms needed and then to develop personal relationship with academic experts'. Also, the interview study suggest, that RIMS could be useful from the perspective of management, because it would help to plan next steps in research. Therefore, industry professionals, who have management/planning positions within their enterprise, could be a relevant sample for the study, in order to explore, how useful/relevant RIMS from a different sample perspective. Also, other Danish or international universities could be sampled.

Contents

1 Introduction

The objectives of the thesis is to investigate the phenomenon of University - Industry interaction (UII) with the purpose to evaluate usefulness of graphical visualizations and to design taxonomy and metadata scheme, so that it support visualizations on Research Information Management Systems (RIMS). The study has been carried out in a narrow context of UII, from the industry's perspective. As a consequence, the thesis has carried out a systematic literature review (LR). Elsevier - a major provider of scientific and medical information, is used as a typical case for the thesis (Elsevier, 2018a). Elsevier's Pure Portal allows to see organizational performance, showcase expertise and enhance academic collaboration capabilities (Elsevier, 2018b). Therefore, it is used as a prototype during research interviews, were informants feedback will be collected, in regards to appropriateness of graphical visualizations, categories and metadata on Pure Portal (Elsevier, 2018a). While all of these factors will be elaborated on later in the thesis, I will begin by motivating and presenting problem area and follow up with the research questions (RQ).

1.1 Motivation

The motivation for the research area that is addressed in this thesis has primarily originated within society. UII has greatly increased in the past two decades with growing federal funding for research and development (R&D) (Azeroual, Saake, & Wastl, 2018). The growing number of publications that investigate the phenomenon of UII, show the rising societies interest in examining the UII (Murashova & Loginova, 2017). Likewise, scientific studies are addressing the challenges of UII and ways to establish effective collaboration and promote scientific information, measure research impact (Penfield, Baker1, Scoble, & Wykes, 2013). Apart from that, the growing popularity of Internet opened possibilities to store and manage scientific information digitally by using RIMS (Azeroual et al., 2018). In order to manage such systems, not only it is important to keep the expert profiles up to date, but also provide high quality data so it can support various user groups (Ebert, 2015). Nonetheless, the user interface of RIMS should be modern and ergonomic, at the same time, enabling users to quickly navigate, process and evaluate the information (Ebert, 2015). These are the societal, technological and organizational motivators for the study.

The personal motivation for the research area has developed during the internship. I have been working as a research assistant at the Department of Communication & Psychology and Aalborg University (AAU) where I have been executing tasks in relation to the research project Responsible Impact (ReAct) and Open Research Analytics (OPERA) research projects (ReAct, 2018), (OPERA, 2019). ReAct taxonomy has been created, in order to present academic researcher activities, products and impact development, the OPERA project was directly focused on visually presenting impact data to replace textual information. By using IA, I was motivated to investigate, how well graphical visualizations showcase expert profile data on RIMS (Elsevier, 2018b). Furthermore, I was motivated by Løkkegaard (2018) which found, that presenting information visually, would be useful for the enterprises, but it was not explored what is a useful visualization. I believe, that my study can contribute to the field of UII in a more specific, narrowed context (VBN, 2019). After reviewing dissertation I had left myself questioning: What kind of information should be presented on RIS to facilitate UII? How to visually present academic professionals' expertise so that it supports UII? What type of visualizations and metadata are useful/relevant for the large industries? Løkkegaard (2018) has focused on SMEs, she found, that scientific knowledge for SMEs was 'too theoretical', also, university is perceived as 'unknown world'. Therefore, in the thesis I want to focus on large enterprises, because they have larger absorptive capacity for scientific knowledge and more frequently establish collaboration with academia (S.N. Ankrah & Shaw, 2012).

1.2 University - Industry Interaction

Number of studies are addressing the phenomenon of UII. Authors define it "as interactions between all parts of higher-educational system and the industrializing economy" (S.N. Ankrah and Shaw, 2012, p. 50). UII began to emerge significantly in 1980's, well documented studies have described benefits for UII (Ebert, 2015). The knowledge transfer between university and industry is recognized as one of the primary areas for research, innovation and policy development across many countries (Vick & Robertson, 2017). The benefits for the industry are categorized into economic, institutional and social. Improved products and processes, enhanced innovative ability and capacity for R&D and increased credibility (S.N. Ankrah & Shaw, 2012). It has become evident, that solving UII challenges is an important task and is highly discussed. Since 1970's, total number of scientific studies within the field of UII has increased in Europe and Scandinavia (Murashova & Loginova, 2017). In March 1998, the Government - University - Industry Research Round table, together with Committee on Science, Engineering and Policy, have organized a workshop, where overcoming UII related challenges has been discussed (Ebert, 2015). Since, the number of scientific publications, addressing the challenges of UII phenomenon, continued to grow (Murashova & Loginova, 2017).

1.2.1 Large enterprises

The thesis is focused on facilitating interaction between university and large size enterprises. Large enterprises covers the category of companies, employing more than 250 employees, with annual turnover exceeding EUR 50 million (Løkkegaard, 2018). It has been suggested, that large enterprises deserve attention, because they play a critical role in the world economy as innovators (Fryzel Barbara, 1955-2010). Moreover, they tend to collaborate with governmental institutions, operate with longer perspective and has a greater intellectual skills, as opposed to SMEs (Fryzel Barbara, 1955-2010). The size of an enterprise has a direct effect on its absorptive capacity for scientific knowledge (Freitas, Geunac, & Rossie, 2012). It has been discussed, that large enterprises benefits from institutional collaborations and are better at searching for knowledge providers (Alan Collier & Ahn, 2011). Therefore, informants from scientific field of engineering have been selected for the research interview, because it is one of the few leading areas for establishing UII (Murashova & Loginova, 2017).

1.3 Research Information Management Systems

RIMS serve as digital library databases for managing research publications, registering activities, grants and awards (Bryant et al., 2017). University adopts RIMS for organizational use, because of increasing competition with other academic institutions, globalization or societal mandates to collect and present research impact and measure performance (Penfield et al., 2013). RIMS are valuable for academic institutions, because they promote collaboration on an institutional and industrial level (Bryant et al., 2017). I want to indicate, that the important function of the RIMS in the thesis study, is the researcher expertise showcasing on RIMS. Academic expert profiles can be locally restricted, or operate as publicly available portals to support expertise presentation and discovery (Bryant et al., 2017). There are different user interfaces, that are used to facilitate RIMS and researcher profile presentations. Similarly, Elsevier's Pure Portal is showcasing academic profile data, such as their expertise, research output and personal network. Thesis will evaluate, how these visualizations can be supported by taxonomies and metadata, so that it can facilitate UII.

1.3.1 Data visualization

Today's work environment places a great importance for evaluating metrics in a most efficient and accurate way as possible (Jean-Daniel Fekete & North, 2008). Organizations, sponsoring research, challenge researchers to show their productivity (Jean-Daniel Fekete & North, 2008). A picture is often cited to be worth a thousand words – it is dramatically easier to use than a textual description (Scheniderman, 1996). Humans solve problems that are presented in two ways - sentential and diagrammatic representation (Larking & Simon, 1987). Sentential data representation is a natural-language description, whereas, diagrammatic express components of diagram (Larking & Simon, 1987). When humans solve problems, they use both internal representation, which is stored in their brain, as well as, external representations

- recorded on paper, board or some other medium (Larking & Simon, 1987). Data visualization is "speeding up" the cognitive processes of filtering the information, therefore it plays an important role in the sciences as an insight generating method (Jean-Daniel Fekete & North, 2008).

1.4   Problem area

Recent scientific studies outline diverse challenges for UII, however, there is lack of scientific publications that would examine challenges from the industry's perspective. Additionally, I have found, that there is lack of publications that would investigate the challenges in the specific context of UII (Vick & Robertson, 2017). Number of publications, addressing challenges for finding partners for collaboration, conclude that one of the difficulties for effective UII, from the industry's perspective, is the 'difficulty to make contact with the university' (Freitas et al., 2012). Yet, there are no further studies that would explore these challenges. The findings of the PhD dissertation by Løkkegaard (2018) are perceived as a valuable source for the thesis. One of the ways could be to visually present information on RIMS (Løkkegaard, 2018). However, studies do not evaluate what type of visualizations or metadata are relevant for the enterprises.

In recent years, with the growing information load, systems that facilitate the processes of finding the right expert for a given problem are becoming more beneficial than ever (Yimam-Seid & Kobsa, 2003). Organizations are using expert finder systems for purposes, such as: knowledge sharing, team formation, project launching and team building (Yimam-Seid & Kobsa, 2003). The core problem within the expertise finding systems is 'how to represent what someone knows' (Ehrlich, 2003). The approach, as authors stress, could be to develop a system, supported by rich taxonomy, that could include high-level granularity (Yimam-Seid & Kobsa, 2003).

1.4.1   Why is it being investigated?

Small number of studies that have investigated the challenges for UII from a perspective of the industry and conclude, that one of the challenges for enabling effective UII is 'how to find what someone knows', or that it is 'hard to contact university' (Ankrah & AL-Tabbaa, 2015). According to the LR conducted in the thesis, there are no studies, that have investigated the challenges and the needs of the industry, in a narrow context (Vick & Robertson, 2017). Therefore, interview will investigate, whether current graphical visualizations, taxonomy and metadata, effectively support UII on RIMS.

1.4.2   Research questions

The gap between university and industry, also lack of scientific publications, addressing narrow context of UII, has led me to develop the following RQ. In pursuit to investigate the phenomenon of UII, also to evaluate graphical visualizations and taxonomy/metadata on Pure Portal with the purpose to facilitate UII, the thesis will define and explore RQs.

Research questions:

RQ1. How can we visually/graphically present researchers' profile data to the enterprises with the purpose to facilitate University – Industry Interaction?

RQ2. How can we design metadata scheme and taxonomy so that it supports graphical visualizations of researchers' profile data?

Before I discuss RQs of the thesis, I want to emphasize and explain, how taxonomies, metadata and data visualization are connected. Data visualization can be perceived as beautiful, but in order to be useful and meaningful, it has to be informative (Steele & Iliinsky, 2010). Taxonomies and metadata are structured techniques, used extensively in digital information systems, such as RIMS (Jeffery, Houssos, Jorg, & Asserso, 2014). Taxonomies support navigation and metadata management, also provide categories and meaningful relationships between the concepts (Hedden, 2010). Likewise, metadata support graphical visualizations by providing relevant descriptions. They are essential for RIMS, because they provide clear labels, categories and navigation support (Jeffery et al., 2014).

RQ1 aims to investigate how to present graphical visualizations, so it supports UII. I want to investigate, how large enterprises understand, what is useful and relevant visualization for them. Likewise, I want to understand the channels for UII, challenges from perspective of large enterprises in regards to UII and their viewpoint on RIMS.

RQ2 is focused on investigating what is a relevant and useful taxonomy and metadata. I want to evaluate the prototype, in order to design taxonomy and metadata, with the purpose to support graphical visualizations. I want to understand, what makes graphical visualization informative, in the context of UII. Overall, RQs aims to gather insights and feedback of the study informants' in relation UII.

1.5   An exploratory study

The research conducted in this thesis has an exploratory character. The exploration is defined as examining and analyzing, investigating and becoming familiar with something to generate new ideas (Stebbins, 2001). Exploration occurs when it is believed that there are new

elements to be discovered about the group, process, activity or the situation (Stebbins, 2001). In this study, I will be exploring the phenomenon of UII, because I believe, that the field has not been explored in a narrow context and there are new elements to be discovered. When asking how to visually present researchers profile data, so that it facilitates UII, thesis will not only explore the current visualizations on RIMS, but also consider user feedback, in order to propose ways, how to showcase profile data in the future. Similarly, study will evaluate existing categories and metadata that are assigned to present visualizations on RIS. Interview study will allow informants' to explore different elements of the prototype. Thesis will aim to weave ideas together in order to generate new ones, instead of suggesting concrete or final solutions. I will now present the findings of a LR.

2 Literature review findings

2.1 Literature review findings

The focus of the LR in this thesis is to obtain knowledge about the phenomenon of UII and to get an overview of previous scientific publications in the field. For me, it will help to understand the context of the study. LR findings are important, because they support and frame the thesis. I will start by presenting the synthesis of the review.

2.1.1 Bibliometric findings for assessing UII

A bibliometric analysis in the Baltic Sea region has revealed the growing research interest of addressing the field of UII (Murashova & Loginova, 2017). Between 1972-2014 there has been 932 publications within the field of UII and joint scientific publications of universities and businesses (Murashova & Loginova, 2017). Publication number has been rapidly growing, the peak reaching in 2014 with 64 scientific works, since 1998 it has increased by 57% (Murashova & Loginova, 2017). According to geographical distribution, the leaders for addressing the field of UII and publishing it, are the United States (24%) (Murashova & Loginova, 2017). European countries are highly active, United Kingdom contributes to 12,8% of the publications (Murashova & Loginova, 2017). The data in regards to the Baltic Sea region countries indicates three leading countries, that contribute the most: Sweden with 4.2%, Finland 2.1% with and Denmark with 1.8% scientific works (Murashova & Loginova, 2017). Which is the total of 94,03% of all publications in the Baltic Sea region (Murashova & Loginova, 2017). Between the period of 2004-2014 there has been 65 publications in the Baltic Sea region in relation to the study of UIC (Murashova & Loginova, 2017). Authors conclude, that the interest in the field of UII gradually decreases in some countries, located in the Baltic Sea region, as the publication number around the world is still growing (Murashova & Loginova, 2017). Lack of publications in the Baltic Sea region can be seen in countries like Lithuania, Estonia, Latvia and Iceland (Murashova & Loginova, 2017). In order to increase number of publications, the solution would be to strengthen the collaboration with Scandinavian countries for joint research projects (Murashova & Loginova, 2017).

According to Scopus database, the leading industrial fields between 2000-2004, for collaboration, is engineering and computer sciences (Murashova & Loginova, 2017). However,

the number changed drastically between 2010-2014, business management and accounting industry seems to be the leading fields, followed by social sciences and engineering (Murashova & Loginova, 2017). Likewise, the latter industrial areas are the leading ones in Baltic Sea region (Murashova & Loginova, 2017). Between 2010 - 2014 the popularity of publications, suggesting ways of how to reduce the UII obstacles have increased (Murashova & Loginova, 2017).

2.1.2   University - Industry Interaction motives

University's motives

The collaboration between Universities and industries have emerged in the past twenty years (Vick & Robertson, 2017). The interaction between the two was highly influenced by increased competition and shorter product life-cycles (Ankrah & AL-Tabbaa, 2015). The societal constraint brought on universities - they must be seen as 'engines of knowledge transfer' has been the motive for UII (Ankrah & AL-Tabbaa, 2015). Ankrah and AL-Tabbaa (2015) confirms - UII is necessary for university, in order to stand against increasing competition and fast technological change. University benefits from wide range of benefits, such as: commercialization, product development and market knowledge (Ankrah & AL-Tabbaa, 2015). Also, collaboration with the industry is more efficient for universities, because funding coming from the industry usually requires less bureaucracy than the public funding (Ankrah & AL-Tabbaa, 2015). UII provides stability to universities, academics perceive UII as effective opportunity to develop and test hypothesis and their skills (Ankrah & AL-Tabbaa, 2015).

Study by (S.N. Ankrah et al., 2012) stress the importance for evaluating individual motives for UII, because knowledge transfer also depends on the individual actors. Survey findings across 115 universities suggest, that academics are generally cautious to collaborate, but have reported the pressure, where the need for research funding has weighted their academic freedom (S.N. Ankrah & Shaw, 2012). Furthermore, main financial initiatives for academic engagement is to support their own research (S.N. Ankrah & Shaw, 2012). Career related motives are the primary drive for academics to engage in UII (S.N. Ankrah & Shaw, 2012). Academics see firms as knowledge trading partners, they see such relationship as opportunity for their career and funding (S.N. Ankrah & Shaw, 2012). Furthermore, universities are driven by new knowledge, exposing students and faculties to practical problems (Ankrah & AL-Tabbaa, 2015). The problem based learning is also evident at AAU, which has a lonf tradition to support student-industry collaborations (University, 2019). A Systematic review within the field of UII articulates the personal motivating factors of researchers, it emphasize that researchers are self motivated to engage in UII activities (Vick & Robertson, 2017). On an individual level, academics are not driven by external factors, they are motivated by competition and need to increase their professional status within the organization (Vick & Robertson, 2017). Some researchers perceive financial rewards as an important factor,

however, majority of academics engage in UII, in order to further develop their research (Vick & Robertson, 2017).

Industry's motives

Systematic LR differentiates the motives of university and industry, and stress that industry is focused on commercial outcomes of the research (Vick & Robertson, 2017). Industry is motivated to engage to UII, in order to commercialize university-based technologies for commercial gain (Ankrah & AL-Tabbaa, 2015). Hiring talented students is perceived as motivation for the industry when collaborating with the university (Ankrah & AL-Tabbaa, 2015). Again, similar study confirms the fact that newly graduates are seen as a benefit for the industry (S.N. Ankrah & Shaw, 2012). Financial benefits that research brings are one of the motives for establishing the interaction, it has been reported, that collaboration between the two promotes and speeds up the process of research and development (R&D) (Ankrah & AL-Tabbaa, 2015). Collaboration presents industry with competitive advantage on the market. Moreover, R&D is highly supported by the government through grants and tax credits, which helps to promote new technological development (Ankrah & AL-Tabbaa, 2015). Furthermore, stability seeking is another motivator for the industry to enter in collaboration with universities, interaction with leading research universities is providing a legitimate status to the industry, by enhancing status in the eyes of stakeholders (Ankrah & AL-Tabbaa, 2015). Likewise, University - Industry collaborative research programs are sometimes much cheaper for the enterprises, than similar research in-house (S.N. Ankrah & Shaw, 2012). Lack of in-house capacity by industry to carry out complex technological research as a great benefit for business executives (Ankrah & AL-Tabbaa, 2015). Collaboration provides the access to diverse resources, such as access to university research and consultancy, the cutting edge technologies, which can greatly shorten the life-cycle of product development for the industry (S.N. Ankrah & Shaw, 2012). Also, industry enhances their legitimacy by having their staff publish with the 'star' researchers (S.N. Ankrah & Shaw, 2012). On a more personal level, employee ambitions for seeking new knowledge are motivated by gaining personal and professional skills (Løkkegaard, 2018). Moreover, gaining knowledge and finding new solutions are important, the latter are labeled as 'purposeful search' and 'inspirational search' (Løkkegaard, 2018).

2.1.3 Absorptive capacity of the enterprises

Løkkegaard (2018) stress that absorptive capacity, which refers to 'enterprises ability to use external scientific knowledge', is one of the differences between small and large enterprises. Small enterprises have a smaller absorptive capacity than large enterprises (Løkkegaard, 2018). Therefore, they need more help for applying scientific knowledge and understanding the value of new information (Løkkegaard, 2018). Smaller enterprises may also have less

experience, they can not afford to spend time and resources, because they tend to be unsure about the usefulness of the research (Løkkegaard, 2018). Large enterprises can collaborate with universities more efficiently, because they have more resources to do so (Løkkegaard, 2018). It has been found, that smaller enterprises, because of their spare resources (financial resources, personnel, managerial skills) tend to engage in personal contractual collaboration mode with universities, rather than institutional collaborations (S.N. Ankrah & Shaw, 2012). It could be individual scientist hired as external consultants to work on the firms project, where firms have a full access and control of the project and it's value (S.N. Ankrah & Shaw, 2012). At the same time, larger industries commit to institutional interactions, because they have higher absorptive capacity, this means, they would benefit more from institutional collaborations with university (S.N. Ankrah & Shaw, 2012). Moreover, industries that rely on technology sourcing using external organizations, tend to have better capabilities for searching and identifying 'knowledge providers' (S.N. Ankrah & Shaw, 2012).

2.1.4   Challenges for establishing University - Industry Interaction

The challenges exists between social and cognitive distance of university and industry (Løkkegaard, 2018). The main challenge for effective UII is the organizational differences between university and industry (different aims, levels of formality, risk perceptions and values) (Alan Collier & Ahn, 2011). The differences could be two contrast structures of knowledge production, in terms of controlling private and public knowledge (Vick & Robertson, 2017). Likewise, different working environments and communication barriers, resulting in risks of failure of UII (Ankrah & AL-Tabbaa, 2015). The primary difference lies between the motives of the two. While universities want to develop knowledge, industries seek to solutions, profit and functionality (Løkkegaard, 2018). Individual barriers for industry actors are the 'lack of time' and 'initiative', while institutional barriers are 'lack of reward' and investment (Vick & Robertson, 2017). Universities seek for long-term partnership, because they have long-term goals, yet industries have short-term goals (Løkkegaard, 2018). University takes too long to publish and commercialize the findings, on the other hand, industry wants fast and effective outcome, because they must keeping up with the rapidly growing market (Løkkegaard, 2018).

Moreover, companies find it difficult to contact universities (S.N. Ankrah & Shaw, 2012). It has been noted, that industry is moving at a different pace, than university. It takes around 11-18 months to finish the projects, which is considered too long for small enterprises (Alan Collier & Ahn, 2011). Universities come across as a more business-linked, which poses challenges for university's commitment to 'open science' (S.N. Ankrah & Shaw, 2012). Meaning, that knowledge is becoming less available to the public, because universities invest their time in industrial corporations, that are most likely restricted by patents and intellectual property rights. Which could affect researchers academic freedom and unbiased pursuit of truth with the widest dissemination of knowledge to society (S.N. Ankrah & Shaw, 2012). Academics face with dilemma of restricting the publications until patenting takes place. There is a risk of knowledge becoming obsolete (S.N. Ankrah & Shaw, 2012). In contrast,

industry is relying on practically oriented results, with profit as its main goal and secured disclosure of information (S.N. Ankrah & Shaw, 2012). The quality issues are identified as a challenge, academics are seen as too theoretical and not very practical, on the other hand, industry's focus is much more practical with the centered interest on critical issues (S.N. Ankrah & Shaw, 2012). Author suggest, that in order to overcome the challenges of UII, universities should be more proactive to make connections (Alan Collier & Ahn, 2011).

2.1.5   Channels for establishing UII

The process of UII can be carried out in a form of business to business collaboration (Ankrah & AL-Tabbaa, 2015). The process of UII formation has five stages, such as: identification, contact making, partner assessment and selection, partnership negotiation and agreement signing (Ankrah & AL-Tabbaa, 2015). Further stages of partnership negotiation involve steps of agreeing on the purpose or mission of the collaboration, as well as the deliverables (Ankrah & AL-Tabbaa, 2015). The formation process is done with signing collaboration agreement and settling on the intellectual property use (Ankrah & AL-Tabbaa, 2015). UII formation process identifies key stages and steps for forming collaboration with university. However, the review by Ankrah and AL-Tabbaa (2015) does not provide information interaction channels used to establish UII, only that 'pre-existing relationships' could be considered. Similarly, the study in the Australia, present some interesting findings. SMEs actors address the importance of personal links for making contact with university (Alan Collier & Ahn, 2011). It is important for the industry actors to collaborate with communicative type of persons, who are pleasant and reasonable to work with (Alan Collier & Ahn, 2011). Personal linkage ensures that the work is done at the speed that the industry wants to move (Alan Collier & Ahn, 2011). Interesting findings are presented in a similar study of SMEs in Australia. Interviews with CEOs' reveal, that when making a contact with university, industry actors pay attention to the competences of the researcher, rather than the status of an institution (Alan Collier & Ahn, 2011). One of the directors explained "We didn't choose the university, we chose the professor because of the expertise – he's an acknowledged expert in the field" (Alan Collier and Ahn, 2011, p. 8). However, authors do not elaborate on the type of channels that were used to find the expert. Industry actors perceive expertise as an important aspect for establishing contact with the academic expert. Again, it has been found, that personal relationship is one most frequent interaction channel. "<...> the issue for managers was to identify the skills their firms needed and then develop personal relationships with relevant academics" (Alan Collier and Ahn, 2011, p. 9).

In the dissertation by Løkkegaard (2018), it has been found that the majority of the employees (33 out of 35) seek for knowledge by asking colleagues (Løkkegaard, 2018). It suggest, that enterprises prefer to access knowledge through relational pathway, that is experience-based and person-dependent, employees usually accustomed to work in small groups, they tend to solve problems together, besides, asking a colleague is quick and immediate (Løkkegaard, 2018). It also identifies a lack of resources in this type of enterprises,

implying, that large enterprises would have more funds - providing employees with needed resources for acquiring new knowledge (Løkkegaard, 2018). However, it has been found, that (31 of of 35) study participants seek for knowledge online (Løkkegaard, 2018). Results show, that besides Google, interview participants would visit Aalborg University, Harvard, Stanford websites to search for scientific publications (Løkkegaard, 2018). Also, once introduced with RIMS, enterprises perceive it as useful tool (Løkkegaard, 2018). Likewise, university library and journal collections were identified as useful sources for knowledge seeking by technically oriented enterprises (Alan Collier & Ahn, 2011).

2.1.6 Presenting information to the industry: taxonomy and metadata

Enterprises have limited time and a busy working environment, they want information to be presented in an easy to understand way and use it practically (Løkkegaard, 2018). Qualitative study by Løkkegaard (2018) addresses the importance of data visualization, "You would definitely catch my attention 100 percent better visually than if you write a report with 100 pages. Sure, I will read that report if you have caught my attention, but you have to catch it first." (Løkkegaard, 2018, p. 172). 'Subject categories' are the first thing users would search for on RIMS (Løkkegaard, 2018). Therefore, information on RIMS must be organized and presented in subject categories (Løkkegaard, 2018). Categorization of scientific knowledge according to business area or market was found to increase user interest, however, they must be detailed enough to present large number of industrial areas (Løkkegaard, 2018). Likewise, taxonomy should be created so that it fits with the culture and structure of the organization, the level of granularity, at which taxonomy should be created, should be chosen according to the needs of the users (Yimam-Seid & Kobsa, 2003).

User study has found, that expert profile information should present what they know and what they will know (Yimam-Seid & Kobsa, 2003). Author presented the key findings (metadata), that could be presented on the expert profile. The fundamental information of the expert profile is the credentials, accessibility and demographics and the picture (Yimam-Seid & Kobsa, 2003). Industries pay attention to the profile information on Research Information Systems "<...> Then my experience is that you often get to a page where there are pictures of some persons and then I guess I would send them an email.", "<...> I rather quickly would be able to find information about, how to get in contact if I want to collaborate." Løkkegaard, 2018, p. 181. It is improtant to know, whether this person is willing to take unsolicited calls from people who are seeking for knowledge - name, address, phone numbers should be available (Yimam-Seid & Kobsa, 2003). Person's credibility, the area of knowledge and professional interest are important elements (Yimam-Seid & Kobsa, 2003). Likewise, credibility could be addressed differently - within the context of academia, researcher credibility could be established by published papers and awards, grants and patents, professional affiliations reference to attended university (Yimam-Seid & Kobsa, 2003). Study of SMEs in Australia suggest, that the personal expertise are more important

for the industry rather than the status of the university (Alan Collier & Ahn, 2011). Likewise, there has been found, that experts were modest, when they were asked to rate their own skill levels (Yimam-Seid & Kobsa, 2003). However, getting someone else to do it, such as supervisors, as a part of annual assessment, is too costly (Yimam-Seid & Kobsa, 2003). Therefore, the decision for showcasing expertise, should be easy to keep up-to-date (Yimam-Seid & Kobsa, 2003). The biggest challenge for such systems is the user engagement and their ability to maintaining the up-to date profile, as there is very little or no reward for doing so (Yimam-Seid & Kobsa, 2003).

2.1.7 Summarizing the findings

I will now summarize the findings and answer objectives of the LR, that are presented in the section 4.

With the thesis LR findings, I confirm, that there is lack of studies, that would focus on investigating UII challenges in various types of activities, for example challenges when identifying an expert on RIMS. I also confirm, that most of the studies are based on perceptions of the university (Vick & Robertson, 2017). "What are the university's motives for interacting with the industry?", the primary motives for UII are the 'rising costs' and 'societal constrains'. University is motivated by having an opportunity to expose students to the industry related problems. On a personal level, academics are self-oriented to engage into the UII. They want to form a career opportunities within the enterprises. In spite of, university researchers are generally cautions of collaborating with the industry, as it limits their academic freedom. "What are the industry's motives for interacting with the university?", aspiration to achieve 'commercial gain', also, industry is motivated to engage into UII, in order to get 'access to talented students'. To reach the 'competitive advantage', 'stability', 'legitimate status'. "What are the differences between large and small enterprises in their ability to use scientific knowledge?", large enterprises has a 'larger absorptive capacity', they collaborate with universities more efficiently. Smaller enterprises have 'less experience' in collaborating and 'smaller absorptive capacity to use scientific research'. Smaller enterprises tend to engage into 'personal contractual' collaborations with the university, whereas large enterprises benefit more from an 'institutional collaboration'. Also, large enterprises have 'better capabilities searching and identifying knowledge providers'. "What are the challenges for establishing the UII?", the main challenge is the 'cognitive distance'. Also, the 'difference in aims and values'. Industry is seeking to 'profit', whereas university wants to 'develop knowledge'. Difficulty to contact university, low motivation because of 'lack of reward' and 'uncertainty about confidential information and IP rights'. University is seen as 'too theoretical', 'unknown world' and not 'welcoming enough'. "How does industry seek for new knowledge and what channels are used for establishing the UII?", industry prefers to use 'personal contacts', because they' solve problems themselves', they find new knowledge using generic pathways 'Google', 'Online forums', 'RIMS'. "How to present information for the industry and what is useful taxonomy and metadata?", information should be 'easy to use', 'practical'. It should

be 'visually catching', 'short and specific', 'quickly decoded'. Visual aspects such as expert 'profile picture' are important. RIMS should be supported by taxonomy, so it represents the needs of the user. The 'expertise' and most importantly 'subject categories' should be supported by a high level granularity taxonomy. Metadata should contain 'credentials', 'accessibility' and 'demographics'. Also, it must be possible to assess expert credibility, by his 'published papers and awards', 'grants and patents', 'professional affiliations'.

3 Methodology

In this chapter I will present the theory of science claimed by the thesis, it is important for me, because it defines thesis investigation process. Also, I will describe the research methodology, and information ecology of the thesis. For me it is important, because it determines, how I will obtain the knowledge.

3.1 The philosophy of science

Establishing the philosophy of science means to determine research paradigm that is adopted during the research process (Mackenzie & Knipe, 2006). Research paradigm is defined as a systematic investigation and the theories, selected during the research process (Bryman, 2016). The paradigm influences the way knowledge is studied and interpreted (Mackenzie & Knipe, 2006). In this thesis, the ontology claims that there is no single reality. Within the theoretical framework of epistemology, the social world is viewed as separate from the social actors, their world is influenced by the organization or a culture (Bryman, 2016). The research epistemology determines, how I will gather the knowledge, in order to answer RQs. The thesis is densely influenced by a theoretical perspectives of interpretivism, and because there is no single reality, I will interpret it, in order to find the underlying meaning (Mackenzie & Knipe, 2006). The central figure of interpretivism is the German sociologist Max Weber, with his notion of understanding "verstehen", - which means to 'perceive and comprehend the nature of social world' (Chowdhury, 2014). Interpretivism research is focusing on understanding peoples' ideas, thinking and meaning that are important to them, 'looking through the eyes of the ones that are being studied' (Williams, 2000). The 'meaning making' is the the primary focus of interpertivist paradigm, by its nature it promotes qualitative data in the aim to produce the knowledge (Chowdhury, 2014). The research in this thesis can be characterized as interpretive, because I try to understand a particular social phenomenon. Understanding social actions requires methods to provide contextual depth (Chowdhury, 2014). I will use qualitative research methodology, together with the principal orientation of the inductive theory, which aims to provide the understanding by bringing out the theory as a result of empirical work (Bryman, 2016).

3.1.1 Validity and generalisability

The nature of qualitative research is to recognize and make sense of language, it aims to answer 'how, when, where, who and why'. Likewise, interpretive research is often praised for providing contextual depth and creating uniqueness to the data, however, it is often criticized of validity and generalisability (Chowdhury, 2014). In order for research to be considered 'trustworthy', it must have true value, consistency and applicability (Morse, Barrett, Mayan, Olson, & Spiers, 2002). It has been stressed, that the appropriateness of methodology and the interpretation of results (the clearness of research questions; appropriateness of sampling; data collection and analysis and coherence between data, interpretation and conclusion) can be used to assess the quality of research (Leung, 2015). The appropriateness of research is measured by research question, if it is valid for the desired outcome and if methodology is valid for the sample (Leung, 2015). Similarly, transparency and systematicity is also a criteria for quality research, each step of the research process should be presented, from sampling, data acquisition and analysis to results and conclusions (Leung, 2015). The challenges for assessing validity comes from ontology and epistemology and the way different researchers perceive the concept of "individual" (Leung, 2015). For instance, positivists think, that there is a single reality, which can be measured, whereas humanistic psychologists believe, that human awareness is shaped by the social constructs around him (Leung, 2015). However, generalizability is usually not an expected attribute for the qualitative research study (Leung, 2015). Likewise, I outline, that the results of the thesis will not be possible to generalize, because of limited sample, also because I place the study within interpretivist paradigm, therefore, I believe, that social world is changing, forming individual experiences. In addition, limitations are deeply related to the nature of interpretative research, as those who regard themselves as interpretivist, often differ in their means to what counts as an interpretation (Williams, 2000). Also, the limitations of sampling in interpretive research poses its challenges for later generalizing the findings, because the sampling qualitative research may be rare or difficult to find (Williams, 2000).

3.1.2 Interpretative phenomenology

A phenomenon is a situation or a fact, that is happening and can be observed, examined and who may require certain answers (Dictionary, 2019a). UII is a phenomenon, occurring for more than two decades and it is highly studied within society. Within epistemology and interpretivism, different methodologies to research exists. The anti-positivist tradition phenomenology is concerned with the individual sense-making and how people perceive the world, instead of measuring reality just by reliable and valid tools, without seeking deeper meaning (Bryman, 2016). Alfred Schutz, the major representative of phenomenologically based sociology, perceives real life world as something that modifies individual actions (Dreher, 2011). The primary goal of interpretive phenomenology is to investigate, how individuals makes sense of their own experiences and world around them (Pietkiewicz & Smith, 2014). It is a dynamic study, where researcher is actively trying to get access to

informants' experiences, in order to understand, how they make sense of their personal world, through the interpretation (Pietkiewicz & Smith, 2014). My focus is "to capture circumstances and conditions of an everyday or common place situation", (Bryman, 2016, p. 62). Phenomenology in the thesis takes the interpretive stance, I refer to a single case and examine individual perspectives of the study participants in their unique contexts. In the following chapter, I will present the research methods, claimed by the thesis.

4 Research methods

In this chapter I will introduce research methods. I started by conducting LR, because I wanted to understand the context of UII. I will present the research design, also how I planned the information ecology. Likewise, will introduce functional elements of Pure Portal, that will be explored during the interviews. Further, I will describe how I conducted the interview study, according to 'seven steps of interview inquiry. Below I will present how I planned LR and interview study.

4.1 Systematic literature review

In this thesis, I conduct a systematic LR, which differs from the narrative review, because it minimized bias and provides a replicable and transparent scientific process (Bryman, 2016). Systematic process is important for me, in order to ensure, that the LR is valid. The literature study will actively focus on the perspectives of the industry, because I want to understand challenges from the industry actors' perspective. The methodological process and steps for conducting LR has been inspired by Ridley (2012). Further, I will present the goals of the literature study, describe the process of searching and selecting the publications, also provide an overview of selected publications.

4.1.1 Objectives of the literature study

The goal of LR is to understand the field of research or address the knowledge gap, it provides a supporting evidence for a problem that research is addressing (Ridley, 2012). The focus of LR in this thesis is to understand the context of UII also to review what has been published in the field. Also to understand UII, identify new RQ, explore UII and relate to previous research. The goals of the LR in the thesis are, 1) get an overview of the UII phenomenon, 2) understand the motives for UII, 3) find out about the challenges related to UII from the industry's perspective, 4) learn about the channels that are used to establish the UII, and 5) to understand the needs of how information should be presented to the industry. The objectives are 'translated' to questions, that were answered in the LR findings section 2.

1. What are the industry's motives for interacting with the university and vice versa?

2. What are the differences between large and small enterprises in their ability to use scientific knowledge?

3. What are the challenges for establishing the UII?

4. How does industry seek for new knowledge and what channels are used for establishing the UII?

5. How to present information for the industry and what is useful taxonomy and metadata?

The objectives of the LR, provides a criteria for collecting the scientific publications. In other words, determining objectives of the study, helps to make a valid decision of what can be considered a relevant publication. I therefore present the criteria for chose publications that:

1. Examines the challenges, motivations, benefits from both industry's or both university's and industry's perspective;

2. Provides answers of how to facilitate UII through digital channels;

3. Examines UII in Europe or/and USA.

In regards to the third objective, UII is significantly different in developing countries, it is a result of 'poor education quality' and lack of financial availability, therefore, it is difficult for the university to join industry in innovation-related projects (Guimon, 2013). In order for the publication to be selected, it must meet one or more of these criteria. When selecting publications, I was looking at the titles that were including terms such as: University - Industry Interaction; University - Industry Collaboration; University - Industry Collaboration; Challenges or barriers for of University - Industry interaction or collaboration. Also, I was focusing on the publications that were including empirical data, because experiences are important for this study.

4.1.2 Searching and selecting publications

First step of the systematic literature study is to select a number of publications for the review (Ridley, 2012). Ridley (2012) stress, that all decisions in regards to selecting publications, including/excluding criteria, search terms and databases must be documented. Likewise, I have documented retrieved publications, in order to ensure transparency of the process. The list of the reviewed publications can bee seen in the appendix A.2 together with the descriptions of selected publications A.1, where I document publications and provide inclusion/exclusion arguments. First, the databases must be selected for searching for publications (Ridley, 2012). I have conducted the search in the databases, such as Science Direct, Google Scholar, Research Gate and AAU's library (AAUB). I have experienced, that AAUB works the best, because it provided me with an 'open student access' to relevant publications. During the process, I noticed, that I can find exactly the same publications on other databases,

however, most of the publications were restricted, therefore, I was always coming back to AAUB database.

4.1.3 The search terms

During the search process I have identified main search terms, in order to keep the search precise. The study related terms - 'large industry', 'large enterprises', 'university - industry', 'interaction', 'collaboration', challenges', 'barriers', 'channels', 'expertise'. During the search, I have combined these terms with other synonyms or adjective, in order to increase the recall. I used boolean search attributes, that shows the relationships between the terms. Boolean term 'AND', gives results of the publications that include both search terms in the title. Also, I have searched for publications in my native language. I have used these search combinations: 'University - industry interaction channels', 'University - industry AND interaction (in all fields - title and text)', 'Universiteto bendradarbiavimas (translation from Lithuanian - University collaboration)', 'A systematic literature review university', 'University AND barriers', 'Barriers AND university', 'Expert locator systems'.

4.1.4 Retrieved publications

It is important to mention, that the review is focusing on UII, but not necessarily large industries. This way I expand the search, in order to collect a bigger number of related publications. Publication search started in 2019, February 11th and was finished on the 25th. However, as it is stressed, the LR is an ongoing process, that will be carried out during the process of the thesis (Ridley, 2012). I red the abstracts of the publications if they had a combination of the relevant terms in the title. After reading the abstracts, I have excluded the publications that were not meeting one or more criteria. The publications, that were included in the review have met all three criteria and were considered highly relevant for the study. In total I have skimmed 27 publications. After, some publications where eliminated, because they had a different perspective of UII, or they were considered grey area - not reliable sources or not peer reviewed. Only 20 publications were selected for the review, only 8 were included in the actual report of LR. The publications were critically red, coding the text in different colors, to capture the meaning. I will explain the process of writing the LR in the following section, but will first introduce the selected publications.

4.1.5 Writing literature review

"After the articles selected for inclusion have been identified, the data extraction takes place", (Ridley, 2012, p. 191). I have registered all the publications in the Excel sheet, indicating the authors names, year, publisher, title, search quires and databases, also included a brief descriptions of the subject area and methods. During the reading process, I have color coded the text according to the LR objectives, which helped me to address the synthesis between the selected articles (Ridley, 2012). I chose a red color to mark challenges' or 'barriers',

green for 'motives or benefits' of collaboration, blue for the 'differences between large and small enterprises', yellow for 'different channels for establishing connection'. The synthesis takes place, when connection are made between all reviewed publications (Ridley, 2012). The writing of the LR was an iterative process and I was shifting between the papers as I was writing, adding knew findings.

4.2 Information ecology

Here I present, how I use information ecology, in order to plan the IA study.

4.2.1 Context

The context in information ecology is defined as "the set of circumstances or facts that surround a particular event, situation, etc." (www.Dictionary.com, 2019). The context of the thesis study has a narrow scope, it will explore different experiences in relation to UII. Interaction can occur in form of hiring, contacting academic experts, collaborating, engaging into institutional or personal contractual collaborations with the university. In order to study the context and expand the knowledge within the field of UII, I will conduct a LR, which will will focus on the challenges, motivations and benefits for UII.

4.2.2 Content

Content is broadly defined as elements that belong to the information environment (Morville, Rosenfeld, & Arango, 2015). The elements used in the system can be icons, buttons, links, visualizations, and the like. User, who engage with the system, should find relevant information, therefore, it is important to distinguish the difference between components, understand and study them (Morville et al., 2015). In the research study, I will focus on the visual content of the prototype, taxonomy and metadata. I will explore visualizations that showcase professionals' profile data. In addition, I will investigate the taxonomy and metadata and how they support/present the visualizations. Not to mention, Pure Portal is a complex database, that has number of elements (Intelligence, 2016a). In order to understand the purpose of visualizations, I will communicate with the Pure Portal team at Elsevier (Elsevier, 2018b), (Elsevier, 2018a). I want to indicate, that the thesis will not focus on engaging or describing stakeholder interviews. Because, the primary focus of the thesis is to explore the phenomenon and not to redesign, test or evaluate Pure Portal. Elsevier's Pure Portal prototype is used as an example, in order to generate more general insights.

4.2.3 Users

Users, within the information environment, are defined as respondents, visitors and actors (Morville et al., 2015). They are the individuals, who inspect and shape the product. For effective Information Architecture project, it becomes important to identify and evaluate

users in order to understand their needs (Morville et al., 2015). Additionally, Pure Portal, aims to facilitate collaboration not only cross-institutional, but also with the industry partners (Elsevier, 2018b). Industry actors is the particular user group, that will be studied in the thesis. Thesis will focus on understanding the phenomenon of UII through the eyes of the user. I will use semi-structured interviews, in order to evaluate the prototype and explore experiences of the participants, in relation to thesis RQs.

4.3   Case study

A 'case study' focuses on detailed and intensive examination of the notion of the setting (Bryman, 2016). According to Bryman (2016), it is important to be clear, what is the unit of analysis. Likewise, the UII is the unit of analysis in the thesis, where phenomenon of UII is explored. The 'case' is commonly associated with community, organization or location. A case can be the industry, scientific area or an individual. With that regard, I see large industries, based in Northern Jutland, as the base for the case study. I consider large enterprises, within the field of engineering, who benefit from UII, as an empirical unit of analysis. However, in order to form an understanding about individual experiences, the primary extent of the study unit are the individuals, who have experience in establishing collaboration with the university. I will now present the sample of the study.

4.3.1   Study sample

Three large industries situated in Northern Jutland, with more than 250 employees, were selected for the case study. The target sample was obtained using a combination of convenience and purposive sample method (Bryman, 2016). The sample was approached on behalf of AAU contacts persons, who are in touch with large enterprises, which has increased the participation in the study. I wanted to get in contact with individuals from large industries, the main requirement for the sample was that the individuals, should have professional functions in relation to the university or/and research activities. A criteria for sampling was also that UII would be relevant for the company. Three informants, from large enterprises - Bila, Grundfos and Bang&Olufsen, were selected. Two informants have double-positions, they are industry professors, have part-time position within academia and a position within their enterprise. This means, that sample will present rich insights to UII. To reconsider, snowball sample could have been used, in order to obtain larger number of participants, that may have different functions. It was the original sampling method, however, it was difficult to obtain bigger sample. I am ware, that saturation will not be reached because of the sample size. However, the findings will lay a groundwork for further research (Bryman, 2016).

4.4 Elsevier's Pure Portal

Elsevier, a major provider of scientific and medical information (Elsevier, 2018a). Elsevier is Netherland based publishing company, established in 1580, publishing the scientific knowledge of seventeen century (https://www.elsevier.com/about/history, 2019). With the growth of technology in 1991, with nine American universities, Elsevier releases the first database, which allowed to access scientific publications online, it later formed a basis for ScienceDirect (https://www.elsevier.com/about/history, 2019), (https://www.sciencedirect.com/, 2019). Today Elsevier's products include the entire academic research lifecycle - from database, to citation software and research analytic platform.

Elsevier's Pure Portal, is used as a typical case for the the thesis. It has several major functions, however, most important functionality of Pure Portal is, that it allows researchers to showcase their professional expertise (Intelligence, 2016a). Pure Portal increase profile data visibility, enhances possibility for collaboration between organizations. Therefore, it has been chosen as a prototype for collecting interview participants' experiences in terms of how useful and relevant visualizations are. The prototype implementation process was supported by Pure Portal team, AAU's data from VBN Research System has been used and displayed on Pure Portal interface (VBN, 2019). It was decided to manipulate VBN data, in order to create a realistic experience for the informants and use university data that informants are familiar with, because they do interact with AAU. VBN was the database, that AAU used before April 10th, 2019. It was a custom Pure Portal solution, without graphical exposure. However, this year (2019), Elsevier decided to stop providing customized solutions and apply standard Pure Portal interface to all their clients, including AAU. In the following section I will describe functionalities of the Pure Portal prototype, that will be evaluated and explored in the interview study.

4.4.1 Describing Pure Portal visualizations, taxonomy and metadata

The prototype of Pure Portal is used, in order to generate deeper insights, in regards to graphical visualizations, taxonomy and metadata, so that RQs can be answered. The prototype will be introduced to the interview participants' during the interview. They will be able to ask questions, express concern and opinions during the exploration process. I do not evaluate information-seeking behavior, nor do I conduct a usability evaluation, therefore, informants will not browse the prototype themselves. I want to present certain elements, in order to gather their insights. After I have introduced the Pure Portal to the interview participants, I will present the front page of the prototype, where the main categories appear. The elements of the Pure Portal were presented in a different arrangement during the interviews and followed natural exploration process. However, in this section I will present elements of Pure Portal according to the theoretical aspects of the RQs (taxonomies, metadata, graphical visualizations), because I want to make it clear, why I evaluate certain elements/visualizations of the prototype. I will start to present graphical visualizations, that will be examined during

the interview study. Also, present categories and metadata that are assigned to visualizations and are of importance to evaluate, in order to answer RQs. I will start by introducing the fingerprint engine.

Presenting fingerprint engine

The Elsevier fingerprint is the back-end software, that is processing natural language text in order to extract information from unstructured texts (Intelligence, 2016b). Fingerprint search engine applies rich controlled vocabulary terms, which covers different scientific domains, such as life sciences, physics, economics, engineering, humanities, act. Fingerprint engine mines the unstructured text (documents, abstracts, project summaries, awards) and presents it to a domain-specific subject terms, called concepts (Intelligence, 2016b). Fingerprint visualization is showcasing concepts, that describe academic professionals' expertise. I want to understand, whether and how fingerprint can be useful for identifying academic profiles with relevant expertise.

Pure Portal categories

In order to investigate whether categories, presented on Pure Portal, are relevant and useful for the large enterprises, I investigate categories, that are represented by taxonomy, Common European Research Information Format standards (CERIF) (Elsevier, 2019). As presented in the figure 4.1, navigation of top level category terms on Pure Portal is embedded as a global navigation. It emerges in the top of the page and assists navigation on the Pure Portal.
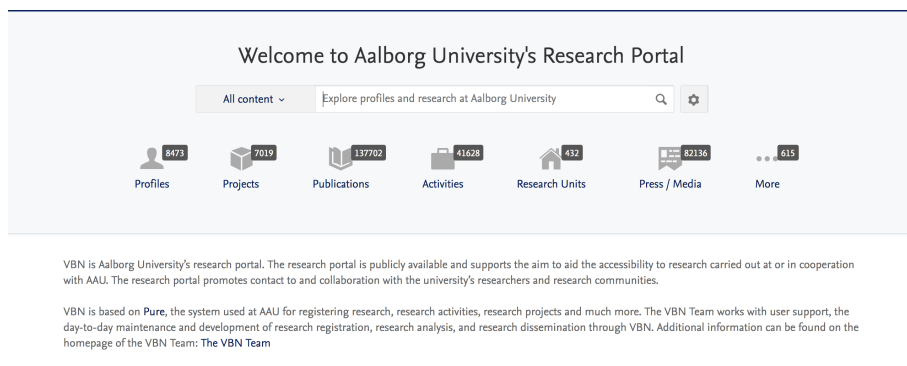
Figure 4.1: Categorization of top level terms

Metadata evaluation

In order to evaluate usefulness of descriptive metadata and how well it supports graphical visualizations, I will evaluate these elements of the prototype. As it was mentioned in the earlier chapter, descriptive metadata provides suppoorts discovery and identification 5.
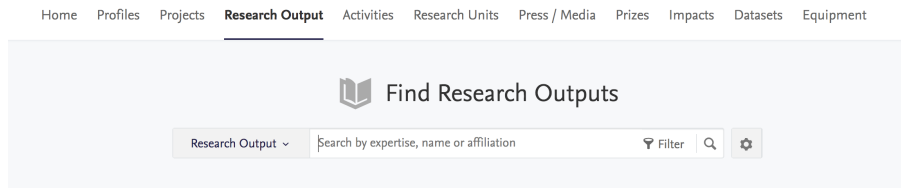
Figure 4.2: Global navigation

The list, presented in the figure 4.2. appears, when the category 'profiles' is chosen in the navigation system. The volume of the list is high and can be browsed thought more than 150 pages. The list of experts is presented together with descriptive metadata. The descriptive metadata, in this list, is the information about the expert - name, contact information, faculty, department and occupation. In addition, small icon 'research output' is considered as metadata, because it describes his/her activity. I evaluate this list, in order to find out, what metadata is relevant when choosing expert from high volume lists. Also, whether 'research output' icon is useful when browsing the expert list and how it supports description of the expert.

Other element, supported by metadata is the fingerprint subject terms, presented under the list of publications, as can be seen in the figure 5.4. It supports the publication content, by describing the key areas of the publication. I want to get insights, whether this type of metadata, that describes key themes of the publication, are useful to large enterprises. I want to investigate, the consequences concerning developed fingerprints. Also, publications are described with metadata such as author name, year, title, status of the publication. I will evaluate, what kind of metadata values are relevant/useful for the industry actors when searching for academic experts on RIMS.

Another component, providing information about the expert profile, is the citation and hirsch indexes, as presented in the figure 4.5. It is a type of descriptive metadata, that presents the experts' profile data. Hirsch index is the element, that attempts to measure academic production and the impact (citations) in one type of measurement (university, 2019). It determines both the quantity and the quality of research publications. H-index is calculated by ranking the publications according to the falling number of citations and stopping to the point where the 'h' number of publications have minimum of 'h' citations (university, 2019). For example, a researcher has a 100 publications, were 12 of them are cited at least more than 12 times. The h-index would then be 12. The h-index is calculated based on publications on Pure Portal and Scopus database (Scopus, 2019). I want to understand, whether h-index and citation index are useful measurements to describe researchers.

In order to examine, how well metadata supports certain visualizations with the purpose to answer RQs of the thesis, I will evaluate the following elements. As it can be seen in the
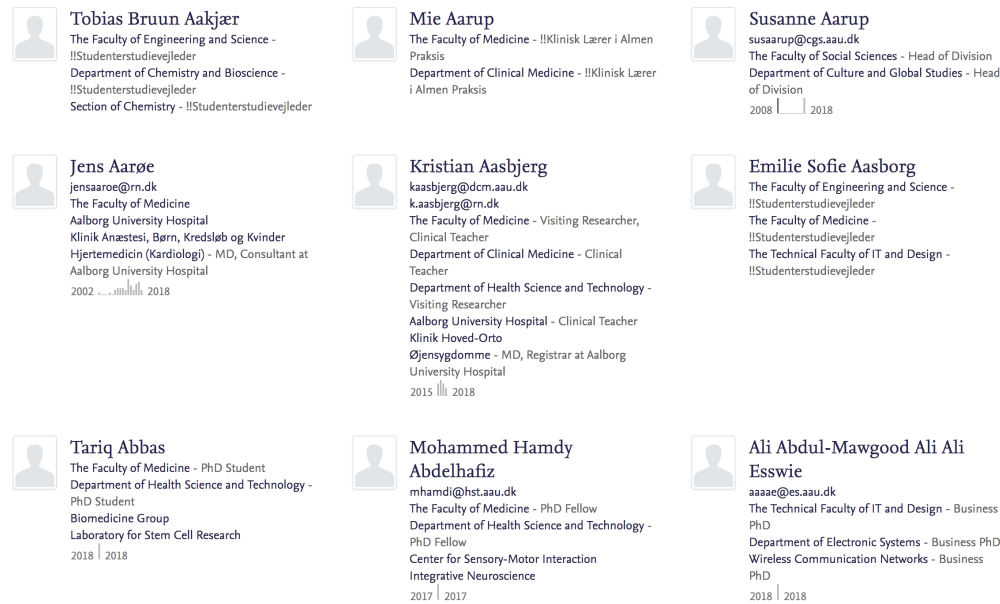
Figure 4.3: Descriptive metadata of the expert

Figure 4.4: Fingerprint subjects terms presented as a metadata to support list of publications

figure 4.6, metadata on Pure Portal supports network visualization and presents collaboration with the individual researchers and research units, both internal and external. Descriptive metadata - years and minimum number of collaborations also support network visualization, allows user to narrow down the information according to their information need. This type of metada will be evaluated during the interview study, in order to collect user insights - how they understand it, how useful it is, what is their opinion.

Network visualization

One of the graphical visualizations, that appear in the professional experts' profile is the network visualization. Network visualization in the figure 4.7, presents collaboration with the individuals and research units both internal/external. This type of visualization is described
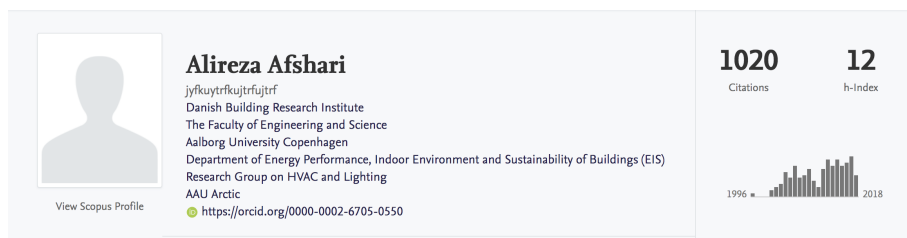
Figure 4.5: H-index and citation index
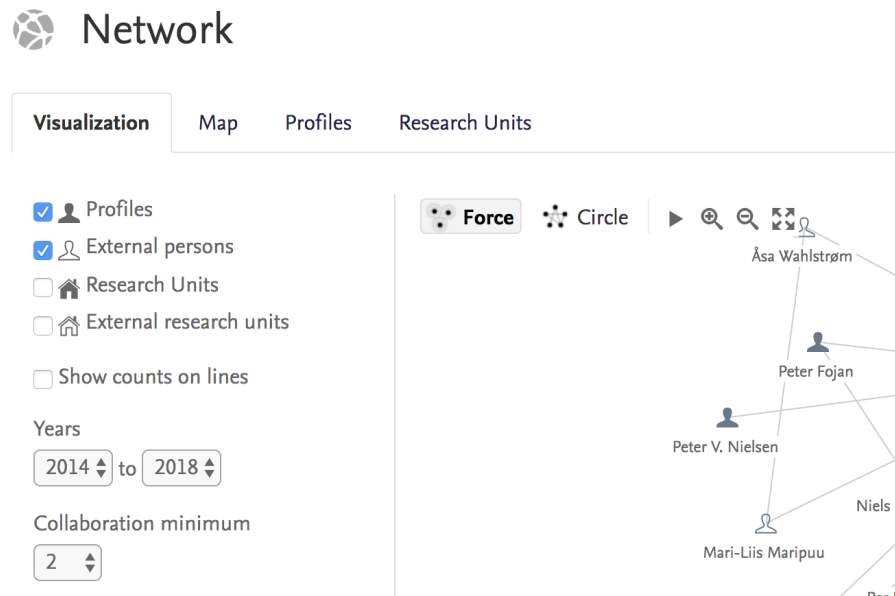
Figure 4.6: Metadata supporting network visualization

by Steele and Iliinsky (2010) and it has been found in 1930's by a group of sociologists and ethnographers, who wanted to derive a social structure of women in United States, in order to visualize what social events they are attending. At that time, visualization was developed using interviews and surveys to find out, who is a friend of whom or who plays key role in social structure (Steele & Iliinsky, 2010). Network visualization is using statistical algorithms to find important nodes and detect clusters (Steele & Iliinsky, 2010). Network visualization is presented in two different ways, as can be seen in the figure 4.9. I want to understand, is it relevant and useful for large enterprises, also, which version is preferred and why. Similarly, Network visualization presents collaboration with different internal/external research units, as can be seen in the figure 4.9. The intended message of visualization is to show experts' connection to different research departments. The experts name, who is a collaborator with all of the nodes (departments), is indicated in green. I want to understand the usefulness of this representation, and to know, how large enterprises perceive this type of visualization and how it supports UII.
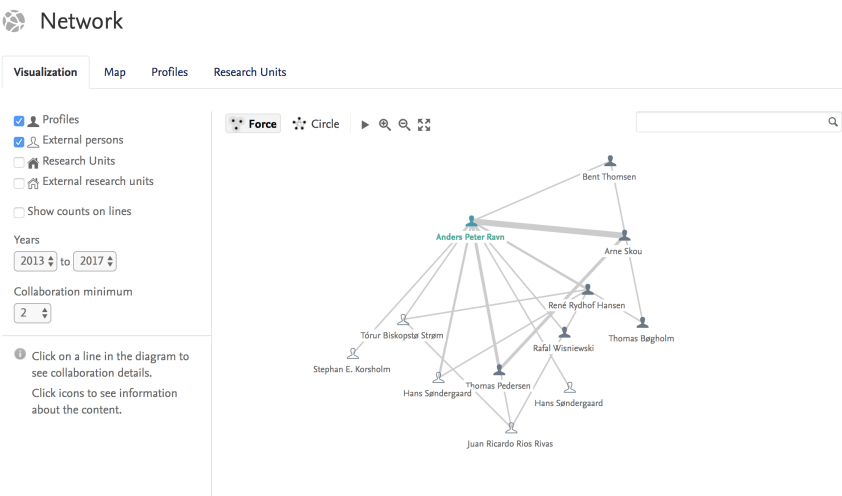
Figure 4.7: Network visualization presenting individual connections
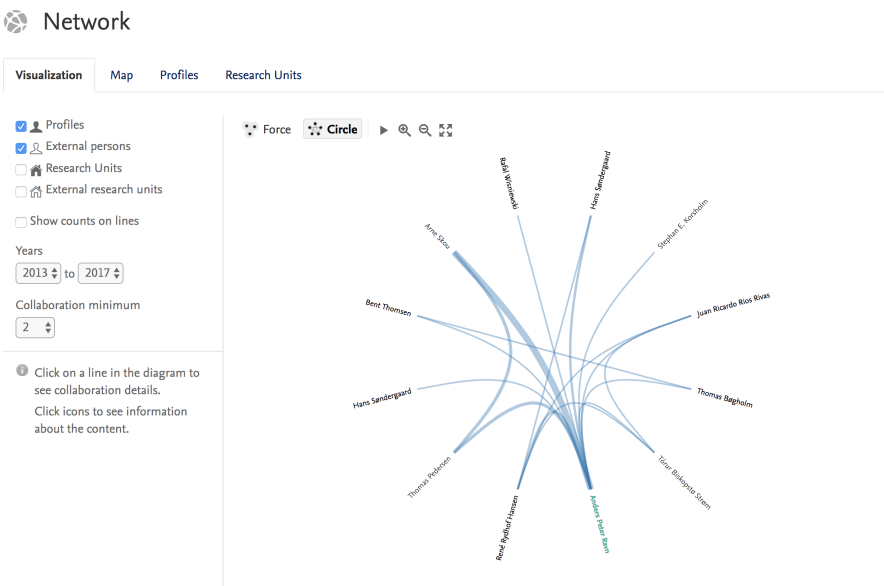
Figure 4.8: Network circle visualization

Fingerprint visualization

Fingerprint visualization, in the figure 4.10, intends to present expertise of academic professionals'. The algorithm mines the abstracts, in order to provide weighted terms, which define key subject areas of an expert. The representation of fingerprint depends on the uploaded abstracts of the publications. The 'circle icon' visualization, indicates the level of expertise in the subject field, the fuller it is, the higher ranking the subject has within the

Figure 4.9: Network visualization presenting connection with research units

publications of that particular academic expert. The ranking of the concepts is supported by weighted numbers, that are presented in the figure 4.10. The weight represents, how frequently terms have appeared in the abstract. As can be seen in a full fingerprint visualization figure 4.11, thesaurus terms are categorized in domain-relevant broad level categories. These broad categories represent the terms within different controlled vocabularies, that are part of a fingerprint engine. In order to find out how large enterprises perceive fingerprint, how useful/relevant it is, I will be evaluating fingerprint during the interview study.
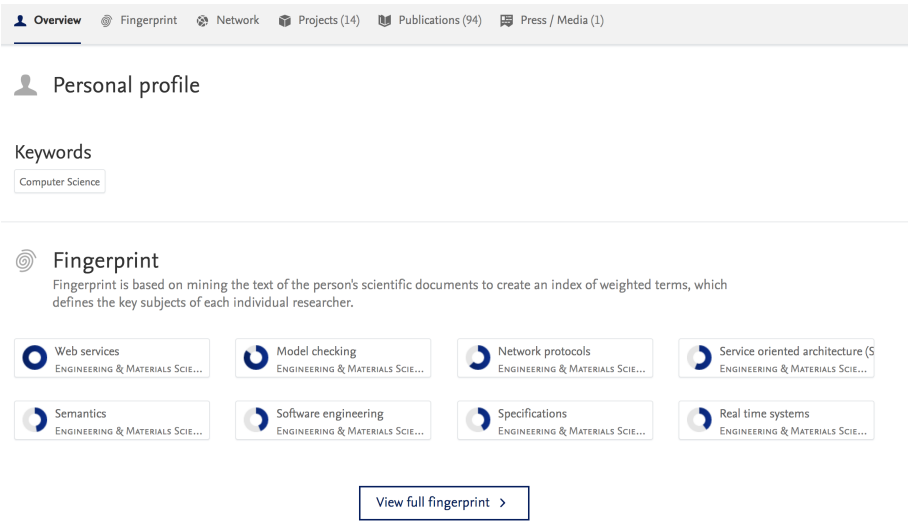
Figure 4.10: Fingerprint visualization
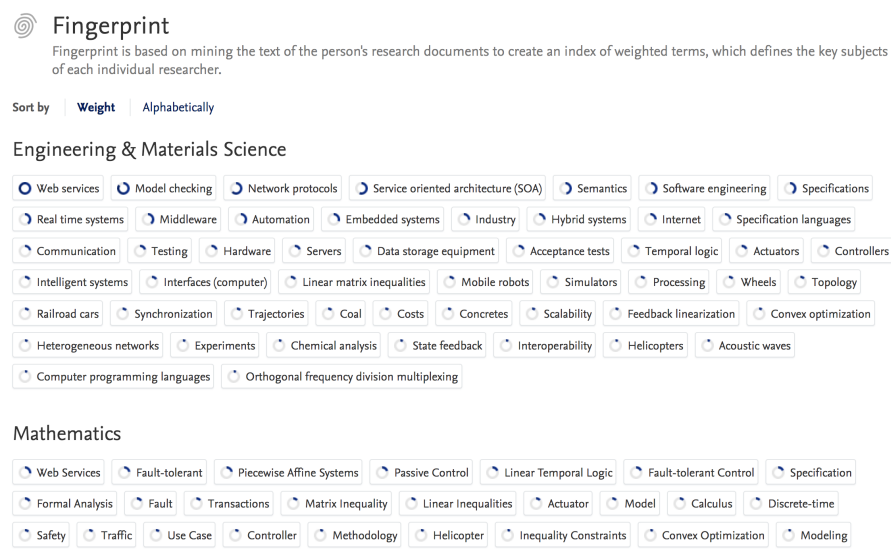
Figure 4.11: Full Fingerprint visualization
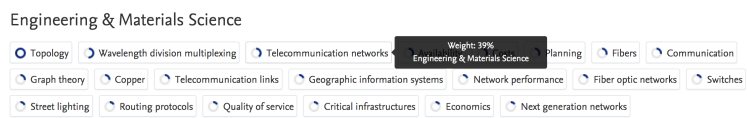
Figure 4.12: Fingerprint visualization weighed terms

Research output visualization

Pure Portal presents academic experts research output development, as is presented in figure 4.13. Research output presents number of publications per year, when dragging the mouse over, it shoes number of publications for that particular year. I want to understand, how relevant this visualization is for large enterprises, when they seek for academic experts. How it is perceived and if it is useful for the industry actors. I will collect informants' feedback in regards to research output during the interview study.
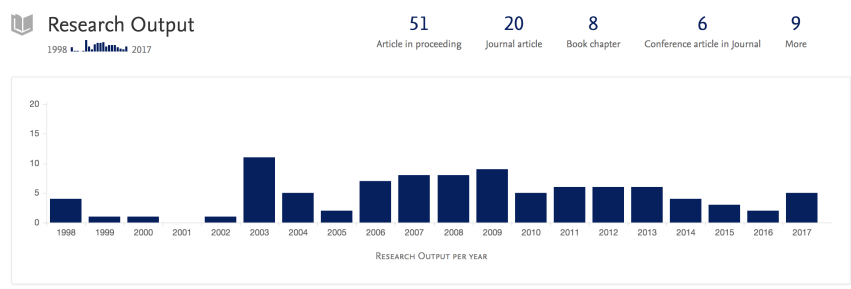
Figure 4.13: Research output visualization

4.5   Interview study

The qualitative interview study in this thesis is carried out, in order to answer RQs, presented in the introduction 1. I use semi-structured interviews as a research method, in order to collect interviewee's point of view, as opposed to quantitative structured interviews, where the purpose is to answer key questions to maximize validity and reliability (Bryman, 2016). In order to plan and reflect on the interview study, I will use seven stages of an interview inquiry (Kvale, 2007). I will now start to describe the process of the interview study, according to stages of interview inquiry.

4.5.1   Seven stages of an interview inquiry

The seven stages of an interview inquiry are used in the thesis as a process for planning the interview study. It is stressed, that qualitative interviews are open and there are no standard procedures or rules for conducting qualitative interviews (Kvale, 2007). Yet, seven stages of an interview inquiry helps to make reflective decisions about the interview method. Seven stages of an interview inquiry consists of thematizing, designing, interviewing, transcribing, analyzing and verifying and reporting results. I will now present processes during the stages of an interview study that has been conducted in the thesis.

Thematizing

Before I formulate the purpose of the interview study, I want to define the word usefulness and relevance, as it will be used frequently during the interview study. In the context of investigating graphical visualizations on RIMS, usefulness can be defined as 'serving the intended meaning and being effective, delivering knowledge and answering questions' (Dictionary, 2019c). Relevant in this thesis is defined as 'related to the matter at hand' (Dictionary, 2019b).

The interview purpose is twofold, first is to explore whether graphical visualizations are useful for facilitating University – Industry interaction within the context of collaboration, hiring and use for scientific knowledge. The second is to understand, whether taxonomy and metadata are relevant and useful, in order to support graphical visualizations. The goal of the interview is to gather the insights and feedback, in order to understand, whether showcasing of researchers' profile data is not only presented in a novel way, but also, if it serves the intended purpose of facilitating collaboration. It is emphasized, that the questions of 'what' is being investigated and 'why', should be answered before the 'how' to design interview process (Kvale, 2007). The question, 'why' is answered in the introduction of the thesis 1.

Therefore, I will answer: What is being investigated?

During the interview study I will be investigating graphical visualizations on Pure Portal,

specifically, such as: fingerprint visualization, network visualization, research output visualization. Also, taxonomy and metadata that is used to describe visualizations and academic expert profiles. In particular metadata that supports network visualization (individuals - internal/external, departments - internal/external). Weighted terms, that support fingerprint visualization. Also, subject areas such as: projects, research outputs, activities, citations and whether they are useful for facilitating UII.

Designing

In this stage, I will answer question 'how' to design an interview study. I am aware of other methods for qualitative inquiry, like observations and focus groups. However, I do not aim to study the behaviour of individuals, where observations can be a useful method. In regards to the focus groups, there are discussions, whether focus groups can be combined with phenomenological perspective, because the aim of phenomenological study is to 'seek individual experiences' and to describe them in an 'uncontaminated' way (Bradbury-Jones, Sambrook, & Irvine, 2009). However, some authors suggest, that focus groups could be used in phenomenological studies, because combined participant experiences could provide new insights into the phenomenon (Bradbury-Jones et al., 2009). Focus groups was considered as an original research method for the interview study, however, it was difficult to obtain larger number of informants.

In the interview study, I will use semi-structured interviews for the interview study, because it provides flexibility and ability to explore different themes of the interview, but at the same time allows to maintain the structure (Bryman, 2016). Differently from unstructured interviews, the semi-structured interviews have pre-formulated questions. It is emphasized, that the quality of an interview depends on the openness of the interview and whether interviewer decides to follow-up on the new leads during the interview (Kvale, 2007). Because I want to understand the context, every day work-life situations, experience and perceptions, I will allow the exploration of the prototype and will follow-up on new leads during the interview. The number of the interview subjects depends solely on the purpose of the study (Kvale, 2007). The aim is to understand, explore and gather insights of specific individuals in specific context, therefore, it is important to find participants, who themselves 'lived' the experience of UII. I understand, that small number of interview subjects will have an effect on generalization and validity of results (Kvale, 2007).

Interviewing

In this section I will present the interview questions and what I aim to uncover during the interview process. I have designed the interview guide, presented in the appendix A.3. The guide ensured effectiveness of the interview procedure and planning of the interview study. In the interview guide I indicate, that the interviews will be audio recorded for further analysis and inform them with the consent letter A.5, that I will not disclose their personal

information. I have formulated the interview questions and categorized them, as shown in the appendix, A.4. The interview has an exploratory nature and allowed informants to ask questions and provide suggest in relation to the prototype. I will now explain what is the purpose of the interview questions in every category.

The themes for the interview study has been somewhat predefined and determined by the thesis RQ. However, during the step of 'thematizing', I could reflect on 'what' i want to evaluate, and also 'why' I want to evaluate it. The interview questions are therefore divided in themes/objectives and are as following: 1) to understand the context of the interview informants, their perception about UII and RIMS; 2) to evaluate categories and metadata on Pure Portal; 3) to evaluate graphical visualizations on Pure Portal; 4) to gather insights whether Pure Portal facilitate UII.

The first category in the interview guide 'Channels and challenges related to expert search' the questions are focused towards understanding the context of the interview informants. I want to enable interview participants to explore experiences in relation to UII. Similarly, I aim to understand the context of RIMS in the work-life, explore their roles within the enterprise. I aim to identify the channels used for establishing UII and to understand the challenges, that industries face when seeking for experts and how they search for experts. In the second 'Taxonomy and metadata' I aim to find out, what categories are relevant and useful when searching for experts on RIMS. Also, what metadata is useful for supporting graphical visualizations on Pure Portal. The third categry 'Fingerprint visualization' aims to gather insights, whether fingerprint visualizations are useful and relevant for identifying the area of researcher expertise. Also, how well it represents the area of expertise and how industry actors perceive fingerprint. I also want to understand, whether informant's see usefulness in 'weight representation' of each concept in the fingerprint visualization. With the forth category 'Network visualizations', I am to understand, how participants perceive visualization. Also, how does it promote UII, do they find it useful/relevant. Additionally, network visualization is supported by metadata, I want to know, if it is useful metadata for large enterpsies. 'Research output timeline' category, focus on the particular research output visualization with the purpose to understand, whether and how it is useful/relevant for large enterprises. The conclusion questions aims to understand whether Pure Portal visualizations are useful and facilitate UII. I want to know, if large enterprises perceive Pure Portal as useful and relevant system for identifying the experts.

Transcribing

The interviews were audio recorded and later transcribed. I have collected total of 121 minutes of interview recording. Where each of the interview lasted 30-40 minutes. I have transcribed the interviews myself, which provided me with in depth knowledge about the data, also I could reflect upon my interviewing style and detect issues concerned with technique. The transcribing procedure included all the sentences and words, it is a full transcription

protocol of the interview, as can be seen in the appendix, figure A.6, A.7, A.8. The mishears and misinterpretations happened during the transcription, because of the accent. In order to ensure, that the interview transcriptions are reliable, I constantly checked correspondence between the audio recording and what have I transcribed (Kvale, 2007).

Analyzing

The qualitative data analysis process is defined as "a search for general statements about relationships and underlying meaning", (Gibson and Brown, 2009, ch. 1). By analyzing the data, I aim to capture the meaning and interpret informants statements. In the following section, I want to explain the distinctive features of the thematic meaning condensation, before I start to describe the actual process of the analysis.

Thematic meaning condensation process

Thematic analysis refers to the process of analyzing the data according to commonalities, relationships and differences across the data (Gibson & Brown, 2009). "The word 'thematic' relates to the aim of searching for aggregated themes within data", (Gibson and Brown, 2009, ch. 8). Thematic analysis was developed under the influence of grounded theory, however it differs from Grounded Theory, because it is not an iterative process, where data collection interplay with analysis, in order to generate a theory (Bryman, 2016). Other quantitative data analysis methods are available, such as: interpretive phenomenological analysis and analytic induction, however, I do not aim to examine individual experiences for the purpose to then compare them and find patterns in similarities/differences of the phenomenon (Pietkiewicz & Smith, 2012). Nor do I start the research with a hypothetical explanation of the problem, where I would seek an explanation of phenomenon by examining different cases, as it is common in analytic induction (Bryman, 2016).

As suggested by Kvale (2007), there are analysis processes developed on the basis of phenomenological philosophy. A systematic text condensation is used as an inspirational process to systematically 'deal' with the data (Kvale, 2007). It is a process, inspired by phenomenological philosophy and is borrowing methods from thematic analysis (Kvale, 2007). I use systematic text condensation as a method under the interpretive phenomenological paradigm, because I focus on meaning condensation and interpretation of informants experiences (Kvale, 2007). I use meaning condensation, because it is an exploratory process and focuses on meaning and it helps novice experts, by providing reflective and detailed steps to data analysis (Malterud, 2012). It differs slightly from traditional thematic analysis, because the process focuses on meaning condensation. Differently from thematic analysis, first step is to identify meaning units, that are relevant for the RQs, rather than assign the codes to the text as a first step. Steps to thematic meaning condensation, and are as following: "1) total impression – from chaos to themes; 2) identifying and sorting meaning units – from themes to codes; 3) condensation – from code to meaning; 4) synthesizing – from condensation

to descriptions and concepts." (Malterud, 2012, p. 795). A 'meaning unit' is defined as a fragment of text, containing some information about the research question (Malterud, 2012). In the thesis analysis, the 'meaning unit' is a piece of text, that represents a certain concept of meaning and is essential for answering RQs. I will describe the process of data analysis in the following section.

The analysis process

Data processing aims to provide structure and organize the data, at the same time present the findings in meaningful, readable way (Gibson & Brown, 2009). In order for the themes to 'emerge from the data', one should familiarize with the text by reading it carefully (Bryman, 2016). Considering, that I have transcribed the interviews, I have familiarized with the data before the initial analysis has started. I adopt inductive reasoning to the analysis process, however, I had a priori codes, that were related to the thesis RQs, such as: industry's perspective on UII, taxonomy/metadata and Pure Portal graphical visualizations, those were the major categories or 'a prior codes'. For the analysis process, I have used a computer software NVivo (NVivo, 2019).

After transcribing the interviews, I have red each transcriptions, in order to get total impression of what is being said. It is suggested to stay theoretical and read the texts with an open mind, but still have an interpretive position, determined by research questions (Malterud, 2012). Similarly, I have red the transcriptions at least two times, before starting to organize text into the 'meaning units'. The second step is to organize data in order to clear up the research question of the study (Malterud, 2012). The a prior codes have helped me to identify relevant meaning units during the second phase. The example of the process, of how I condensed meaning units in the thesis can be seen in figure 4.14.

I have identified relevant meaning units according to RQs, then I have condensed meaning units and expressed them into codes. It is stressed, that sometimes the first code assigned to the condensed meaning units are not sufficient enough to represent the meaning, therefore, I have few codes (Malterud, 2012). Also, I have changed the codes several times, in order to be sure that they accurately represent meaning units (Malterud, 2012). The codes then formed a category, and finally, the meaning was expressed into themes. As I progressed, I had identified number of meaning units across interview transcriptions.

The themes that emerge from condensed meaning units, can thereafter be subjected to more extensive interpretations (Kvale, 2007). In the synthesis phase, I present description of phenomenon and concepts, where I also interpret the findings, based on the empirical data. Overall, thematic meaning condensation, is useful process for novice experts. The process helped me to reflect particularly on, why do I include this meaning unit, why it is relevant, what knowledge does it provide in relation to the RQs of the study. I will now explain the

Meaning unit	Condensed meaning unit	Codes	Categories	Themes
First of all for me, I do not know the interpretation and the definition of the weight, right. So for me I think it would be sufficient to just to see the graphical representation of whether it is half full or fuller, whatever. But the specific numbers, whether it's 44% I don't know… It is not really a detail, that is relevant for me. I can't navigate in these numbers, cause I really don't know what they mean. For me it is just, is it much relevant, less relevant or a big relevant. That would be sufficient.	I do not know the interpretation and the definition of the weight; I can't navigate in these numbers, cause I really don't know what they mean; It would be sufficient to just to see the graphical representation of whether it is half full or fuller;	Fringerprint visualization numbers are overwhelming; Fingerprint weighted terms do not provide any further explanation of how 'weight' is applied; I don't know the meaning of numbers;	Expressed judgment towards the content of fingerprint visualization	Fingerprint 'weight percentage' does not provide context about how it was generated

Figure 4.14: Meaning condensation process inspired by Giorgi (1975)

last step of the interview inquiry by Kvale (2007), which is concerned with verifying the interview.

Verifying

The verification of reliability and validity is concerned with consistency and trustworthiness of research findings; whether the method investigated what it is intended to investigate, for example, does it indeed reflect phenomenon or variables that are relevant and of interest to the study (Kvale, 2007). Validation in qualitative research becomes complex, because of the falsifiable interpretations (Kvale, 2007). Author suggest communicative and pragmatic approach to validity, presenting three contexts of validation. Communicative validity is a process of testing informants' claims during the interview (Kvale, 2007). In the context of self-understanding, the interviewer becomes the member of validation and validates his interpretation against the interviewee statements. This approach was the most available during the research interview, therefore, used to validate the informants' responses. Other way to validate is critical common sense validation, where validity comes from the audience and goes beyond self-understanding (Kvale, 2007). The third context is the theoretical understanding testing, which is done by a research community and refers to peer validation who are familiar with the research subject (Kvale, 2007). Moreover, pragmatic validation is

concerned with the interviewees responses and their reaction to the interpretation, however, I do not aim to produce changes in the social system, which pragmatic validation is concerned with (Kvale, 2007).

It is emphasized, that none of these contexts of validation are superior to each other and each are appropriate to validate the interpretations (Kvale, 2007). The interviews in the thesis were validated using self-understanding context. Validating questions were asking all three study participants, to ensure that the interpretations are valid and correlate with interviewees' statements. In the interview study with representative from large enterprises, the communicative validation process was carried out as presented in the quote.

Interviewer: "But a little bit to sum up. For you, the topic is important, the unit is more important than the individual, multidisciplinary is important and especially to see collaboration between disciplines."
Informant 2:"Yes, exactly." (A.7, line 473-477).

In this section I presented the steps of the interview study. I have described design process and the focus of the interview questions. Also, the process of transcription and analysis. Likewise, explained the process of communicative validity of interview interpretations. The last step in the process is to report the findings, I will present the findings in the chapter **??**.

5 Theory

In this section I will present theoretical framework of the research study. Research impact will be presented, because RIMS facilitate registration of academic impact, because it is important to understand why it is necessary to capture it and what tools can be used to register it. LR is important, because it forms the theoretical basis for the thesis. I will present data visualization principles, for me it is important, because it provides guidelines and understanding about what is effective and good visualization. Also, I will present Information Architecture (IA), it is important for the thesis, because describing and indexing researchers expertise and their activities with metadata is the foundation for designing useful visualizations. Taxonomies is a tool to manage metadata and labels, in my view, IA theory is a tool to describe and evaluate descriptions of researchers, with the purpose to find out, whether Elsevier use relevant metadata and labels.

5.1 Research Impact

Research impact is defined as "an effect on, change of benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia." (Penfield et al., 2013, p. 21). Measuring research impact benefits the institutions and enables them to manage and understand their performance in society (Penfield et al., 2013). Likewise, it is a good way for the government to justify and explain their position for spending public money (Penfield et al., 2013). Bibliometrics, citations and h-index is the most popular and traditional ways to measure research impact. However, they do not show the full picture of the impact (Penfield et al., 2013). One of the challenges for evaluating research via numeric interpretations is the time delay between research and impact (Penfield et al., 2013). Other challenges are related with short-term impacts, should they be counted as an actual impact, that brings societal benefit. Therefore, it is important to capture the impact not only when it has happened, but capturing data interactions and indicators when they emerge, would is valuable (Penfield et al., 2013). The impact studies now suggest, that academic impact such as: contribution to knowledge, educational development, informing public policy, contribution to economy should be measured, presented and evaluated as impacts (Penfield et al., 2013). When describing research impact, I want to emphasize the role of RIMS, because they are tools that help researchers to transfer knowledge, register

their activities and products. Similarly, systems are developed to capture research impact, such as, responsible impact research project, which aims to capture, measure and explore diverse ecosystem of humanistic faculty at AAU, by applying impact taxonomy, combined with web-based registration interface, the project aims to capture diverse impact (ReAct, 2018).

5.2 Literature review

LR refers to the action of reviewing literature with the purpose to evaluate and compare existing sources about a specific topic (Ridley, 2012). LR has different levels of complexity, depending on its purpose. It can be a stand-alone review, where the entire thesis is a LR, that is mainly seen in a PhD dissertations (Ridley, 2012). I conduct LR in the thesis, in order to obtain and demonstrate knowledge, in relation to UII phenomenon. Also, so that I can position my study within the filed of UII and relate it to the sources within the UII field. Likewise, I conduct LR, in order to rely on extensive references of the field (Ridley, 2012). LR is a part of a theoretical framework of this research study, and it used as a tool to obtain knowledge about UII phenomenon.

5.3 Data visualization

In this section I will present the principles of data visualization. I want to define data visualization, because it is important to understand what is good and acceptable data visualization.

Data visualization is a graphical presentation of data, it aims to 'represent complex information at a glance' (Steele & Iliinsky, 2010). Information visualization has to be beautiful, beauty in this context is defined as 'aesthetics' (Steele & Iliinsky, 2010). According to Steele and Iliinsky (2010), data visualization can be qualified as beautiful, when it meets three core principles, besides being aesthetic, data visualization must be: novel, informative, efficient.

Novel in this context means, that visualization must be presented in a well-understood format, that excites users and results in new understanding (Steele & Iliinsky, 2010). The novelty of a good visualization is the ability to effectively reveal new insights (Steele & Iliinsky, 2010). Also, to present visualization in a well-understood formats (Steele & Iliinsky, 2010). It is stressed, that one should 'step out' from the default formats of data visualization, in order to present something novel, fresh and unique. However, defaults should be overturned only when there is a more effective and stronger solution, with the condition, that it also can provide 'intended message' (Steele & Iliinsky, 2010). One should not design a beautiful visualization, just for the sake of beauty.

The primary goal of visualization is informativeness, which means to provide information that can result in knowledge (Steele & Iliinsky, 2010). It has been emphasized, that if visual does not achieve to provide knowledge, it is considered as failed visualization (Steele & Iliinsky, 2010). Two factors, ensuring informativeness of visualization is to bring 'intended message' and 'context of use'. To ensure that visualization communicate intended message, first one should consider what are the questions, that visualization aims to answer, or a story to tell (Steele & Iliinsky, 2010). When the message is decided, it is important to consider the users and their needs, also the terminology accordingly, in order to ensure, that labels make meaning (Steele & Iliinsky, 2010). The context of visualization should be considered, because it will determine visualization type. For example, charts, graphs are the type of visualizations that aim to answer what is already known. In the business contexts, the visualizations, that facilitate discovery or validate hypothesis, usually require different types of visual representations to ensure that intended message is presented (Steele & Iliinsky, 2010). During the thesis study, I will explore, whether visualizations are informative.

Graphical construction of data visualization consists of layout, lines, shapes, colors and typography, these are the elements, that are useful for guiding user, revealing relationships and communicating a message (Steele & Iliinsky, 2010). Efficiency can be achieved by using graphical elements to enhance, make it bigger, apply the color to the information/elements that matters the most (Steele & Iliinsky, 2010). Once the rest of requirements for 'beautiful' visualization are met, the elements of 'aesthetics' can be used to enhance the utility of the visualization (Steele & Iliinsky, 2010). Minimizing redundancy and enhancing encoding of information by using aesthetics can be done via labels and sizes, applying colors and paring attributes (Steele & Iliinsky, 2010). It is stressed, that the primarily purpose of data visualization must be to present information, because graphical elements can not simply aid the visualizations, if it is not informative (Steele & Iliinsky, 2010). Similarly, in this thesis I am investigating, whether graphic exposure is beautiful, but most importantly, if it provides knowledge.

5.4   Information Architecture

Information Architecture (IA) is the main theoretical aspect of RQs, presented in the introduction 1. IA used in this thesis as a theoretical framework, which aids the process of answering RQs of the thesis. Also, IA components will be presented in the thesis, because they help to understand the content that is a part of RIMS. Likewise, IA components are presented and defined, in order to support interview study and analysis. By presenting theoretical framework of IA, I aim to explain and define the study scope. I will start to present the field of IA, its definition and brief story behind the term of IA. Also, present the information ecology claimed by the thesis. In order to understand the theoretical components of IA, I will now present the definitions of IA.

Defining Information Architecture

The term 'Information Architecture', was formed by Richard Wurman in 1975 (Dillon & Turnbull, 2006). The term was created because of the growing need to describe the process of data transformation into a meaningful information (Dillon & Turnbull, 2006). I want to emphasize, that IA can be concerned with many different disciplines, but it has common goal - to understand human, organize information and pursue clarity of meaning. Similarly, the thesis is focused on understanding the phenomenon of UII by making meaning on RIMS, using IA components, that will be presented shortly.

Two influential events, that helped to shape IA as it is today, is the publication of the book, on the IA topic by Rosenfeld and Morville, in 1998. And another is the organization of a preliminary summit, by the 'American Society for Information Science and Technology', in May 2000, on the theme of 'Defining Information Architecture' (Dillon & Turnbull, 2006). Authors have applied principles of architecture and library science to the web site design and define IA as:

1. "The structural design of shared information environments.

2. The synthesis of organization, labeling, search, and navigation systems within digital, physical, and cross-channel ecosystems.

3. The art and science of shaping information products and experiences to support usability, findability, and understanding.

4. The structural design of shared information environments.", (Morville et al., 2015, p.24).

Definition that represents the focus of the thesis is that IA is "The art and science of shaping information products and experiences to support usability, findability, and understanding", (Morville et al., 2015, p.24). Because with IA in this thesis, I aim to shape information environment, in order to support understanding, usefulness and informativeness.

5.4.1   Information Architecture components

IA consists of four primary components, the following are: navigation systems, searching systems, organization systems and labelling systems (Morville et al., 2015). Shortly, I will present IA components and their different elements. However, because metadata, labels and taxonomies are the elements of IA, which are used in RIMS and addressed in the RQ2, thesis will primarily focus on particular IA components - organization systems and labelling

systems. I want to emphasize, that all IA components are interconnected, presenting relationships among the IA discipline (Dillon & Turnbull, 2006). I will present four components of IA separately, but it is important to understand, that are all connected with each other.

Navigation systems

Navigation systems provide the point of access and interaction, in a form of browsing and navigating around functional menus or links (Dillon & Turnbull, 2006). Navigation systems exist in most digital environments (as presented in figure 5.1 5.2), they help user to explore, prevents confusion (Morville et al., 2015). Navigation systems can be globally or locally embedded and each serve a specific purpose. Global navigation, is a type of navigation, that is embedded in the structure of a website and is always present (Morville et al., 2015). Contextual navigation, is a part of a system content and is in most cases presented as links, that enable users to examine the content fast, pointing them to related articles, products or services. Taxonomies can be used as a technique to support navigation systems, they are referred to as 'navigational taxonomies' (Hedden, 2010).
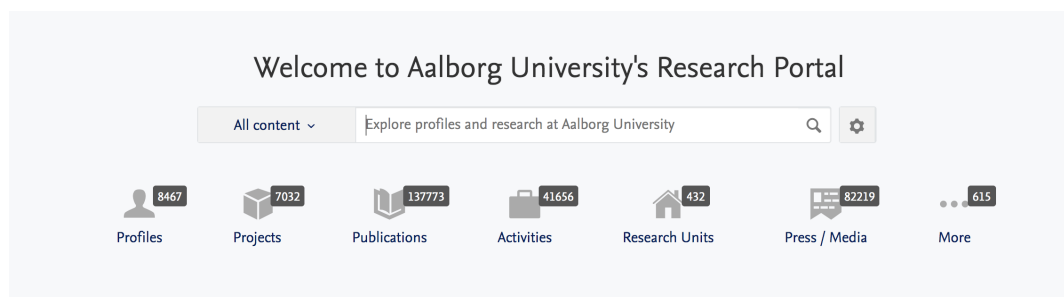
Figure 5.1: Navigation on landing page on Pure Portal

Search Systems

Search systems allows to search for the information, by entering specific queries and search terms users can retrieve information – as opposed to navigation, where user search through a predefined structure and subject categories and follow a determined path, the search system search across the navigation and organization structure 5.2, 5.3 (Morville et al., 2015). User can narrow down the search by using predefined concepts/categories, this way increasing precision of the results. Furthermore, user can combine more search terms in a query, as opposed to navigating the structure. The growth of digital libraries, have increased the popularity of search engines (Dillon & Turnbull, 2006). In order to increase precision of
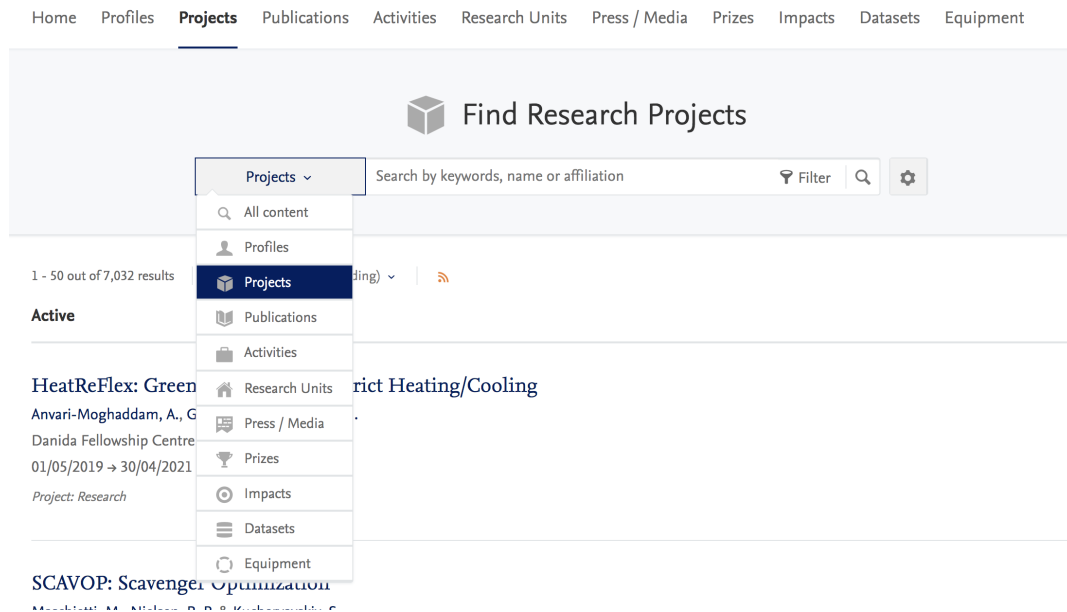
Figure 5.2: Global navigation on Pure Portal

results, search engines have algorithms for processing search queries include metadata, that aids search engine and taxonomy, that aids metadata assignments (Morville et al., 2015).

Organization Systems

Organization systems are used to categorize information on the information environments (Morville et al., 2015). Information can be organized by subject type, chronology or geographical order, organizations systems are used for organizing information under certain categories (Morville et al., 2015). Structured techniques, such as taxonomy creation and metadata descriptions are important for structuring knowledge within RIMS (Morville et al., 2015). The conceptual work of structuring large sets of information involves the creation of thesaurus or taxonomies (Jean Aitchison & Bawden, 2000). Thesaurus serves as an information retrieval and as a browsing aid for the user (Hedden, 2010). Also, it helps to understand the general subjects areas, by providing relationships and definitions of the concepts (Jean Aitchison & Bawden, 2000).

Labelling Systems

Labelling, is another component of IA and is defined as a 'form of representation' (Morville et al., 2015). We name specific meaning concepts with words, so the word present the intended meaning (Morville et al., 2015). It could be the concepts we name in the navigation
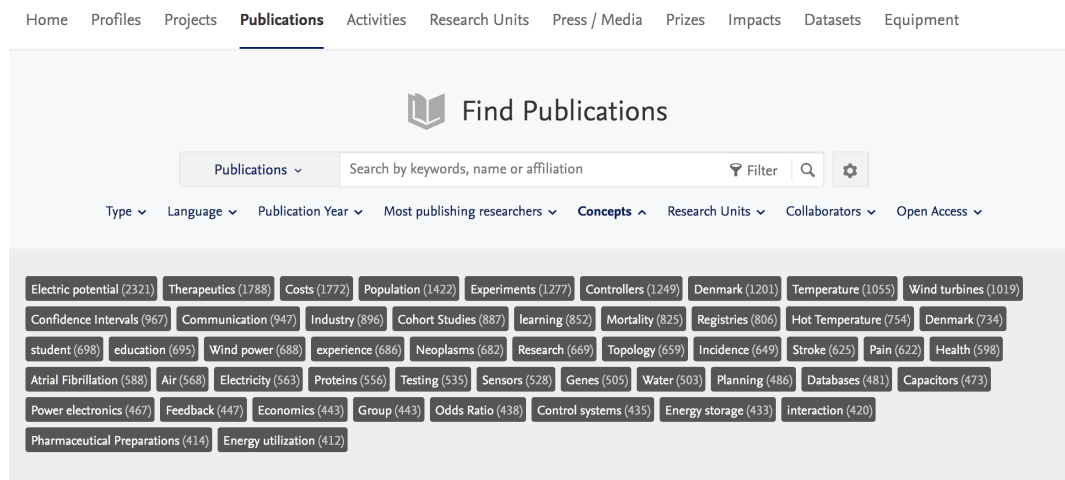
Figure 5.3: Search system on Pure Portal

systems, such as: menu, about, contacts, etc., or it can be contextual links, index terms, headings and even as icon labels. The main emphasis on labelling is that labels should be named in the language, that is understandable for the user (Morville et al., 2015).

5.5 Information ecology

The concept of 'information ecology', as presented in the figure 5.4, is used to describe dependencies that exist in the information environment (Morville et al., 2015). Information ecology is used in the thesis as a theoretical framework that helps to organize the exploration process (Morville et al., 2015). Authors, Morville et al. (2015) emphasize, that IA can not be designed in vacuum. Therefore, I seek to understand ecological context, content and users in the first part of the interview study.

"The three circles illustrate the interdependent nature of users, content, and context within a complex, adaptive information ecology." (Morville et al., 2015, p. 32). The middle of the diagram, represents IA as a central attribute, that is in balance with other aspects (Morville et al., 2015). When creating IA, we must understand the context, which is constructed of business goals, politics, culture, technology, constraints and can vary in organizational structure (Morville et al., 2015). As has been explained before, Information ecology model is effective for understanding user needs, project opportunities and the context of a given project (Morville et al., 2015). Information ecology is used as a model, in order to define the scope, introduce the context, users and the content of the thesis. Three attributes of information ecology (context, content and users) have been described in the section 4. Further, I will present taxonomies, the core element of organization systems.
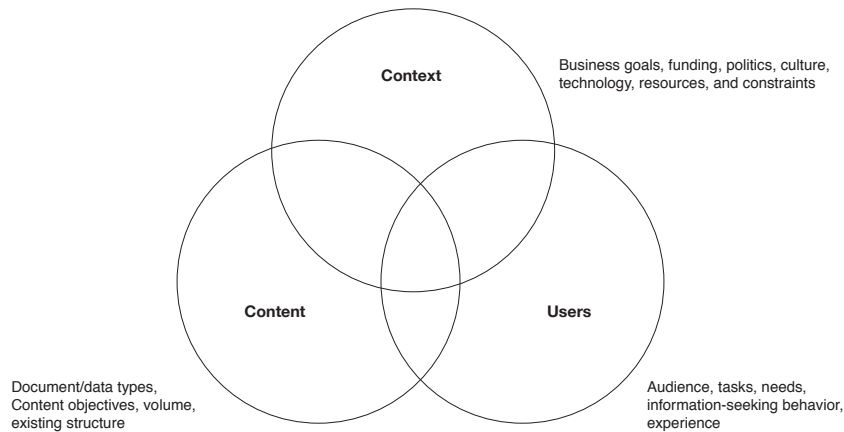
Figure 5.4: The infamous three circles of information architecture

5.6 Taxonomy

I present taxonomy as a part of theory in this thesis, because it is a are major element of the RQ2 1. Taxonomies are the instruments for supporting the needs, content and purposes of information systems (Hedden, 2010). Likewise, taxonomy is a major element of all four IA components and essential element of RIMS e-infrastructure (Jeffery et al., 2014). I want to emphasize, that the structure of taxonomy will not be examined directly. Instead, I will obtain user feedback, in order to understand, whether Elsevier is using relevant labels on Pure Portal interface. I will now define and present different types of taxonomies and how they relate to RIMS.

5.6.1 Defining taxonomy

The role of taxonomies within digital information environment began in 1990's, when problems of information navigation and use of free text become more widespread (Hedden, 2010). Taxonomy comes from Greek word 'taxis', meaning arrangement' and 'nomos', meaning science (Hedden, 2010). In the field of IA, taxonomy would fall under the component of organization systems, however, taxonomies are used widely within other IA components, such as labeling, search and navigation systems. "Taxonomy in this sense includes controlled vocabularies for document indexing and retrieval, subject categories in content management systems, navigation labels and categories in website information architecture, and standardized terminology within a corporate knowledge base", (Hedden, 2010, p. xxi). Taxonomies are dynamic and ever changing element of information environment, they have a distinct purposes, which I will present in the following.

5.6.2 Taxonomy types and functions

Controlled vocabularies are restricted set of words, that have a specialized purpose, usually for indexing, labelling or categorizing (Hedden, 2010). They are called 'controlled', because only the terms from the list of particular controlled vocabulary are used (Hedden, 2010). The new terms can only be changed or added under defined policies (Hedden, 2010). The purpose of controlled vocabularies is to ensure consistency among the application of terms, labels and tags, in order to avoid ambiguities or the wrong use of terms (Hedden, 2010). In this thesis research interview I will explore, whether labeling on Pure Portal is effective.

Hierarchical taxonomies are common in classifying geospatial terms, as for regions, countries, provinces and cities (Hedden, 2010). This type of taxonomy is usually used to organize generic things or concepts, however, they can also be used for organizing proper nouns, such as place names, product names, government agency names and department names (Hedden, 2010). Hierarchical taxonomies can be also seen in RIMS, presenting hierarchy of different research departments and organizational units (Jeffery et al., 2014). I will explore, whether Elsevier is using relevant categories.

Thesauri is used for to index with metadata to allow searching as opposed to navigating, share similar characteristics as hierarchical taxonomy (Hedden, 2010). It is a more structured type of taxonomy and provides more conceptual information about the scope, broad terms, narrow terms and related terms, whereas the hierarchical often only provide information about broader and narrow terms (Hedden, 2010). Different types of taxonomies were outlined in the section, however, other structured techniques, such as metadata, are also applied for supporting information systems.

5.7 Metadata

Metadata is underlined in the thesis, because it is a part of a RQ2, which aims to find ways to design a metadata scheme, in order to support visualizations 1. The metadata is prominently used to describe content, context and structure within digital systems (Jeffery et al., 2014). Metadata is a main element to successful e-infrastructure, additionally it is an important element of RIMS (Jeffery et al., 2014).

5.7.1 Defining metadata

"The prefix meta - comes from ancient Greek and is usually translated into English by the preposition about. It is often used to express an idea that is in some way self-reflexive.", (Gartner, 2016, p. 2). Metadata, could be interpreted as self-reflective data, therefore, it is defined as 'data about data' (Gartner, 2016). I will present different types and purposes of metadata in the following section, in order to explain, how metadata is used on RIMS.

5.7.2 Metadata types and functions

There are three types of metadata, - administrative metadata, structural metadata and descriptive metadata(Gartner, 2016). The administrative metadata is used to reinforce intellectual property rights (Gartner, 2016). It allows to manage resources, such as when the document was made, the file type, who can access the information (Gartner, 2016). Structural metadata defines structures that bring smaller components into something larger (Gartner, 2016). It can be used to describe page numbers, chapters, table of contents. It allows system to successfully locate the files, it covers everything that systems needs to know about the object, in order to deliver it (Gartner, 2016). In physical libraries it could be the keywords, that are used to describe books (year, genre, author, publisher). In digital environments it may include the details of the size of the document, pixels, colors, etc. Likewise, I will explore descriptive metadata, that is used to describe researchers' positions and expertise.

5.8 The role of taxonomies and medatata on RIMS

Metadata helps users to understand different components of RIMS within information environment (Jeffery et al., 2014). "There are existing models to support information systems, such as RIMS, "The Common European Research Information Format (CERIF) is a model of the research domain, typically applied in Common Research Information Systems (CRIS)", (Jeffery et al., 2014, section 5.3). In addition, Elsevier is applying CERIF standards, to support rich description of research domain on Pure Portal (Elsevier, 2019). CERIF standards support broad taxonomy entities on RIMS related to a research domain metadata (projects, profiles, publications, activities, research units, etc.). Also, some second level entities as institute, research department, research center, etc. CERIF also provides relationships between these entities (Jeffery et al., 2014). However, metadata that is used to support visualizations on RIMS, is managed by the editors or RIMS. In order to design taxonomy and metadata with the purpose to support graphical visualizations, next chapter will present the findings of an interview study.

6 Interview findings

In this chapter I will present the findings of the interview study. I will present the findings through the categories, themes and codes that have emerged from an open analysis of the interview data. The aim of the interview study was to gather insights and feedback in order to answer RQs 1. The focus of the interview study was to collect user feedback with the twofold goal: 1) to evaluate usefulness and relevance (defined in 4) of graphical visualizations, 2) to evaluate usefulness and relevance of the taxonomy and metadata. One of interviews were conducted at the enterprise location, the second was held at AAU and the third one was held via Skype. Interview provided good understanding of informants' expressions, the 'screen sharing' was used for the Skype interview, therefore, it does not limited the quality of the interview. The interviews were elaborate, the interviewees could identify with the problem area and provided detailed viewpoints on and feedback about UII, visualizations, and metadata. The table 6.1, 6.2, 6.3 presents the themes and codes that have emerged from the interview data. Overall I have three main subject categories, that support the RQs. The themes are organized into sub-categories, in order to report the findings more systematically. I will present quotes, to support the themes and the interpretation.

6.1 Exploring industry's perspective in regards to UII and RIMS

In this section I will present the themes, that have emerged from the meaning units during the analysis. The themes emerged form the data and reflect what study informants have discussed during the research interview.

6.1.1 Professional functions of the interview informants

Informant 1 has an academic background in engineering and automation, and a PhD in control & engineering. He is employed at the pump development company, where he has a position as a chief engineer and is working within control and supervision. He is an industry professor at AAU, where he has a part-time position at Department of Electronic Systems, Technical Faculty of IT and Design and Automation & Control. Informant 1, have emphasized, that he does 'integrates with research', it means, he has a research-related position within his enterprise. He also described, that he is 'working with control systems and supervision systems, exactly the same as here, but just at X enterprise'. It means, he has the same professional

Category	Sub-category	Theme	Code
Industry's perspective on UII and RIMS			
		Perception about University and RIMS	Important; Familiar; Valued; Registration; Profile; Browsing; Complicated; Useful
		Double-positions	Industry Professor; Part-time Professor; Aalborg University
		Informants are familiar with RIMS	Research system; Reporting; Browsing; Expensive; Requirements; Publications; Manages publications
		Scientific publications are important	Valued; Familiar with scientific knowledge; Understand; Theoretical; Applied; Not afraid of theory;
		Professional functions of the interview informants	Chief engineer; Chief specialist; Product manager; Director Research
		Differences in using research	Industry is using applied research; They aim to solve problems; University aims to create difference; Raise awareness
		Channels for establishing URI	Personal connections; Bachelor students; Master students; Internship programs; Research groups
		Challenges for URI from perspective of large enterprises	Expensive; Takes time and planning; Prefer to collaborate with people they know; In-house research groups; Broad domain-knowledge; Wide competences; Solve problems themselves; Physical presence is important

Figure 6.1: Categories, subcategories, themes and codes

Positive expressions towards Pure Portal			
		Pure Portal has good graphic exposure and is useful	Quite good; Useful for the industry; Informative; Better than VBN
		Network visualizations are important, because they support cognition	Helps the memory; Information interpretation; Provides quick overview;
	Positive expressions towards content of network visualization	Network visualization helps to identify experts with similar research focus	Helps to identify who is collaborating with who; Identify research groups; Contacting experts; Find primary collaborators
		Network content refer to other possible collaborators	It is Interesting; Helps to choose different university for collaboration; Content is useful; Important to see research units
	Expressed judgement of network visualization	Visual presentation of network visualization is not efficient	Visual presentation is confusing; A mess; Can't navigate;
	Expressed judgement towards the content of network visualization	The network content is not useful for the context	Never used; Individual network does not provide new knowledge; can't understand usefulness
		There is no lead to explore different experts	Expert search is overkill; There is no initiative within the enterprise to look for different experts
		There is no context of how the graphics were generated	Graphics are unclear and uncertain; Expecting more information;
		Intended message of network content is not understood	Can't understand how is it useful; Have seen it before
		Network visualization could be useful from the management perceptive	Would help the overview; Find departments to collaborate; Helps to establish future plans
	Positive expressions towards visual presentation of fingerprint	Fingerprint has nice graphical presentation	Novel visualization; Useful; Nice
	Positive expressions towards content of fingerprint visualization	Fingerprint is useful for identifying subjects' area of expertise	Interesting; Useful; Identifiable; Description; Expertise
	Expressed judgment towards the content of fingerprint visualization	Fingerprint visualization is not self-explicit	Not explained how concepts were generated; Gives a clue; Many concepts; It is important to find the most important concept;
		Fingerprint 'weight percentage' does not provide context about how it was generated	Uncertainty; Undefined; Detailed; Can't navigate; Difficult
	Positive expressions towards content of research output visualization	Research output visualization is a useful measurement	To measure activeness; Provides quick overview; Helps the to judge productivity and volume;
	Expressed judgment towards the content of research output visualization	Research output description is relevant from perspective of management	Not important; Management; Collaboration; Future work; Planning

Figure 6.2: Categories, subcategories, themes and codes

Opinions in regards to taxonomy and metadata			
	Content and descriptions that are relevant	Publications, topic and leader are important	Subject area; Specificity; Expert; Research groups; Important; Author; Leader
		Tile, author and abstract are useful	Professor; Supervisor; Identify; Value; Important; Second; Third; Interesting; Indication; Figures
		Metadata describing researchers' position is useful	H-index; Citation index; Title; Department; Research output metadata
	Taxonomy and metadata that would support visualizations	Labeling visualizations to support intended meaning	Informant is uncertain; User does not understand the meaning of the visualization; The label is ambiguous ;
		Metadata facets that would support content of network visualization	Foreign contacts; Subject types; Publications; External descriptions
		Fingerprint as metadata would support expert comparing	Would provide comparison of expertise; It would be more efficient
		High-level granularity and specificity taxonomy is relevant	Multidisciplinarity is important; Narrow terms are preferred; Specificity is important; Narrow subjects

Figure 6.3: Categories, subcategories, themes and codes

position, related with research, within his enterprise and academia.

"But then we have this "core tech", which work with development in 3 to 5 years, time-frames. So. . . And this is where I am placed. So we are the people that integrates with research. . . And doing, maybe not research, but close to applied research inside the company also. And this is where I am placed." - Informant 1

Informant 2 has an academic background of mathematics & computer science. He is employed at development company, for optimizing the industry, where he is a product manager. His responsibilities are concept development, product management and business development. Informant 2 has no university-related position, however, he has a university-related position within his enterprise, where he is managing student collaborations from AAU.

"Yes, that is one track. Another track is when you look for, for the last two year more or less, I've continuously has a project team, collaboration, from Aalborg, it could be bachelor students, it could also be Master students." - Informant 2

Informant 3, has a PhD in acoustics. He is employed at high-end innovation company of electronics and audio products, where he has functionalities of managing research groups.

"Right, so I am director research, which means that I have corporate responsibility for our research activities. And I have a research groups consisting of seven, eight, nine, depending." - Informant 3

Informant 3 is also employed at AAU as a part-time industry professor at The Technical Faculty of IT and Design, Department of Electronic Systems and Signal and Information Processing Department. As it can be seen in the table 6.4, informant 1 and informant 3 have double-positions, being employed both by their enterprise and AAU. However, during interview they were asked to reflect on their positions from the enterprise perspective.

Double-positions

One of the criteria for the sample was that the informants should have university-related functionalities within their enterprise. Not necessarily have a double-positions both in academia and industry, instead relation with research. All three Informants have UII related positions within their enterprise. However Informant 1 and 3 have double-positions, which has an effect on their viewpoints, particularly how they perceive university and RIMS. Informants with double-position use RIMS in their academic job context. However, Informant 2 (who has no university-related position) is familiar with RIMS too. However, main difference is that Informant 2 is not using RIMS in the same extent as Informant 1 and 3,

	Industry name and type	Eudcation background	Work title/functionalities	Relation to the university	Sex	Enterprise size
Informant 1	Pump development for delivery water solutions	M.Sc., Control Engineering and Automation Ph.D, Control Engineeing	Chief engineer/ Chief specialist - working with control and supervision systems both at Grundfos and Aalborg University	Industry Professor Part-time Professor, Department of Electronic Systems Part-time professor, The Technical Faculty of IT and Design Part-time professor, Automation & Control	Male	<19,000 employees globaly
Informant 2	Robotic optimization development for the industry	M.Sc., Mathematics & Computer Science	Product manager - business development, concept development, product management	No university related position	Male	<370 employees in Denmark, Sweden and Norway
Informant 3	Manufacturer of electronics and audio products, television sets, and telephones	M.Sc. and PhD in Accoustics	Director research - responsible for resarch activities, managing research groups	Industry Professor Part-time Professor, The Technical Faculty of IT and Design Part-time Professor, Department of Electronic Systems Part-time Professor, Signal and Information Processing	Male	<1,028 employess

Figure 6.4: Overview of the informants and enterprises

therefore, he might have different perception. Still, all informants have positions related with UII, which means, they have an understanding about the phenomenon of UII.

6.1.2 Informants are familiar with RIMS

All three informants have indicated, that they are familiar with RIMS, particularly the AAU Portal - VBN (VBN, 2019). It has been indicated by Informant 3, that RIMS are used in relation to his academic position, however, the use of RIMS is limited to what is demanded from him. Informant 1 have also described the VBN, which means, he is familiar with the portal. However, Informant 1 and 3 have double-positions, where they use RIMS in the academic context, with the purpose to manage their research output. On the other hand, Informant 2, that has no university-related position, but he is familiar with the portal, because he browsed it.

"I report my publications in VBN, but that's about it. But we have to do it in order to fulfill the requirements at the university. But that's about it." - Informant 3
Interviewer: "So you never used VBN to look up an expert?" Informant 3: "No."

"VBN is the research systems, that collects the papers at Aalborg University. . . " - Informant 1

"I actually have browsed Aalborg system, that's the VBN, right?"- Informant 2
.

"So I am not sure, it will really be a good idea with free publications, again, it is too

costly right now. I think it is a real challenge, for use of research in industry, is these high costs. Cause normally, you maybe have to read 10, 15 papers, to find one that you can use. And if each of them cost 50 dollars." - Informant 1

Overall, it has been found that none of the informants have ever used RIMS to look for experts, RIMS are not used for searching academic experts, but rather for browsing and maintaining academic profile. Additionally, it has been emphasized, that the research is being too expensive for the industry, high cost is perceived as the main challenge for not using RIMS.

6.1.3 Scientific publications are important

Informant 2 have emphasized, that he values scientific publications. Likewise, he answered 'yes', in order to confirm, that within company X, they are mostly oriented in solving problems. Informant 1 identify this enterprise as similar to university, because within X enterprise, they know how to use theoretical knowledge. Moreover, study informants are the people, that as part of their job at the enterprise, develop and innovate solutions. They do it systematically and with use of scientific knowledge, from universities. Informant 1 prefers application oriented papers, but he indicates, that people within his enterprise, are not afraid to use scientific knowledge.

"M: Do you see value in research publications? Informant 2: Yes, I do."

"Yes, but again I think there is a difference between large and small companies. We are a look-a-like University within company X, so the people in my area knows how to read this stuff. So, I don't think we this is an issue."- Informant 1

"Of course there are papers who are more concerned with a math, you would sometimes typically jump over those and go for the ones that are more application related. Because they seek to show that this is the solution for something in the easier for me to understand way. Where if it is more mathematical proofs we have to do more work to understand how I can use that. So I would of course go for the easy one, but it's not like people would be afraid of the theoretical part." - Informant 1

It means, that within X enterprise they are not afraid of scientific knowledge. It just takes longer for the X enterprise to learn, how to use it, but it is indicated, that they know, how to apply theoretical knowledge, it is part of their job.

6.1.4 University is using research to create awareness, industry - for solving problems

It is understood that university is oriented towards creating awareness in the world. On the other hand, industry is oriented in solving specific problems. Therefore, there is a different

perception and use of research. Also, informant 1 tells, the he seeks for publications, that are oriented towards solving problems.

"Again, coming from the industry, I am more interested in, does this paper solve a problem. Cause I think that is biggest difference, from university and industry. From university, you are looking for something that creates awareness in the world. When you write papers you want them to be red. Whereas in industry you have a particular problem that you want to have a solution for. And that's where you're going. . . You are trying to find headline and the abstract that fits the problems that you want to solve the most. " - Informant 1

6.1.5 Channels for establishing UII

Personal contacts

Informant 1 and 2 tells, that the primary channels for UII are established via personal contact. Informants 2 describe, that it could be someone that they know at the university, like individuals who manage research groups and that way they provide contacts for the industry actors. Likewise, Informant 1 says, that his personal network is where he finds people to collaborate to.

Basically this has been via main contact, in this case this has been via X person or by X person. So when we have addressed something, or propose something, so basically they have, let say, found whatever persons, that could be suitable or project team that could be suitable. So I have not been picking the guys myself." - Informant 2

"It is typically sufficient, or it has always been sufficient to take the phone, call X or X person, whomever, and then they just resumed, right". - Informant 2

"You were invited into research project, and then you kind found the people you need to work with in these research projects." - Informant 1

It means, that industry Informant 2, who has no university-related connection, still tend to rely on personal contacts, who know the experts at the university and then direct them to the industry. The reason Informant 2 is using personal contact, it is because is sufficient 'to just take a phone and call'. Likewise, Informant 1 is the industry professor, which means, he is involved in the academic life, where he had formed close partnerships with other experts, who are his channel for UII. Overall, their social networks have influence on how they establish UII, that even thought Informant 1 does not have university-related position, he still knows people within university and uses personal channels for UII. This means, it is a common channel.

Internship programs

Internship programs is yet another channel for establishing UII, it can also be perceived as an economic benefit and motivation to establish UII, because students bring academic knowledge during the internship. Informant 2 tells, that students are 'used' as a channel to collaborate with university. Student collaborations perceived as valuable, because they address the problems and/or suggest solutions for the enterprise. Similarly, AAU has a long tradition for collaborating with companies, in order to promote problem based learning (University, 2019). Informant 2 and 3 have mentioned, that internship programs are popular within their enterprises.

Another track is when you look for, for the last two year more or less, I've continuously had a project team, collaboration, from Aalborg, it could be bachelor students, it could also be Master students. So for instance, last year, or actually, I have that also now, I have a person, a guy, from X department, being in, as a trainee here, on his 9th semester, but actually also now, he is on 10th semester. Of course, where he approaches and addresses specific product problems or opportunities, that we identify, and via that student basically collaborate. Yes, so whether we can call that a research project, not really, but still a collaboration, right. So we basically done that continuously for the last two years. - Informant 2

Informant 3 (industry professor), has told, that he did not looked for academic experts. Because, within enterprise X, they have internship programs and usually hire talented experts after the internship process. It means, that enterprise X is getting access to talented students via open internship positions. Likewise, they do not directly hire for positions within the research group, this explains, why they are not searching for academic experts.

"Well, I have not been looking unfortunately, we get applications from all over the world, because we run this internship program. Were the interns are typically in their last or... Close to doing their master thesis project. And what we usually do, that if they are good, we will either hire them to a PhD project, or hire them directly. We just hired two of them directly. As for members in the research group, that consists of people who have done PhDs with us, so I hire them after they did they PhDs. And others have applied directly to me. So we never announced for positions in the research group." - Informant 3

6.1.6 Challenges for UII from the perceptive of large enterprises

Employees have broad competences

It became evident during the interviews, that the problem of 'finding experts' was not perceived as a problem. The uniqueness of this finding is, that both Informant with and without AAU relations have told, that finding an expert is not a problem, however, he does not elaborate on why it is not a problem. Again, it means, that personal contacts are effective. Another

important finding is that, within X enterprise they are using in-house research groups. As a result, Informant 3 have 'never looked' expert for collaboration, because employees within X enterprise can solve problems themselves. Both informant 3 and 1 have emphasized the fact, that employees within their enterprises have broad-domain knowledge and are able to help each other with specific questions.

"No, I think that addressing, or basically being able to find, a person at Aalborg that has a knowledge, really has not been a problem." - Informant 2 (no AAU relation).

No, because we have a fairly board research group, so all of them can sort of work within the area and have knowledge of acoustics, which means, that they can sort of help out as a team they can usually solve the problems. So we have never looked for a specific person to a specific job in the research group. I usually hire them with very broad competences. Of course they all have a PhDs, so they have done a PhD in a specific domain, but in addition they are being trained, so they know all about other domains as well." - Informant 3

It is very rarely, that I have experience that you want to ask a specific questions, except if you know the guy. For example, when I was only at X enterprise and I had a question and I would call X person, or X person, because those were sort of people I knew, if it was a specific question. But I think that is rare, at least in X enterprise, because there are so many people that knows a lot inside the company." - Informant 1

Moreover, it is described, that there are people within the enterprise X, who are a part of an in-house research group, where applied research is done inside of the company. It means, that within enterprise X, they use in-house research, this again explains, why finding experts is not a problem, because they use the in-house research team for doing research.

"We have this "core tech", which work with development in 3 to 5 years, timeframes. So... And this is where I am placed. So we are the people that integrates with research... And doing, maybe not research, but close to applied research inside the company also." - Informant 1

Personal collaborations are preferred

Informant 1 have expressed, that the reason for not collaborating with university, is that within X company they tend to collaborate with persons, that they know. However, it has been not identified, why is it 'hard to find people to work with in the universities'. I understand it as, it is hard to find particular people within university, that they would know and are comfortable working with. Because most of the research is done within the enterprise.

"We say, we want to collaborate with the best, but sometimes it is also very important to

collaborate with the people who are close to you. And then I think it is very hard to. . . It is hard to find people to work with in the universities. But within company X, it is normally by personal contacts. Most, at least half of the staff in "core tech" has a PhD, so they have close collaboration, not only the collaboration, but also contact to universities, and typically this is the first touch point."- Informant 1

UII takes time and planning

Another drawback for UII, from Informant 2 perspective, is that collaboration takes time and planning. The X enterprise is not always able to manage and set back enough time to be able to support university in the collaboration process, it has been described that the challenges are mostly coming from enterprise X perspective. It means, within X enterprise they perceive UII as demanding process, that requires preparation and time, which they 'have not been good at'. It is a busy environment, where it is hard to keep up with requirements and deadlines.

"I think actually, if there has been any obstacles or challenges that basically has been on the enterprise side, on our end. In relation to being able to timely allocate resources and get back information basically, that Aalborg requested." - Informant 2

"So we have actually been a "bottom like", I would say sometimes, right. Where the students and someone worked on something and had some lack or they had a need for information, that we would provide, or I would provide. That sometimes has been a bottom. I think that, of course, you need to commit to collaboration. And also to understand, that from our end it actually requires some effort. That you need to allocate and actually commit. And, it doesn't let say the allocation doesn't really flow, you could say, regularly you need to allocate one or two days suddenly. That requires a schedule that we probably have not be good at. - Informant 2

6.1.7 Physical presence is important when collaborating

Also, it has been found, that proximity is an important aspect when collaborating with the academic experts or/and students. It has been described, that effectiveness of collaboration depends on the presence of internship students or/and researchers and how much involvement they have in the company's activities.

"The reason it is important to have them on a regular basis is that when they are down here they are considered to be employed by X enterprise and which means, they participate in you know all sorts of activities, information meetings and whatever. Which is important for them in order to be and feel, understand what is going on in the company. So the distance of the university, in cases like that, is pretty important." - Informant 3

Interviewer: "So physical presence is important?"
Informant 3: "Yes".

6.2   Pure Portal visualizations

In this section I will present the findings in regards to the graphical visualizations on Pure Portal prototype. I will present positive expression in regards to Pure Portal visualizations, likewise, expressed judgment.

6.2.1   Pure Portal has good graphic exposure and is useful

The overall expressed opinions about visualizations are positive. The first impression of Pure Portal is described as being complex, yet still, Pure Portal is seen as a tool that is relevant for Informant 1 within his enterprise. Furthermore, Informant 2 is familiar with VBN portal, he is referring to it, in order to provide a comparison. It has been described by Informant 2, that visual exposure is much better, than on VBN. It gives me a reference point, also it means, that Pure Portal visualizations are more useful than VBN.

Interviewer: "So if you could just summarized do you think that pure portal is useful from the industry's perspective? For finding publications in seeing the profiles of the experts?"
Informant 1: Yes but I think it might be too complicated to start with, but yes I definitely see this could be useful for the industry."

Interviewer: "So now when you were introduced to a Pure Portal, how would you say that visualizations on Pure Portal promote University - Industry interaction?"
Informant 2: "I would say much better than the current set up. The VBN, or whatever it is called. I think actually, that the graphical exposure, it is quite good."

Interviewer: "So would you say, that Pure Portal, this particular interface is useful in presenting the expertise and the activeness of a researcher?"
Informant 3: Yes, the first impression is good."

6.2.2   Visualizations support cognition

Visualizations are important, because they support cognition

Informant 2 tells why he likes graphical visualizations in general. It is understood that visualizations support cognitive processes, aids the memory, provides interpretation of information and speeds the process of understanding the data. This means, that graphical visualizations

are important, because they support cognition.

"Yes, because for me, when it is graphical, I will have, you could say, a much quicker and parallel interpretation of information, right. So I don't have to, you could day, scantily try to reach, understand whatever. By visually, that could be the graphs, whatever, right. It gives me kind of a parallel quick information overview." - Informant 2

Picture is important for the memory

Because the prototype did not had any pictures presented in the expert profiles, another interesting finding, suggest, that the picture is indeed an important element. It helps to get an impression about the person, also aids the memory.

"For my memory basically. That's what it's for. Because otherwise, again, it would just be a character." - Informant 2
"Because that's for me often, you know, the visual thing getting kind of a figure who is the person." - Informant 2

6.2.3 Positive expressions towards content of network visualization

Network visualization helps to identify experts with similar research focus

Informant 3 tells, that network visualization is useful, because it provides the understanding about experts' research group and who is he publishing with. This information is important when there is a need to identify expert with related research focus. It means, network visualization can help with contacting experts within particular research groups. It provides relevant content.

Informant 3: "I guess it would tell me something about if he is a part of research group, then I guess his research group members will appear in that diagram. And then you could say, okay, who is he most often collaborating with in terms of publications. So it would give an indication of who are his primary collaborators research wise."
Interviewer: "And how is that helpful for you? Would you then contact them?"
Informant 3: "Yes, because I would assume that they have a common research interest. So that could be useful".

Network content refer to other possible collaborators

As described by Informant 3, it is useful to see different 'research units', rather than individual collaborations. 'That is pretty fancy' - this was the expression once informant 3 has been

introduced with research unit network. It is relevant to see, with what research units the expert has been involved in collaboration with, it provides more options to chose from. Here, another expression, related to proximity is expressed, the physical presence is important, when establishing UII.

"Well, that could be interesting. But them would indicate, I mean if we don't, for one reason or another, don't want to collaborate with the Aalborg University, who could be. . . Because Aalborg University is far from us. If there is another university close to us. Then if that university is within this research group, then we could start there, talking to those guys. So that would be useful, in terms of seeing it from the company point of view, the physical distance to the University is actually of importance." - Informant 3

6.2.4 Expressed judgment of network visual presentation

Visual presentation of network visualization is not efficient

Graphical presentation of network visualization is hard to understand, 'it is just a mess, 'I can't navigate in that', as expressed by Informant 2. It means, that network visualization is not efficient, the design is redundant, if it is not being explored.

"I think if you don't click on the individual persons and just leave it there, then it is just a mess. It is. I can't navigate in that." - Informant 2

6.2.5 Expressed judgment towards the content of network visualization

The network content is not useful for the context

Informant 1 express, that the content of network visualization is not useful within the context of his enterprise. The context of use is not useful, if a person already have found expert he wants to contact.

"And this of course shows that this person is working together with this person so maybe I should talk to him also. But if I already have contacted him and he probably knows exactly the same why bother to date another guy. So I have never used it." - Informant 1

There is no lead to explore different experts

The information, presented is 'overkill', because within X enterprise they do not have a lead to explore different experts in specific areas. It means, that the context of use is not seen as

relevant within X enterprise.

"I think... Maybe it is overkill. That from our point of view we are not really... We don't have a lead of explore a lot of different persons to find the specific area." - Informant 2

Network visualization could be useful from the management perceptive

Network visualization was perceived as not useful for informant 1. He indicates, that it is more oriented towards helping the management department to located different experts, universities and departments to collaborate with. This means, that network visualization could be more useful in the context of management, for people who have functions of planning the next steps for the research group within the enterprise.

"I think again if I take an overview this again helped you from a management point of view to find places where we want to work, which we want to work together with." - Informant 1

There is no context of how the graphics were generated

Moreover, informant 2 emphasize, that he does understand intended message of network visualization. However, he does not understand the context of network, he is confused, of what does it actually mean. For Informant 2 it is important to see further information about related researchers. Informant 2 is expecting further information will be presented. His expression indicates, that he did not know, that when you click, then you get extra information "Okay, yeah... Then I get...".

"Well, it basically shows the network, right. So, all the correlations from this persons to other persons. But the definition of "has been working with", I don't know really... Maybe that's, with whom he has made publications, with whom he has 'whatever', I don't know. But it gives a kind of an idea of right... So what is he attached to. And then actually I would also expect that I could click on the other persons' to get further information." - Informant 2

Intended message of network content is not understood

Although, it has been identified by informant 1, that he have seen it before, being familiar with visualization, did not increased his interest or understanding, how it can be useful. Informant 1 does not understand the intended message of content, he express it wrong, instead of collaborated with, he expressed as 'talked to', which is not the intended message of the content presentation.

"I've seen that couple of times, so and I have not really understood what is it good for and how to use it. Because it shows which people... who he he has talked to." - Informant 1

6.2.6   Positive expressions towards visual presentation of fingerprint

Fingerprint has nice graphical presentation

In regards to fingerprint visualizations, the expressions are positive. Informant 1 says, that the graphical representation is nice, however, he does not precisely describe why.

"And I think there is a nice graphical representation as well." - Informant 2

6.2.7   Positive expressions towards content of fingerprint visualization

Fingerprint is useful for identifying subjects' area of expertise

Fingerprint is useful for the industry, it helps to identify the area of expertise. Informant 1 have recognized the 'intended message' of fingerprint concepts, which is - showcasing researcher expertise. Informant 1 tells, that fingerprint informative - is useful for indicating subject knowledge of an expert. However, it lacks accuracy in presenting concepts. Informant 1 was not sure, whether this expert is relevant for his enterprise. It means, terms are not sufficient on their own to define researcher expertise.

"Yes, definitely. Because by this he shows that he is working with an area that could be interesting for me because this is hydraulics, fluids there's something about controllers. However, there's something about hydraulic drives, wind turbines, which might indicate he is working in mobile hydraulics systems. Just not for water transportation, so I would say then you have to look at the papers. But it indicates that you can probably find someone." - Informant 1

Similarly, fingerprint terms, that are listed under the title of publication, serves as a descriptive metadata for the abstract, and helps Informant 3 to determine, whether the publication is relevant for their enterprise.

Interviewer: "Are they relevant, when trying to identify whether this publication is relevant to your enterprise?" Informant 3: Yes, they would be, yeah."

6.2.8 Expressed judgment towards the content of fingerprint visualization

Fingerprint visualization is not self-explicit

Also, fingerprint is presented efficiently, it uses bigger typography to express the importance of subject terms. Also, fingerprint terms are not self-explanatory, there is not explanation, about how particular expert has actually been involved in each disciplinary field. The way fingerprint is presented, is not totally clear. Informant 2 express confusion in regards to graphical representation, he can not tell, whether some graphical elements are bigger than others, as can be seen in figure 4.11. This means, that fingerprint 'intended message' is understood, which makes it informative visualization, however, it does not provide context of use.

"The topics of course are not self-explained, but it gives kind of a clue, right. There are a lot of topics here, a lot of domains and which one for me is the most relevant and how much does this person actually been involved in that area." - Informant 2

"And the graphical representation is that, maybe it is just an optical illusion, but for me they seem with the bigger font, than those. But maybe it is an optical illusion, I don't know, it works." - Informant 2

Fingerprint 'weight percentage' does not provide context about how it was generated

In regards to fingerprint visual exposure, the judgments are related with how weighed terms are presented. The weight percentage on every concept is redundant and does not provide context, is 'difficult', because there is no information on how the weighting is calculated. It means, that the intended message is not understood by the user. Percentage of each subject term is found irrelevant, unless it provides more context, possibility to explore particular. It means, that metadata, with weight percentage is not efficient, it maximizes redundancy, by presenting numbers, that are not relevant nor possible to explore. Also, weight percentage is not relevant to see, the important elements in the fingerprint visualization is the subject terms and the way they are visualized 'more full, less full'.

"First of all for me, I do not know the interpretation and the definition of the weight, right. So for me I think it would be sufficient to just to see the graphical representation of whether it is half full or fuller, whatever. But the specific numbers, whether it's '44' I don't know... It is not really a detail, that is relevant for me. I can't navigate in these numbers, cause I really don't know what they mean. For me it is just, is it much relevant, less relevant or a big relevant. That would be sufficient." - Informant 2

"Not very much for me. It is difficult." - Informant 3

"And if I chose to dive into it, right, then I can get the numbers. Of whether what's '44' or whatever. So it gives me a divide and conquer, so that is what graphical representations are suitable for. At least for me." - Informant 2

6.2.9 Positive expressions towards content of research output visualization

Research output visualization is a useful measurement

Presentation of content of research output visualization, in the profile section, is perceived as useful and helpful for judging experience and activeness of the expert. Research output helps to determine the level of expertise and position within academic organization, provides quick look into publishing history. However, research output, presented as a part of metadata in the profile list, is too small to be informative.

"For me, it probably show his activities, so how active has he been. So that would give me a kind of idea of that. Plus it would also give me a kind of background, his history, right. Very quick overview of how much ballast has the person had and how experienced is he, in terms of volume of research." - Informant 2

Interviewer: "What about his one here? The research output visualization, does that help you to decide or does it affect your judgment when choosing a person from this list?" Informant 3: "It is very small... So what does it say down there?"

6.2.10 Expressed judgment towards the content of research output visualization

Research output description is relevant from perspective of management

It has been emphasized by informant 1, that research output is not important for him as an individual, who is a developer. Informant 1 indicates, that metadata, that provides description about the title and abstract is the most important for finding relevant publications and then the experts. It means, it is not relevant within this context of use.

"This is something interesting for the University. I don't see it is very important for me as a developer. This is important - the title and the abstract and finding the right title and the right abstract in the easiest way is the most important for me. " - informant 1

6.3 Opinions in regards to taxonomy and metadata

In this section I will present the findings of relevant categories and metadata, as perceived by the informants' and the judgments/requests for the categories and metadata, that would support graphical visualizations.

6.3.1 Content and descriptions that are relevant

Publications, topic and leader are important

The findings suggest, that category 'publications' is a relevant category when there is an intention to locate experts on RIMS. Informant 1 and 3 have said to look for relevant publications, in order to identify universities and researchers groups that are publishing within the field, that is relevant for their enterprise. It means, that the topic metadata is more important, than the researcher. But the subject leads to findings a researcher.

"I would go for the publications and find the experts in the area. I would go to the specific area to see what has been published in that area. Who has published it and then try and identify certain universities or research groups that are working within the area where we are interested." - Informant 3

"Then I will definitely start here (starts with publications category in the landing page). Most definitely. I would look for relevant publications. " - Informant 1

When starting an actual collaboration, Informant 3 describes, that the individual is then more important than the research group. And then the important step is then to identify the leader of the group, because it tells about the researcher qualities. This means, that relevant categories are 'research groups' and the 'leaders' of the selected publications. Also, Informant 1 have said, that the topic is an important category, when searching for publications, more than the index of citations.

No, not when it comes down to starting an actual collaboration. But as you know, I mean, many publications will be by PhD students with the professor or supervisor second or third author. So, the actual content, I mean the topic that they are working on, that's the important point. And then of course, identify, who is actually then the leader of the research group, or the leader of that particular research group. " - Informant 3

"I sometimes look at citations, because it might show that they have some value. But it is not the main. . . It is the topic." - Informant 1.

Tile, author and abstract are useful

Informant 1 and 3 have expressed the importance of descriptive metadata, when searching
for publications, the most important metadata is the 'title', 'author' and the 'abstract'. For
informants it is important, because the abstract indicates the relevance of the publication to
a given problem that needs to be solved. The title and the abstract helps them to judge if it
is an interesting subject and, whether, the publication is theoretical or application oriented,
also whether it is relevant. Still, reading the paper is necessary, in order to fully understand,
whether the publication is relevant, but it helps for 'fast look through'.

*"It gives an indication abstract, together with fast look through helps. Normally, I also
like to see a couple of equations enter figure maybe then I have the feeling of where this is
going sometimes and sometimes not. Yeah, but evaluating I think the title is more important
than the abstract, the title shows that this has a content that is interesting. I look at it and I
typically not only look at the abstract, at least also figures and hopefully a few equations and
this is sometime problem because sometimes you have to pay before you can look at that." -
Informant 1*

Also, it has been emphasized by Informant 1, that *"Finding the right title and the right
abstract in the easiest way is the most important"*.

*"I need to read the paper to find out, if it is relevant or not. So I would go for the title
and the authors." - Informant 3*

Metadata describing researchers' position is useful

It has been found, that citation index is a useful description, that helps to identify, whether
researcher is the expert or a professor or, a PhD student, it also 'would help to identify sort
of who are the key supervisors or leaders of the research group'. Similarly, h-index helps
'to identify who are the key scientific persons in this publication. Because the PhD students
would have a lower index'. This means, that citation and hirsch indexes as useful metadata
and judges the level of expertise accordingly.

*"So if I click on various authors of publications, that citation index would help to identify
sort of who are the key supervisors or leaders of the research group. Because the PhD
students would have a lower index. So I use that to identify who are sort of the key scientific
persons in this publication. - Informant 3*

As well, when users search for academic experts on Pure Portal, they are presented with
the list of profiles (as can be seen in the figure 4.3). It has been found, that the 'title' and the
'department' is useful descriptive metadata when choosing the expert from the list of results.

"I would look at his title and his department. Definitely. I would look at the title and department." - Informant 1

In addition, the 'research output icon' under the profile, is perceived as a useful metadata by Informant 3, that gives 'an indication of whether that's a PhD student or more'. Also, as Informant 3 told, it describes how active the researcher is and that helps to choose an expert from such list.

"Okay, so yes, that would give an indication of whether that's a PhD student or more. That would definitely be helpful to distinguish between publishing in this area or perhaps he is less active." - Informant 3

6.3.2 Taxonomy and metadata that would support visualizations

Labeling visualizations to support intended meaning

In regards to labelling (describing) visualizations, it has been emphasized, that the label 'network', describing network visualization is not clear. The label does not represent the intended message. Likewise, Informant 3 suggested to revise the label and describe it with a term, that would communicate a clear 'intended message'. It means, that the label is ambiguous, it can be associated with many different meanings.

"Please call it what it is, because the network is a lot of stuff. It could be people he played football with. But if it is his co-authors, then that is important." - Informant 3

Metadata facets that would support content of network visualization

Similarly, it has been found that it would be useful to see a metadata facet 'international contacts', it would support informativeness of network visualization, provide new knowledge to the industry. As it has been outlined earlier, network visualization is useful and informative, particularly, network of research units. Also, it would be useful to see research units, that have collaborated on specific 'subject types', 'publications', that are relevant for the enterprises. It means, that network visualization, supported with metadata facets would support informativeness.

"Do you have any possibility for indicating in his network, how many foreign contacts, not national, but foreign contacts he had?" - Informant 3

"Has Department of Computer Science in Aalborg, working together with Fraunhofer in

Germany on this specific topic, right, that has my interest". - Informant 2

"So, if this was not just general, you could say, a general description of what faculties have been working with whom, but if it could be narrowed down within this subject I type, of augmented reality. Then, which departments have then had any kind of collaboration. Then it actually would be useful." - Informant 2

Moreover, for Informant 3, it is important to see information not only about internal collaborators, but also the external individuals. It is useful to see 'where the person belongs', it means, that information about what university, faculty would be relevant to see.

Informant 3: "But if you click on that particular person, you can see where that particular person belongs." Interviewer: "Yes, but only because they are in VBN database." Interviewer: "Yes, but of course it is an information that could be added to the database. And of course we note that you ask for this information."

Fingerprint as metadata would support expert comparing

In regards to metadata, that describes researcher profiles in the result list (figure 4.3), a useful metadata that would support quick expert identification from the list, would be fingerprint subject terms. When asked, how informants can identify the right expert for their enterprise, it was expressed by informant.

"I would need a fingerprint of each of these researchers, perhaps on the first three or four. Because then I would avoid having to click on each of them." - Informant 3

It means, that primary fingerprint concepts would be sufficient to describe researcher's expertise, it would provide a quick comparison and expert identification from he list.

High-level granularity and specificity taxonomy is relevant

In regards to fingerprint terms, specific and narrow subjects are more informative than broad categories, it is not relevant to see the domain of thesaurus vocabulary. It means, that narrow subject terms are preferred more than broad subject categories. Which means, that taxonomy with high level granularity is important for informants. Likewise, terminology 'around business processes'.

Interviewer: "What about the division in sort of disciplines, material science, engineering, physics, astronomy? Does it mean something for you?"
Informant 3: "No, not really. I mean, what I am interested is, has X person published in areas that I am interested in. Whether it is an engineer or in physics or in life sciences that

is not that important."

Interviewer: "And again, this is a clarifying question, it is because, to be good in your business in your industry multidisciplinary is an important factor?"
Informant 2: "Yes, it is. Very important, I think we recognized that, not recently, but yeah. . . That is not just a question of nerd technology and computer science or electronics, but it is also the process around the business, a lot of stuff really in this area."

6.4 Summarizing findings

All in all, informants perceive Pure Portal as a useful too for the industry, however, they do not use RIMS to look for experts. It suggest, that once industry is introduced with RIMS, they find it useful. Generally, to find experts was not indicated as a problem, because industry is using personal contacts for establishing UII. X enterprise perceived themselves are similar to universities, because they can use scientific publications and apply research. Also the main challenge for using RIMS to find publications, is that research is expensive. Graphical exposure is recognized as good. One of the most important graphical element seems to be the fingerprint, however, weight percentage is not efficient. The most important information on a network visualization is different research units. For the industry, relevant categories are 'publications' and 'concepts'. in general, industry is multidisciplinary, therefore, taxonomy with high level of granularity is useful. Citation index and h-index, is important metadata, also the 'title' is important to determine the usefulness of the publication before reading the abstract and the publication. Similarly, it is important to identify 'research groups/units' and who is the 'leader' of the publication/project. 'Research output' icon, as a metadata is useful and relevant to determine, how active researcher is. Precise labels, expressing the meaning of the visualization are important. The label 'Network' does not communicate a clear meaning of the visualization, it was suggested to relabel visualization. The useful metadata that would support visualizations would is 'international collaborations', collaboration between the research units according to the 'subject' or 'publications'. Also, further information about external individuals is important. Also, fingerprint as metadata, would support quick expert comparison.

7 Discussion

In this chapter I will first discuss the interview findings both in relation to both the LR and RQs. Lastly, I will answer the RQs and discuss the limitation of the study.

7.1 Discussing the findings

In this section I will present the findings in relation to LR, where I discuss similarities, differences and unexpected findings, in relation to thesis LR. Additionally, I will present interview findings, in order to provide suggestions for improving informativeness of graphical visualizations by the use of taxonomy and metadata. Afterwards, I will answer the RQs of the thesis.

7.1.1 Discussing interview findings in relation to literature review

The analysis of the interview study has revealed some similarities between the literature review and the interview findings. The size of the enterprise has an effect on the absorptive capacity (Freitas et al., 2012). Informants' from enterprises perceive scientific knowledge as relevant and are 'not afraid' of theoretical knowledge. Scientific knowledge is important for them, they use it solve problems, but are more oriented towards application oriented research. As opposed to university, that is using research to 'create awareness in the world'. As it has been found in LR, university is perceived as 'a different working environment', which would result in risks of failure of UII (Ankrah & AL-Tabbaa, 2015). However, the interview findings extend the previous research with an unexpected finding, because within company X they perceive themselves as 'look-alike-university' and are familiar with scientific knowledge. Moreover, interview findings suggest, that within enterprise X, informants using in-house research groups and tend to solve problems themselves. This finding was unexpected, because, according to the LR, large enterprises tend to use collaborative research programs, rather than in-house research, because it is cheaper (Ankrah & AL-Tabbaa, 2015). Another interesting finding is that, for large enterprises it is important 'to collaborate with people that they know'. This is similar to the LR finding, that sometimes it is not the expertise or the qualities of an expert that matters, but the 'personal traits of the academic expert' (Alan Collier & Ahn, 2011). Another similarity found in both LR and interview study, is

that enterprises are using 'personal contacts' as a channel for establishing UII (Ankrah & AL-Tabbaa, 2015).

The LT suggest, that the challenges for effective UII, is the 'difficulty to make contact with the university' and to identify the right partners (Freitas et al., 2012). However, an unexpected finding was that finding an expert for collaboration and/or making contact with university was not perceived as a problem by the informants. I believe, it is could be due to the fact, that informants have close collaboration to AAU. All three informants have maintained a close collaboration to AAU during their professional life, through internship programs, the explanation to this connection can be the AAU tradition of problem based learning, motivating companies to collaborate with students, in order to provide real-life cases. Likewise, the unusual finding, according to the thesis LT, is that enterprise managers found it hard to 'identify skills, their firms needed and then to develop personal relationship with academic experts' (Ankrah & AL-Tabbaa, 2015). It has been mentioned by Informant 1, that network visualization would be useful from the perspective of management, it would help to plan next steps, 'places where we want to work, which they want to work together with'. This could be a new perspective for the future studies.

During the interview it has been found, that when looking for academic experts, informants start to the search in the category 'publications'. They search by 'concepts' and 'topics', the specific topics within their domain are important for the informants, because it is the first step, towards finding relevant experts. The second step for the informants is then to be able to quickly identify, who are the 'leaders' of the publications, or who is a part of a 'research group', because these are the experts, that informants would aim to get in contact with. The LR have similar findings, it has been found, that the information, presented in 'subjects' is important for the enterprises (Løkkegaard, 2018). Informants have said, that having fingerprint visualization, that is showcasing researcher expertise, is useful and relevant. Similarly, it has been found in the LR, that presenting professional expertise is important for the enterprises (Alan Collier & Ahn, 2011). Moreover, Informant 2 have identified, that 'multidisciplinarity' is important within his enterprise. Therefore, specificity and high-level granularity taxonomy is important, to support subject concepts and rich descriptions of researcher expertise. Also, informants have said, that metadata, such as citation and h-index, that describes, how active and credible the researcher is, are important for them. Likewise, in the study of expert finder systems, it has been found, that enterprises find it useful to have metadata about citations, h-index, awards and grants, because it helps them to judge the credibility of an academic (Yimam-Seid & Kobsa, 2003).

Informant 2 have said, that the graphic exposure is important and useful, 'it helps the memory', and with the 'interpretation of information', otherwise it is 'just a character'. Similarly, in the LR, it has been found, that visual presentation 'catches attention', it means, that visual exposure is important (Løkkegaard, 2018). It means, that graphics support

cognition, it is much easier to perceive than the textual information (Scheniderman, 1996). In addition, informant 2 have said, that profile picture is important, because it 'gives an idea of what the person is'. Likewise, presenting researcher profile picture have been found to be important within the expert finder systems (Yimam-Seid & Kobsa, 2003).

7.2 Discussing the interview findings in relation to research questions

In general, it has been found that Pure Portal is useful for the industry, it has a good graphic exposure for showcasing researchers profiles. Elsevier is effectively showcasing researchers expertise, their research products and network, visualizations are novel. Likewise, the intended message is understood. Similarly, network, fingerprint and research output visualizations are useful and relevant. Moreover, Elsevier is using relevant taxonomy - categories for navigation support, in order to facilitate the academic expert search via categories, such as 'publications' and 'concept' search. Also, the 'concept' search is supported with high-level granularity taxonomy, which is relevant. Likewise, Elsevier is using useful metada, in order to describe researchers and their position, such as 'title', 'department', 'research output icon'. Also, to describe how credible the researcher is, by using metadata, such as citation index and h-index. On the other hand, Elsevier have challenges with visual presentation on Pure Portal. The graphic visualizations are not informative, does not provide the context of use.

It is evident from analysis, that network and fingerprint visualizations does not provide clear context and the intended message in not understood. Elsevier should work on improving informativeness of graphical visualizations, metadata should inform user about intended message of visualization. Network visualization lacks aesthetics - it is not efficient, too clustered with lines, 'not possible to navigate'. Also, it is important to efficiently identify, who are the leaders of the publications, because these are the experts that are would be relevant to contact. Elsevier should provide a metadata label, so Pure Portal user can describe his/her contribution to the publication, whether he/she is a 'leader' or 'co-author', or whether there is an equal intellectual contribution to the paper. Likewise, the informativeness network visualization can be supported by providing metadata, that would provide information about different research units, in relation to collaboration on a 'specific subject' or relevant 'publications'. There, it is critical to have a high-granularity taxonomy, to support multidisciplinary, that is important. Granular, rich taxonomy with diverse categories, related domain-specific terms, would provide subject and publication selection by topic, ensuring that user can find relevant term. Similarly, informativeness of network visualization can be supported by metadata facets, which provide information about 'international collaborations' between universities, also further information about external researchers, who are not the users of Pure Portal. In addition, 'network' is a confusing label, associated with different meanings, the intended message of visualization is not described clearly, it has been suggested to relabel 'network' to 'co-authors'. Elsevier should revise/create controlled vocabulary for including and managing

labeling systems to avoid ambiguous terms and provide more built in meta-communication and explanation in the interface.

Moreover, graphic exposure of fingerprint concepts is unclear, informant 1 have said, that it is unclear, whether typographic is actually bigger for some concepts or it is just an illusion, as can be seen on figure **??**. Therefore, Elsevier should revise the graphic design, making more clear what they present as more important, or less important concepts. Furthermore, metadata, that supports fingerprint visualizations, is not self-explicit. Elsevier has to find a solution, in relation to explaining the context of the fingerprint concepts and how weighting is generated. Fingerprint concepts do not present the expertise accurately, it is evident from the interviews, that Informant 1 could not comprehensively identify, whether the expert is relevant for his enterprise, because some concepts were not related to his field. Therefore, Elsevier should revise fingerprint thesaurus, in order to make sure, that vocabularies indeed have domain-specif terminology and that terms have genuine relationships. Also, Elsevier should inform their clients and the end-users, that in order to have a full picture of fingerprint, it is important that the abstract is uploaded together with the publication. The problem now is, that because of lack of abstracts in the database, fingerprint can not be considered as accurately presenting expertise.

In regards to descriptive metadata, implementing fingerprint concepts, expressed as metadata, under the expert profile in the search list, would be useful description that would allow to compare different experts, without needing to click on each of them. Also, it has been found, that research output (presented on the right corner, besides the profile picture), is not efficient, it is too small, in order to be efficient. Moreover, picture is important for the memory and helps to form an idea about the person. Therefore, Elsevier should inform Pure Portal clients about the importance of having picture on their profile.

7.3 Answering research questions

RQ1. How can we visually/graphically present researchers' profile data to the enterprises with the purpose to facilitate University – Industry Interaction?

The analysis findings suggest, that in order for graphical visualization to facilitate UII, it has to be informative. It means that, visualization must communicate intended message, answer questions, that are relevant for the industry. Also, provide new knowledge and the context of using the knowledge. The information should be prioritized as opposed to design. Once visualization relevant informativeness, it should then have a balance between novelty and efficiency, in order to be graphically aesthetic. Likewise, visualizations should present context of use and information in the most efficient way, in order to support UII. The study found, that some content, presented on current visualization is relevant, however, some is missing. The academic expertise, individual and research unit collaborations, volume of the

publications has been found to be the useful content. However, according to the analysis findings, more specific content is missing. Study suggest, that the content about collaborations with international universities or international individuals, collaborations between universities on a specific scientific subject would be useful for facilitating UII. The study have found, that graphic visualizations, that can be explored, are more relevant, than those, who do not provide exploration. Also, visualizations, that use graphic elements for enhancing what is more important, are perceived as useful and more efficient. Also, minimizing visual cluster, by reducing redundant graphical elements, such as lines or numbers, can be a way to make visualization more aesthetically attractive. This leads me to the RQ2.

RQ2. How can we design metadata scheme and taxonomy so that it supports graphical visualizations of researchers' profile data?

In order for graphical visualization to be informative, it must be supported by useful metadata, that express clear meaning, answers questions and provide knowledge. In order to support visualizations, labels must clearly describe the intended message and provide meta-communication to support context of use. Taxonomy should avoid including ambiguous terms, instead, it should maintain specificity and a high-level granularity taxonomy. Taxonomy must provide multidisciplinarity within the enterprise domain, this way supporting informativeness and thus graphic visualizations. Study found, that useful taxonomy and metadata is used in Pure Portal. Category 'publications' is relevant for searching experts, also, category search by 'concept' and 'topic' is useful. Metadata, describing 'title', 'department', 'individual and research unit collaborations' are useful, informative descriptions. Also 'citation index', h-index', is useful metadata, that supports credibility of an expert. However, according to the analysis, some taxonomy terms and metadata are missing. It has been found, that metadata describing the 'leaders' would be useful, because it is important to identify who are the main experts of the publications. Also, metadata that would support network visualization, providing metadata facets about 'international collaborators', and department collaborations between the 'subject' would be useful information. Likewise, it has been found that metadata providing information about external individuals, who have collaborated with the expert, would support informativeness of network visualization. Moreover, labelling should be more user oriented. The study found, that labeling system is not specific enough to support visualization, 'network' was a confusing label, not describing the intended meaning of visualization, which is to showcase co-authors. Also, it has been found, that context of use is not supported by visualizations, fingerprint terms are not self-explicit, therefore meta-communication could be included, providing description of how graphics have been generated.

7.4 Limitations of the study

The imitations of the study are related with the small number of interview informants. Larger number of interview participants would have made the study stronger and thus more valid, however, getting in contact with enterprises was difficult. However, industry informants have been sampled with the purpose, they do have an interaction with the university and the need for UII and experience. Due to they experience both with UII and RIMS, they have an idea, of what is useful knowledge. Informants have expressed similarities in their answers and provided relevant, detailed insights and feedback. The fact that two of the informants are both part time professors and enterprise persons can be seen both as an advantage, because they have knowledge and experience. And a problem, because they have specific knowledge because they are close to university.

Limitations, related to the LR of the study are existing. There are lack of studies that would address phenomenon of UII in a narrow context and/or from the large industries perspective. Publications, such as Løkkegaard (2018) and (Alan Collier & Ahn (2011) were included in the LR, because they investigate UII in a detailed context, however, only from perspective of SMEs. It have, to some extent, limited the ability to obtain knowledge about the UII phenomenon, specifically from perspective of large enterprises.

8 Conclusion

In this study, I have explored the phenomenon of UII, in a narrow context and from the perspective of large enterprises. The motivation for the research has originated from society. Increasing numbers of scientific publications, that address UII, indicate the rising interest to address challenges for UII. The problem are for UII, is that it is hard to contact university and find experts to collaborate with, however, presenting data visually could useful for the eneterprises. The thesis have asked research questions: How can visually/graphically present researchers' profile data to the enterprises with the purpose to facilitate University – Industry Interaction? How can we design metadata scheme and taxonomy so that it supports graphical visualizations of researchers' profile data?

In order to understand the phenomenon of UII, I have conducted LR and carried out a research interview. Thesis is influenced by the theoretical perspectives of interpretivism, using methodological approach of phenomenology. I have gathered rich feedback and insights of the interview informants, in their natural work context. Elsevier has been used as a typical case in this research study. With growing societal pressure for universities to present research impact, RIMS became important tool to present and measure researchers' level of expertise. Elsevier's Pure Portal, was used as a prototype because it aims to showcase professionals' profiles and increase collaboration between universities and organizations. Convenience/purposive sample method was used, in order to get in contact with informants from large industries. Three representative from three large engineering companies were selected for the research interview. Interviews provided detailed expressions, insights and feedback in regards to graphical visualizations, taxonomy and metadata on Pure Portal. The seven staged on an interview inquiry was used as a research method to plan and execute the interview study, where I could reflect on 'why' to conduct and 'how' to plan an interview and design the questions. Also, thematic meaning condensation method was use to analyze transcription protocols, it has helped me to reflect on specific meaning units, that must be included in the analysis process, so that RQs could be answered.

The essential finding of the thesis, is that typically identifying or establishing UII, is not perceived as a problem by informants, as opposed to LR findings. This is a result of close personal connections with individuals within academia or the in-house research groups,

because it is preferred to collaborate with the experts that familiar. Personal contacts the most efficient channels for interacting with experts within university, as opposed to RIMS. Moreover, visualizations are important and useful for the enterprises, they provide 'quick interpretation of information'. Most importantly, it has been found, that graphic visualizations must provide the context of use, communicate intended message and be efficient, in order to support UII. They must provide answers that are relevant for the enterprises. The study has found interesting findings, in relation to taxonomy and metadata. Metadata should support the descriptions of the visualizations, providing meta-communication about the context of use and how graphics have been generated. It has been found, that in order to support informativeness, labels should clearly express the intended message of the visualization. For the interview informants', the important categories for looking up the experts on RIMS are 'publications', 'subject' and 'topic'. Likewise, multidisciplinarity is important for the industry, therefore, taxonomy should include high-level granularity domain-specific terminology, to support informativeness. Furthermore, useful metadata descriptions of academic experts are the 'title' and 'department' and 'leader'.

All in all, the findings have provided understanding about UII from perspective of large enterprises, in relation to graphic exposure, taxonomies and metadata on RIMS. It is known from the findings, that in order to facilitate UII, graphic visualizations must be informative. Informativeness can be supported by descriptive metadata and high-level granularity and specificity taxonomy. It is known, that RIMS are perceived as expensive and complex to start with, but a could be useful tool for the industry. However, RIMS are not used to search for experts, because strong channel for establishing UII are the personal connections and the preference to collaborate with the people that are known. It is a part of organizational culture and considered to be sufficient form of interaction. Thesis have contributed with new findings and nuances to UII field from perspective of large enterprises, in the narrow context that point to new directions for future research.

8.1 Methodological considerations for the future

Further work could explore UII from management perspective. The interesting finding, according to the thesis LT, suggest, that enterprise managers found it difficult to 'identify skills, their firms needed and then to develop personal relationship with academic experts' (Ankrah & AL-Tabbaa, 2015). It has been described by Informant 1, that network visualization would be useful from the perspective of management, because it would help to plan next steps, 'places where we want to work, which they want to work together with'. Therefore, industry professionals, who have management/planning positions within their enterprise, could be a relevant sample for the study, in order to explore, how useful/relevant RIMS from a different sample perspective. Also, other Danish or international universities could be sampled.

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A   Appendix

A.1   The overview of selected publications

In this section I will present the publications, that were selected for the systematic review. I will describe the methodologies, that were used in the studies, their context and why they were significant to my study.

"A Systematic literature review of UK university - industry collaboration for knowledge transfer: A future research agenda", Thais Elaine Vick and Maxine Robertson (2017)

Thais Elaine Vick and Maxine Robertson (2017), have conducted a LR study within the field of UII, within the context of knowledge transfer between the two. The review focuses on challenges, motivations, activities and outcomes in relation to knowledge transfer. Publications included in the systematic review are from 1995 to 2015. A systematic review provide rich descriptions of the publications. Using thematic analysis they report the findings. Authors stress that since 1980's there has been a rapid increase in the number of publications of the U-I interaction field (Vick & Robertson, 2017). Findings from thirty five studies are presented in the review in relation to U-I interaction. The publication is included in the thesis LR study, because it provides both university and industry perspectives on UII. Also study emphasizes the fact that there is a lack of studies of UII in a narrow, this way it proves the relevance of the thesis.

"Universities—industry collaboration: A systematic review", Samuel Ankrah and Omar AL-Tabbaa (2015)

The systematic review aims to deepen the understanding of U-I interaction. Authors stress, that the UII related research is still very fragmented and lacks a broad view (Ankrah & AL-Tabbaa, 2015). The aim of the systematic review in this publication, is to examine the existing literature within the field of UII. The review has been conducted between 1990 and 2014, because UII before 1990 was taken less relatively important (Ankrah & AL-Tabbaa, 2015). Authors used databases such as Scopus, Web of Science, Ingenta, NetEc and chose 109 studies from over a 1500 retrieved (Ankrah & AL-Tabbaa, 2015). Systematic review presents the key aspects of UII from both university and industry perspectives, which are relevant for

the thesis, in order to understand phenomenon of UII. The letter review compares motivations of university and industry in relation to U-I collaboration, which are useful findings for the thesis, because they help to understand what drives UII.

"Disseminating scientific knowledge to small and medium-sized enterprises", Sarai Løkkegaard (2018)

Dissertation by Løkkegaard (2018) investigates ways how to disseminate scientific knowledge to the enterprises. Dissertation explores different enterprises based in Denmark, Northern Jutland region. Author investigates the field of UII in a narrow context. Author explores how to promote scientific knowledge to SMEs. Study investigates the relevance of VBN Aalborg University's Research Portal for knowledge seeking. Number of mainly exploratory studies, examine how current knowledge is presented to SMEs. Also, how SMEs seek for new knowledge, find ways to organize scientific knowledge on a current RIMS, according to user needs. The main focus of the dissertation by Løkkegaard (2018) is to suggest pathways for knowledge dissemination. Dissertation contributes to the knowledge of preferred dissemination pathways, also what makes knowledge accessible, understandable, relevant and usable for enterprises. It examines the preferences of SMEs, describes and categorizes existing challenges for promoting scientific knowledge (Løkkegaard, 2018). It is by far the only study that explores the needs from a perspective of the enterprises, in terms of how to present scientific knowledge on RIMS. Let alone, dissertation by Løkkegaard (2018) has influence on the current thesis, because it has a similar context and methodology. It explores the phenomenon of UII, with the goal to promote knowledge to enterprises based on Northern Denmark, author evaluates RIMS during an interview study. The findings of the dissertation helps to me to understand, the preferences of enterprises when using RIMS, therefore, the dissertation is included in the thesis LR. However, author does not examine what specific elements are useful/relevant for the enterprises, therefore, I see a gap, where my thesis can contribute.

A.1.1 University–Industry Interaction Trends in the Baltic Sea Region: A Bibliometric Analysis, Elena Murashova and Valeria Loginova (2017)

The study is analyzing and summarizing the level of scientific interest of researchers from Baltic Sea region. The study aims to measure publications, that assess the field of UII, also joint publications between university and businesses. Study conducts bibliometric analysis, that is based on joint studies and published results between university and industry. Scopus data base is used to identify abstracts, that address the filed of UII or joint international collaborations (Scopus, 2019). The study was limited to only one literature database, therefore, authors stress that statistical error should be considered (Murashova & Loginova, 2017). Bibliometric indicators including the year of the publication, subject area and documents by country were used in order to quantify the number of publications (Murashova & Loginova, 2017). Paper examines the trends in scientific publications on the issue of UII in the countries

around the Baltic Sea (Lithuania, Latvia, Estonia), the Nordic countries (Denmark, Sweden, Norway, Iceland and Finland), northern Germany, Poland. Although, paper does not directly address the issues of UII from a perspective of industries, findings are relevant and present the growing interest of UII field, also the leading countries in UII publications, the industrial are of collaboration between university and industry.

A.1.2 "Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit", S.N. Ankrah, T.F. Burgess n, P. Grimshaw and N.E. Shaw (2012)

Study examines university - industry interaction in five major case studies from the UK Faraday Partnerships. In 1997, the UK government established the initiative and financially supported the departments of trade, engineering and physical sciences, the trade was named after Michael Faraday, 19th century physicist, who has been actively engaged in collaboration with the industry (S.N. Ankrah & Shaw, 2012). The aim of the trade is to encourage closer contact and knowledge exchange between universities and businesses (S.N. Ankrah & Shaw, 2012). Authors examine five case studies from Faraday partnerships by conducting semi-structure interviews with university and industry actors. Authors stress that motives of both university and industry correspond (S.N. Ankrah & Shaw, 2012). Study contributes with LR of academic engagement with industry, it examines motives, outcomes and drawbacks of individuals involved in knowledge transfer. Primarily, study concentrates on an individual, rather than organizational level for initiating the collaboration (S.N. Ankrah & Shaw, 2012). As it is stressed, individual actors are considered critically important for knowledge transfer (S.N. Ankrah & Shaw, 2012). In addition, authors focus on intermediaries, in particular technology translators, who initiate and facilitate the interaction between the university and industry, because two groups exist in different domains, therefore, need a third party to translate between the two (S.N. Ankrah & Shaw, 2012). Paper is included in the thesis LR analysis, because many of the current studies focus only on academics side of motives, there are limited number of studies that would investigate both perspectives (S.N. Ankrah & Shaw, 2012).

A.1.3 "Enablers and barriers to university and high technology SME partnerships", Alan Collier, Brendan J. Gray and Mark J. Ahn (2014)

A case study explores the enablers and barriers of UII and analyze SMEs in the field of electronics based in Australia. It investigates how industry actors establish contact with university, also the challenges in relation to UII. Triangulation is used as a method for data collection, it involves interviews with electronic industry commercialization participants, documentary evidences from firms, that have participated in UII (Alan Collier & Ahn, 2011). High technology case study companies were selected from a group of small to medium enterprises. In depth semi-structured interviews were conducted with the CEO of each of the companies followed by thematic coding for data analysis. Study contributes

with knowledge from the industry actors. Describes how industries establish the contact with university, stress that collaboration depends on the personality traits of the academic expert (Alan Collier & Ahn, 2011). It has been emphasized, that expertise of researcher are more important, than the actual status of the university (Alan Collier & Ahn, 2011). Study proves to be relevant, because it presents the perspective of enterprises and delivers interesting findings in regards to how they chose academic partners. The paper therefore, provides relevant findings about what are the useful and interesting aspects for enterprises when they establish UII.

A.1.4 "Finding the right partners: Institutional and personal modes of governance of university–industry interactions", Isabel Maria Bodas Freitas, Aldo Geunac and Federica Rossie (2012)

Study examines UII in the institutional mode, mediated by the university and administrative structures. Also in the personal form, mediated by the personal contractual modes. Authors stress that previous studies that have investigated the UII, have overlooked the interaction that is happening between university and individual academics (Freitas et al., 2012). Study argues, that the choice of which form of cooperation to adopt, involves different decision making processes of the firms (S.N. Ankrah & Shaw, 2012). Representative sample from Italian firms are examined in their characteristics and strategies of interacting with universities under the different modes. Study presents relevant findings for the thesis - differences between large and small industries and their preferences in different types of collaborations with the university.

A.1.5 "Locating Expertise: Design Issues for an expertise locator system", Kate Ehrlich (2003)

The paper by Kate Ehrlich (2003) address the importance of expertise locator systems. Author presents the benefits of having expert finder systems for the organizations, also the requirements for such systems. Paper stress the importance of maintaining the personal profile up-to-date. Also, the design of the expert systems and the organizational issues for maintaining the system. Moreover, taxonomy creation for such systems is presented as an advantage (Yimam-Seid & Kobsa, 2003). A high level granularity or a simple taxonomy that present different levels of knowledge can be used in expert finder systems (Yimam-Seid & Kobsa, 2003). Requirements from several large multinational companies, (internal system design and development) have been gathered to create a design analysis for expertise locator system. The paper is not addressing University - Industry's interaction directly, but it does provide an information about what metadata is relevant on RIMS, in order to support academic expert profiles. Because the study examines presents the findings from perspective of large companies, it is considered relevant, in order to understand, what type of metadata is relevant for the industry actors. This way, it is relevant for the thesis, because it provides an understanding about the phenomenon of UII.

A.2 Literature review publication list

Database	Retrieval date	Search query	Title/author	Subject area	Publisher/publishing date	Type	Review Status
https://www.aub.aau.dk/	11/02/2019	University - industry AND interaction (in all fields - title and text)	"University-industry research collaboration: a model to assess university capability" Giovanni Abramo, Ciriaco Andrea D'Angelo, Flavia Di Costa	Investigates three factors (size, location, research quality) for university - industry (U-I) collaboration in Italy. The exellence of the university is the most important variabnle for I-U collaboration. Also, notes that larger enterprises are more active in collaborating with Universtiy.	Springer Science, Business Media, B.V. 2010	Paper	Excluded - study does not give insights into the industry actors perspectives. The findings are too qualitative.
https://www.aub.aau.dk/	11/02/2019	University - industry AND interaction (in all fields - title and text)	"Investigating the factors that diminish the barriers to university–industry collaboration" Johan Bruneela,b, Pablo D'Esteb, Ammon Saltera	Article investigates the barriers within the context of University - industry interaction. Barriers: reseach is too sientifict for the industry, mutual lack of understanding about expectations and working practices. Important finding of the study: interorganizational trust is the strongest factor when building interaction between U-I.	2010, Elsevier B.V.	Paper	Excluded - article does not investigate barriers in relation to the information managemen systems. Nor does it present information on how to build trust.
https://www.aub.aau.dk/	11/02/2019	University - industry AND interaction (in all fields - title and text)	"Academic engagement and commercialisation: A review of the literature on university–industry relations" Markus Perkmanna,∗, Valentina Tartarik, Maureen McKelveyb, Erkko Autioa, Anders Broströmc, Pablo D'Ested, Riccardo Finif, Aldo Geunae,l, Rosa Grimaldif, Alan Hughesm, Stefan Krabelh, Michael Kitsong, Patrick Llerenai, Franceso Lissonij, Ammon Saltera, Maurizio Sobrerof	Article skimmed. Has a review of many sientific articles. However, reviewed articles are only from a perspective of academics.	2012, Elsevier B.V.	Paper	Exluded - does not proivide significant relevance for the sthesis.
https://www.aub.aau.dk/	11/02/2019	University - industry *AND* interaction (in all fields - title and text)	"Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit" S.N. Ankrah, T.F. Burgess n, P. Grimshaw, N.E. Shaw	Study examines the motives of knowledge transfer from a persperctive of boh university and industry. There are similarities in terms of motives: economic, institutional and social.	2012, Elsevier Ltd.	Paper	Included - article reveal both universitiy and industry motives for knowledge transfer.
https://www.aub.aau.dk/	11/02/2019	University - industry *AND* interaction (in all fields - title and text)	"Universities—industry collaboration: A systematic review" Samuel Ankrah a, Omar AL-Tabbaa b,∗	A systematic review of literature in the field of U-I interaction. Reviewed articles from 1990-2014 that adopts qualitative methods. Exploratory study describes motivations of University and industry, also compares them.	2015, Elsevier Ltd.	Paper	Included - an important review for the study in order to have an overview of the literature. Relevant points and categories.
https://www.aub.aau.dk/	17/02/2019	University - industry AND interaction (in all fields - title and text)	"University trustees as channels between academe and industry: Toward an understanding of the executive science network" Charles Mathiesa,∗, Sheila Slaughterb	Article examines US and EU university trustees (board members). They are seen as channels between academia and industry. Study explains positive effects of university trustees in terms of making new policy and receiving funding for research.	2013, Elsevier B.V.	Paper	Excluded - there is no information about the interaction barriers from the perspective of industry.
https://www.en.aub.aau.dk/	18/02/2019	University - indsutry collaboration	"Disseminating scientific knowledge to small and medium-sized enterprises" Sarai Løkkegaard	Dissertation examines and evaluates dissemination of scientifict knowledge. Thesis adopts qualtative methods in order to investigate the presentation of scientific knowledge through several exploratory case studies. Also, study investigates the barriers to knowledge dissemination presenting qualitative interview results.	2018, Rosendahls	PhD dissertation	Included - dissertation will be closely used as a starting point for my thesis. It is relevant because it examines inforamtion systems and enterprises.
https://www.aub.aau.dk/	19/02/2019	University - indsutry interaction channels	"Best channels of academia-industry interaction for long-term benefit" Dr. Claudia De Fuentes1 Dr. Gabriela Dutrénit2	Article examines university and industry interaction channels in Mexico. Concludes benefits and channels for long term collaboration.	Unspecified	Paper	Excluded - article does not reveal the barriers from the perspective of industry. Talks about channels such as conferences. I am more focused on getting answers to digital channels.
https://www.aub.aau.dk/	19/02/2019	University - industry *AND* collaboration	"Evaluation Framework for Assessing University-Industry Collaborative Research and Technological Initiative" Sadegh Rasta,*, Navid Khabiria, Aslan Amat Senina	The study is proposing a framework assessing University - industry collaboration in Malaysia. Questionnaire is distributed to academics regardles of their experience in terms of industry collaboration. Mechanisms suchs as consultancy, licensing,	2012, Published by Elsevier Ltd.	Paper	Excluded - study examines a research collaboration from perspectives of researchers. Does not include insights into the barriers or perspectives of the industry.

https://www.researchgate.net/	22/02/2019	University - industry interaction trends	"University–Industry Interaction Trends in the Baltic Sea Region: A Bibliometric Analysis" Elena Murashova, Valeria Loginova	The study examines U-I collboration between universities in the Baltic Sea region. Study examines collaboratons by using bibliometrics in different databases. It presents U-I collaboration rate and joined publications, also subject areas.	Baltic Journal of European studies, 2017	Paper	Included - Presents the bibliometric analysis of university - industry collaboration in the Baltic Sea region. Article is relevant to the study as it shows that U-I interaction barriers are being actively investigated.
https://scholar.google.dk/	23/02/2019	Universiteto bendradarbiavimas (translation from lithuanian - University collaboration)	"Intelektinis kapitalas kaip mokslo ir verslo bendradarbiavimo stiprinimo potencialas" Rita Vaičekauskaitė http://journals.ku.lt/index.php/tiltai/article/view/881 (Lihuanian language)	The study examines the collaboration between univeristy and indstry by providing a systematic literature review about the subject. Study concludes, that it is important to promote the intelectual captial to the companies, this way to promote knowledge and collaboration, whih is still very low in Lithuania.	TILTAI, 2014	Paper	Excluded - although article provides knowledge about university - industry collaboation, however, it solely focuses on converting and promoting knowledge from being relevant not only for financial benefits, but for creating knowledge capital within the industry.
https://www.aub.aau.dk/	23/02/2019	A systematic literature review university	"A systematic literature review of UK university– industry collaboration for knowledge transfer: A future research agenda" Thais Elaine Vick* and Maxine Robertson	Article contributes with a systematic literature review, overviewing knowledge transfer between UK universities and industries. It reveals, that there are no studies, that have focused on university . Industry interaction barriers in the specific context.	2017, Published by Oxford University Press	Paper	Included - article does contribute to the thesis study by reviewing latest literature on the U-I subject.
https://www.aub.aau.dk/	24/02/2019	University industry interaction channels	"Best channels of academia–industry interaction for long-term benefit" Claudia De Fuentesa,b,*, Gabriela Dutrénitc,d,1	Study discuss colalboration channels between university and industry for a long-term collaboration. Study contributes to the insights, that collaboration is very improtant to the industry and university. The est channels for interaction are publications.	2012, Elsevier B.V	Paper	Excluded - presents the same information, that has been discussed in the systemtatic reviews.
https://www.aub.aau.dk/	24/02/2019	University AND barriers AND SME	"Enablers and barriers to university and high technology SME partnerships" Alan Collier, Brendan J. Gray & Mark J. Ahn	A case study in Australia exploreing the barriers between University - industry collaboration through the case study. Semi-structured interviews and thematic coding was used as a method to gather and analyse empirical data. Study examines key factors that bring U-I collaboration.	2011, Routledge Taylor & Francis group	Paper	Included - study gives insights into what industries look for when they want to engage into partnership with university.
https://www.sciencedirect.com/	24/02/2019	University-industry interactions	"Finding the Right Partners: Institutional and personal modes of governance of university-industry interactions" Bodas Freitas Isabel Maria, Aldo Geuna, Federica Rossi	Study examines the previously overlooked U-I personal interaction in Italy. Article uses questioinnaire as a method and discussed the size of the company and the form o interaction it pursuits. Small enterprises tend to hire academics on a personal contract, on the other hand, large firms tend to engage with university as an institutional collaboration.	2012 Elsevier B.V.	Paper	Included - study presents data about why companies do not engage in the collaboration with universities. One of the variables are that it is hard to make contact wih university.
https://www.aub.aau.dk/	24/02/2019	Barriers AND university	"Overcoming Barriers to Collaborative Research" Allison A. Rosenberg, Thomas Arrison, Wanda E. London	A workshop, consisting of institues of medicine, engineering and reseaerch council presents the barriers and possible solutions for U-I research collaboration.	1999, The National Academies Press	Workshop report	Included - report presents workshop findings, barriers for collaboratibe research and solutions for the future.
https://www.sciencedirect.com/	24/02/2019	University - industry interaction	"University–industry interaction in Santa Catarina: evolutionary phases, forms of interaction, benefits, and barriers" Dannyela da Cunha Lemos*, Silvio Antonio Ferraz Cario	Study investigated the barriers between U-I collaboration in Brazil. It discusses forms of interaction, barriers and benefits. In depth interviews are conducted with universities.	2016, Elsevier Ltd.	Paper	Excluded - interaction phenomenon is only investigated from the prspective of the university.
https://www.sciencedirect.com/	25/02/2019	University - industry channels	"University–industry cooperation: Researchers' motivations and interaction channels" Ma ́rio Franco a,*, Heiko Haase b,1	Exploratory study is interviwing university employees in order to investigate researchers motivations and channels for interacting with industry.	2015 Elsevier B.V.	Paper	Excluded - study examines a phenomenon of U-I interaction only from university's perspective. But it does provide motivations of a researcher.
https://www.researchgate.net/	29/11/2018	Expert locator systems	"Locating Expertise: Design Issues for an expertise locator system", Kate Ehrlich, 2003	Paper presents design issues of expertise locators systems. Describes the benefits for organizational knowledge management. Qualitative study presents suggestions for metadata and taxonomy, that are seen relevant for the users.	2003	Paper	Included - althought article does not address the phenomenon of U-I interaction, it does however presents interesting metadata findings for describing the expertese.

A.3   Interview guide

Interview plot guide

    a. **Interview persons –** informants selected for the interview are persons from large industries within the fields of engineering, robotics and technology. Purposive convenience was used in order to get in touch with persons, who are directly involved with university and have different functionalities across the industry, that are directly linked with University – Industry (U-I) interaction.

    b. **Interview type –** individual or group interviews, maximum 3 informants per industry.

    c. **Greeting –** I will meet the informants at agreed time, in their offices and introduce myself.

    d. **Role: Interviewer –** a person who asks the questions in the specified order.

    e. **Interview setting –** the informant will be sitting beside the interviewer, where the prototype will be shown to the informant.

    f. **Interview location –** interview location will take place at the informants' office or any other convenient place for them.

    g. **Tools –** smartphone and the laptop will be used as an audio recording tool, in order to ensure I have two sources for recording.

Welcoming and introduction to the project

a. **Research Team** – My name is Brigita Perchutkaite, I am an Information Architecture student, as a part of my thesis, I investigate the field of University – Industry interaction in the context of collaborating and hiring academic experts. I evaluate, how to present researcher's profile data visually in order to support University – Industry interaction. Also, how to develop a taxonomy and metadata scheme so it supports visualizations.

b. **Interviews –** Interview will focus on asking questions about your professional functionalities in relation to the industry. Thereafter, I will introduce Pure Portal and follow up with questions related to graphical visualizations. The aim of the interview is to gain insights about research information system prototype and if visualizations support both finding and identifying the experts. Your feedback will give insights into the U-I interaction from a perspective of the industry.

c. **Consent statement** – you will be introduced to consent form and I will ask you to read and sign it. It is a normal practice which ensures that participant is informed about how personal data will be managed and used.

d. **Time** – the interview length is expected to be 45 minutes.

e. **Recording** – I would like to inform you, that the interviews will be recorded in order to capture data with the purpose of transcribing and analyzing it later.

f. **Thank you** – we appreciate your participation in the interview session and would like to start by introducing the Pure Portal…

A.4 Interview questions

Interview questions, evaluating graphical visualizations on Pure Portal in order to revise taxonomy and metadata scheme

1. **Channels and challenges related to expert search**

    1.1.   How would you describe your professional functions in relation to your enterprise?

    1.2.   If you look half a year or a year back, can you describe situations where you and X (enterprise) needed to find a researcher at the university in order to ask a question, collaborate on a research project?

    1.3.   How challenging is it to identify particular expert and his set of expertise for collaboration?

    1.4.   How familiar are you with Research Information Systems, likewise VBN or Pure Portal?

    1.5.   How useful Research Information Systems are for helping to identifying academic experts and their expertise?

2. **Taxonomy and metadata**

    2.1.   Please take a look at the different categories on Pure Portal (profiles, projects, research output, activities, research units, press/media).

    2.2.   How relevant are these categories when you want a description of researcher's qualities?

    2.3.   How well do the concepts represent categories within the industry that you are related with? *(interviewer will guide participant and show the filter option with different concepts)*

    2.4.   How do you identify the right expert from the list?

3. **Fingerprint visualization**

    3.1.   How do you understand fingerprint subject terms?

    3.2.   How does fingerprint visualizations help you to identify the key expertise of a researcher?

    3.3.   How well does fingerprint subject terms present the area of expertise?

4. **Network visualizations**

    4.1.   How do you understand network force and circle visualizations?

    4.2.   How would you describe the difference of both visualizations?

    4.3.   How well network visualization presents researcher's collaboration history?

    4.4.   How relevant is it to have different filtering options?

    4.5.   How useful is network visualization?

5. **Research output timeline**

    5.1.   How does research output timeline affect your opinion about an expert?

    5.2.   How does citation and Hirsch numbers effect your judgment when identifying a particular expert?

6. **Conclusion**

    6.1.   How does Pure Portal visualizations promote collaboration with the industry?

    6.2.   How well researchers' profile information is presented on Pure Portal?

    6.3.   How would you describe what it is an important profile information from the industry's perspective?

    6.4.   How well Pure Portal visualizations represent researcher expertise?

A.5 Consent letter

Department of Communication and Psychology
Rendsburggade 14
9000 Aalborg
Denmark

Contact person: Marianne Lykke
Phone: +45 9940 8157
E-mail: mlykke@hum.aau.dk

Date: April 2019

Research project: Open Research Analytics (OPERA)
Master thesis project: University – industry interaction

Informed consent

Dear Prospective Study Participant,

We would like to invite you to participate in a study which investigates usability of the ReAct Taxonomy (Responsible Impact) for description and communication of research activities and their impact. Our goal is to learn how the ReAct Taxonomy, developed to describe, measure, and communicate research activities and impact within the humanities, is a useful tool to map research activities and impact within the natural sciences. Also, we aim to investigate the phenomenon of University – Industry interaction, in the context of collaborating and hiring academic experts. The objective is to learn, how well current researchers' profile information is presented on Research Information System.

The study is a part of the research projects ReAct and OPERA with five participants:

- Professor MSO David Budtz Pedersen, Aalborg Universitet
- Professor Birger Larsen, Aalborg University
- Professor Marianne Lykke, Aalborg University
- Post Doc Rolf Hvidtfeldt, Aalborg University
- Research assistant Louise Nørgaard Amstrup, Aalborg University

You are being asked to take part because you have functionalities within the industry and direct involvement in collaborating with academic experts. In the study we are interested in your insights of the usefulness of graphical visualizations of researchers' profile information. Aslo, whether and how you see the ReAct Taxonomy as useful tool to describe your research activities and their impact in academia and society.

In this study you will be asked to participate in a qualitative research interview, it is structured as following. You will be asked questions related to your functionalities within the industry and the involvement in the university – industry interaction. Thereafter, we will present Pure Portal to you, in order to receive your feedback of graphical visualizations, taxonomy and metadata. Then, we will show the ReAct taxonomy and ask questions whether you find it useful as a tool to describe research activities and impact.

You may not receive any direct benefit from taking part in this study, but the study may help us find ways to describe, visualize and communicate research activities and impact. The interview will be audio recorded in order to transcribe and analyze it. We also ask for your agreement to record your screen during the online interview. We will not collect (and thus will not store) your name or any other personally identifiable data as part of this study. Your answers to our questions and your comments and responses during the interview will be identified only by a code, such as informant #4. Participation is entirely voluntary and you may withdraw from the study at any time.

If you have questions about the study itself, please contact:

- *Marianne Lykke*, Aalborg University, Department of Communication and Psychology, Rendsburgsgade 14, DK-9000 Aalborg, phone: +45 9940 8157, e-mail: mlykke@hum.aau.dk

Sincerely, Marianne Lykke and Brigita Perchutkaite

A.6   Interview transcription A

1: And then they asked if I was interested, it could not be 15 years old because they're not that old it was probably 10 years ago, and then I was asked to if I wanted to start such an industrial professorship. So I am mostly within the industry.

M: yes so are you in charge of a research group?

1: Here?

M: Yeah

1: No what do you mean by research group?

M: It could be that the university sort of have organized a research group around your professorship…

1: No I'm or supporting a research of this department. And then I have I think we have three PhD students right now, 3 to 4. I don't know if you can call that a research group, or something like that official.

M: No, good

1: We are building a big lab right now also based on what I'm working, we are funded by X enterprise foundation, on water infrastructures. So control of a big things distribute things… and that's also where the PhD students a working. 3 4 students.

M: Good…

B: Could you please describe your professional functionalities in relation to your enterprise?

1: I have a title as the chief engineer chief specialist X enterprise. And this means, in X enterprise, it is a very big company. And our development is divided into two to three functions. One function is the product development, developing the systems, the ideas we want to sell. This means that typically within one year from starting we have a product that can be sold, then we have a functions that maintain the product afterwards, more or less the same people, but if you have a product that lives for 10 years, you need to do some engineering on the way, some groups can not be ordered anymore and then you have to change them. Maybe there is some software box that needs to be changed. So there is an engineering phase and then we have what we call "core tech". And this is technical development, we have similar functions on business development. But then we have this "core tech", which work with development in 3 to 5 years, timeframes. So… And this is where I am placed. So we are the people that integrates with research… And doing, maybe not research, but close to applied research inside the company also.

51 And this is where I am placed. And I am placed there with different functionalities, but I am placed
52 in a department working with control systems and supervision systems, exactly the same as here.
53 But just at X enterprise.
54
55 B: If you look at half a year or a year back, could you describe situations where X enterprise
56 needed to find a researcher at the university, in order to ask a question, collaborate or for hiring
57 purposes?
58
59 1: I am not sure I am the right person to ask, because I have this very, very close connection to the
60 university. So typically I know people. But looking at my colleagues, within "core tech", I will say
61 yes and no. We are always in X enterprise seeking universities to collaborate. We say, we want to
62 collaborate with the best, but sometimes it is also very important to collaborate with the people who
63 are close to you. And then I think it is very hard to… It is hard to find people to work with in the
64 universities. But within X enterprise it is normally by personal contacts. Most, at least half of the
65 staff in "core tech" has a PhD, so they have close collaboration, not only the collaboration, but also
66 contact to universities, and typically this is the first touch point. And then, at right before I started
67 up here, this was the first touch point, and then typically you were invited into research project, and
68 then you kind found the people you need to work with to these research projects. It is very rarely,
69 that I have experience that you want to ask a specific questions, except if you know the guy. For
70 example, when I was only at X enterprise and I had a question and I would call XXX person, or
71 XXX person, because those were sort of people I knew, if it was a specific question. But I think that
72 is rare, at least in X enterprise, because there are so many people that knows a lot inside the
73 company.
74
75 B: How familiar are you with Research Information Systems, like VBN or Pure Portal?
76
77 1: VBN is the research systems, that collects the papers at Aalborg University…
78
79 M: It is where you have a profile…
80
81 1: Yeah, exactly…. Normally, looking from the company point of view, the way that you find papers
82 is through Google and thought… I am in electrical area. So there is a I-TRIPPLE-E organization,
83 called I-TRIPPLE-E, which... These are the ways. Elsevier, is more troublesome, because it is so
84 expensive. So normally, people try to avoid that. But it is how it is.
85
86 B: How useful Research Information Systems are for finding these experts?
87
88 1: Again, I don't think I know anyone in X enterprise, that has contacted any authors from the
89 papers. We just read what they write and then we try to understand, and the use it.
90
91 M: Yeah, and I think, I would like to follow up a little bit. Because, when you describe before, how
92 you look for, how you collaborate, then I think I got the impression, that you primarily collaborate
93 with people you know. So you will very, maybe never be in the situation, where you look for a
94 person you don't know.
95
96 1: I believe we have tried to, I know we have tried, but that is on higher level, saying that we want
97 to collaborate with that university and then… Management has contacted and tried to set up a
98 collaboration. We have placed people in Singapore, from X enterprise because we want to
99 collaborate with that university. But then I think one of the guys that are hires up there are coming
100 from Singapore university. So again, this is personal contact I think that drives most of it. With that
101 said I am not sure it is all the way true, but most of it is by personal contact. On of my PhD student

102 has contacted a researcher based on his work and asked if he could come and visit him. And that
103 is I think the only one that we have contacted which was the only one that we didn't know about.
104
105 M: So do you think, that in this situation, you just referred to, your colleague has looked up a
106 researcher in this or similar research management system, in order to get a picture of the person?
107
108 1: Yes, not in VBN, but Google.
109
110 M: Yeah, so Google Scholar maybe?
111
112 1: Yes, typically. And found papers and then to his home page… Looking to what he has
113 published, so based on his publications, is that a relevant place to work, place to collaborate with.
114 But VBN, I ma not sure we have used that, it is true. But I am pretty sure, everyone is using these
115 search machines todays, is very important that our publications at universities are available on
116 these standard search engines. Because you will never be seen.
117
118 M: But that is another situation, is to disseminate your research…
119
120 1: But coming from the other side, when I am looking for someone, I will start with Google Scholar,
121 or Google. And then I will take the ones that pops up first. There might not be the ones from the
122 university, but it is very important that it pops up. Of course, we will pop up, because it is published
123 in I-TRIPPLE-E for example, but it could be good that we are referred to the VBN also, maybe. We
124 are, because I am pretty sure, if you search for a researcher here, they will point to his research
125 profile in university so…
126
127 B: I would like to present to you a Research Information System, it is VBN data, that is put into
128 Pure interface, so it has all the graphical elements of the Pure Portal, but with VBN data.
129
130 1: Pure Portal is…?
131
132 B: Pure Product is the product of Elsevier, which aim to showcase and present researchers'
133 expertise and publications, their profiles in order to facilitate collaboration between researchers
134 and industry.
135
136 M: And this platform, Pure. It is what VBN is using. It was originally made by a local company Atira,
137 a young Engineer here, but he sold it to Elsevier. And they have made a new interface and that is
138 the one that Brigita is going to show you.
139
140 B: so if you going to look at different categories here, in order to find an expert and look up his
141 expertise, what category would you choose?
142
143 1: I think that was two questions… Because I am looking for expertise or I am looking for an
144 expert? I am looking for a person, or I am looking for a someone who knows something?
145
146 B: You are looking for someone who knows something about… specific area.
147
148 1: Then I will definitely start here (starts with publications category in the landing page). Most
149 definitely. I would look for relevant publications.
150
151 M: What do you think when you see these (PlumX Metrics)?
152

153   1: Yes, I was surprised when I have seen these. I thought it will show connections to relevant
154   product publications, or people. But it seems that it is just a paper.
155
156   M: Would it be interesting for you to see related papers?
157
158   1: Yeah! Most definitely.
159
160   M: More than to know about citations and downloads?
161
162   1: Yes, but I sometimes look at citations, because it might show that they have some value. But it
163   is not the main… It is the topic. Again, coming from the industry, I am more interested in, does this
164   paper solve a problem. Cause I think that is biggest difference, from university and industry. From
165   university, you are looking for something that creates awareness in the world. When you write
166   papers you want them to be red. Whereas in industry you have a particular problem that you want
167   to have a solution for. And that's where you're going… You are trying to find headline and the
168   abstract that fits the problems that you want to solve the most.
169
170   M: One could say that citations, could also lead you to other relevant papers, because it is papers
171   that cites it… does that make sense? Or relevance?
172
173   1: Yes, so this is citation to this paper… but when you read the paper and then look at the
174   citations, then is always something that is pointing you back in time. It could be interesting to have
175   something pointing forward in time.
176
177   *Informant has pressed on PlumX Metrics visualization, then chose the Citations section, leading to*
178   *Scopus, where he was presented by a list of publications that has been citing a chosen paper.*
179
180   M: What does this mean: year… does it have any relevance for you to get this type of information?
181
182   1: Yeah…
183
184   M: I would like you to comment a little bit on the screen that you see here.
185
186   1: I didn't noticed this *(subject categories)*, but yes, it definitely has. Because this helps you to kind
187   of… it help you to point out in. I see these *(metadata)* as search facilities, that will help you to pin-
188   point what you want to.
189
190   M: It is filter options, you are actually narrowing down your search when you click here. But what is
191   more relevant for you, you can filter here the year, authors?
192
193   1: These two. Author and subject areas. I would probably also look at this one *(research projects)*,
194   because sometimes it has more value both for article than other things. Because, sometimes is
195   more finished work.
196
197   M: What about article in Press?
198
199   1: So, something that is not published yet?
200
201   M: Yes… I ask because before you said that it is important to look in the future instead of the past.
202

203   1: I think this one is important also, but again, I am not impressed… I would probably look at that
204   also, but again, I will also expect it not to be finished work. And I am not sure, I want to use too
205   much time on that. It is just my feeling right now. This one *(language)* is also very important I think.
206   Affiliation too, more likely, if you want to find out who to contact, what universities to collaborate
207   with. And if you are from industry and want to start up collaboration in a field, you want to find out
208   where to go to, this could be interesting. They have chosen good here, these keywords. But
209   keywords *(on Scopus),* are more or less the same type as here, as subject areas.
210
211   M: Yes, they are quite broad… I don't know whether that means something for you. The keywords
212   they are quite at a board level, energy is…
213
214   1: That was not the keywords, that was the subject area.
215
216   M: Yes, that's right.
217
218   1: The keywords, I don't think it's that broad. I think that is fine.
219
220   M: So they have good level, of what we call specificity.
221
222   1: Yes, i think so. Also, if you do it too specifically, then you have nothing to look at. Also,
223   country/territory, is not relevant anymore once you have affiliation. It becomes redundant.
224
225   B: If we go back to Pure Portal, and if we go to home page and look at the profiles. Here we have
226   the filter with different concepts, these are presenting categories and subjects of publications.
227   Could you identify one concept, that is relevant for your enterprise?
228
229   M: The terms that you show here, where would they come from, a set of documents about
230   something, about what then?
231
232   B: Yes… About the specific subject, it is a subject areas of publications and researcher profiles.
233
234   M: Yes
235
236   1: Yeah… *(informants picks the category "controllers" and after is presented with the list of profiles)*
237
238   B: If you would like to choose a researcher from the list, what would help you to identify, whats is
239   the right profile?
240
241   1: This is a bit hard, because I would go for names, cause I know people here. But if I didn't know
242   people, I would go and look for their publications.
243
244   B: But how would you identify them, would you look at the publication graph, that was presented, a
245   little piece.
246
247   1: What do you mean by publication graph?
248
249   B: If we go back, so you have the profiles, what would help you identify that this is the right person
250   I want to click on. Would you look at matches, that presents how well the profile matched the
251   subject that you chosen, or you would look at the publications or his title?
252
253   1: I would look at his title and his department. Definitely. I would look at the title and department.

254

255 B: If we chose a profile and then we can see his fingerprint visualization. Fingerprint is a search
256 engine that mines the abstract and text, collects the most frequent terms and weights them down
257 with a percentage. You can also see the full fingerprint of a researcher. What does that tell you?

258

259 1: This tells, definitely, which area he is working in. Very interesting I would say.

260

261 B: How would you identify whether he is a more expert in pumps or wind turbines. If you drag it
262 here, you can see the weight, does that…

263

264 1: I would not bother that much with… But I can see hydraulics, fluids, pumps, wind turbines,
265 controllers. So this is more like categories, he is more into that than machinery, energy… But all of
266 these subjects are more or less related.

267

268 B: Is that useful to see when you want to identify…

269

270 1: Yes, definitely. Because by this he shows that he is working with an area that could be
271 interesting for me because this is hydraulics, fluids there's something about controllers. However,
272 there's something about hydraulic drives, wind turbines, which might indicate he is working in
273 mobile hydraulics systems. Just not for water transportation, so so I would say then you have to
274 look at the papers. But it indicates that you can probably find someone. *(looks at other profile)* So,
275 here it's very clear that he is in electrical power, so it shows very fast that he is in the electrical
276 part. When that said, I could also have seen out here because, it says power electronic systems
277 *(points at metadata assigned to the profile in the profile list section).* And the other guy. Fluid
278 Power and mechatronics tells more or less the same.

279

280 B: If we try and try and look at his network presentation. The system also can visualize this. how
281 would you understand this visualization?

282

283 1: I've seen that couple of times, so and I have not really understood what is it good for and how to
284 use it. Because it shows which people... who he he has talked to.

285

286 M: So actually you not sure what you see there?

287

288 1: I know what I can see there I can see which people he has collaborated with but I have never
289 used it. But you are interviewing other than me because I'm sure other people might look
290 differently on search graph. I know some people in X enterprise see that as an advantage.

291

292 M: But why don't you see it as an advantage?

293

294 B: What about different research units or external research units? Is the filter option relevant, does
295 it tell anything?

296

297 1: I think again if I take an overview this again helped you from a management point of view to find
298 places where we want to work, which we want to work together with. But as researcher and
299 developer I am more interested in a person. And this of course shows that this person is working
300 together with this person so maybe I should talk to him also. But if I already have contact it him and
301 he probably knows exactly the same why bother to date another guy. So I have never used it when
302 that said I know people in X enterprise are looking in such diagrams.

303

304 B: Yet again if we look at the research output visualization…

305
306   1: This is something interesting for the University. I don't see it is very important for me as a
307   developer. This is important the title and the abstract and finding the right title and the right
308   abstract in the easiest way is the most important for me.
309
310   M: Do you have any comments on the nature of abstracts. you know very well I can hear that you
311   are used to read the abstracts. Do abstracts provide the information that you need in order to see
312   what it is about and whether it is important and relevant for you?
313
314   1: It gives an indication abstract, together with fast look through helps. Normally, I also like to see
315   a couple of equations enter figure maybe then I have the feeling of where this is going sometimes
316   and sometimes not. Yeah, but evaluating I think the title is more important than the abstract, the
317   title shows that this has a content that is interesting. I look at it and I typically not only look at the
318   abstract, at least also figures and hopefully a few equations and this is sometime problem because
319   sometimes you have to pay before you can look at that.
320
321   M: In a related project we studied small to medium Enterprises, you are large Enterprise, X
322   enterprise, and when they commented on abstracts they were too scientific to abstract. You
323   mentioned earlier in the interview that you will looking very often answers for a specific problem.
324
325   1: Yes, but again I think there is a difference between large and small companies. We are a look-
326   a-like University within X enterprise so the people in my area knows how to read this stuff. So, I
327   don't think we this is an issue.
328
329   M: Good.
330
331   1: Of course there are papers who are more concerned with a math, you would sometimes
332   typically jump over those and go for the ones that are more application related. Because they seek
333   to show that this is the solution for something in the easier for me to understand way. Where if it is
334   more mathematical proofs we have to do more work to understand how I can use that. So I would
335   of course go for the easy one, but it's not like people would be afraid of the theoretical part.
336
337   M: And to judge whether it is more easy one or applied one, it is something you judge from reading
338   the title and the abstract…
339
340   1: Yes and the publication. So typically when it's placed in one publication it is very theoretical but
341   others are more with application oriented views. Also with conferences there you can also
342   categorize these and go for the ones that are more applied, and we do that.
343
344   B: So if you could just summarized do you think that pure portal is useful from the industry's
345   perspective? For finding publications in seeing the profiles of the experts?
346
347   1: Yes but I think it might be too complicated to start with, but yes I definitely see this could be
348   useful for the industry. Two things that pops up first is, it might be a bit too complex just to start
349   with, but I think that it would help if you have work a bit with it. And then price. To get access to
350   this. How much X enterprise should pay to get access to Pure portal. And if it's just a search to it
351   might be free but then how many publications can I have access afterwards by doing this. could I
352   get access to something here, it is not enough to find a title you also have to read the paper and if
353   that's $50 it's time I find a paper it is quite fast it can become costly. That is the strongest asset for
354   I-TRIPPLE-E, because they are more cheap than other publication companies and you have
355   access in that way. And then you of course ask, if we should go for free publications, but I don't
356   think they have the quality yet, and I am not sure they will, because the incentive is different in free

357 publications than in publications that you pay for. Because for free publication they want to have as
358 many publications as possible, because that is were they earn money, but they are kind of…
359 Lower level publications. Where are the other ones, they want people to read them, it means that
360 they have to increase the quality, in order for people to read them. You don't want to read a lot,
361 without getting nothing out of it. So I am not sure, it will really be a good idea with free publications,
362 again, it is too costly right now. I think it is a real challenge, for use of research in industry, is these
363 high costs. Cause normally, you know yourself, you maybe have to read 10, 15 papers, to find one
364 that you can use. And if each of them cost $50....
365

366 M: Do you search by Google and then you pay for each publication?
367
368 1: No… If it seems very relevant, sometimes we do that. Else, we are members of I-TRIPPLE-E,
369 we have access to these papers and then there are most of the relevant stuff is published.
370 Sometime in I-TRIPPLE-E publications. And then we have access to other journals which are
371 relevant.
372
373 M: So you have bought a specific subscription?
374
375 1: Yes, exactly. Energy and buildings, we also read a lot in that. So there are some specific
376 journals that we have. We also going to conferences and get publications from there.
377
378 M: But what about you as a professor at Aalborg University, you must have the access to the
379 publications.
380
381 1: Yes, but I am trying to be very clear, what I do for research and what I am doing for the
382 company, because I can not use the library for development, so I am very clear about that.
383 Because if someone discovers, I will be kicked out. At least they say in the library, that you can not
384 use that for commercial use, so if I have papers that I need to go through to write a paper, or I
385 have my research PhD students, I will go at the library, but if something specific for development. If
386 one of my colleagues from Grundos ask me "can we do that?", then I will not go through the library.
387 Then I will either pay or go to the I-TRIPPLE-E.

A.7 Interview transcription B

B: First of all, if you could please describe your professional functionalities related to your enterprise?

2: Yes, and also a bit about the enterprise?

B: Yes, great

2: Yes, So first of all X enterprise is a company specialised in automized solutions for the manufacture industry. So that comprises robots and a lot of other, you could say, automation equipments ranging from the solution to apply to our customers, ranging from a very small and similar setups, for instance, just with universal robots. Basically, catch and carry over desk too much more complex systems to larger Danish customers or international customers, With 10 robots, assistance complied of a 10 robots, automotive robots driving around a lot of process equipment, so quite complex you could say. So that is basically the range of you could say of products or solutions that we deliver. Within that business we have basically three different pillers. One Of them is our project business, our product business is basically where our customers they come to us and they and they ask " oh we need a kind of solution that can help us make more efficient in the industry, what can we do?", and then we basically build up a project, where we sign up on a specifications and we deliver a solution. so that is very much project-based. The second pillar or vertical that's the product business, basically where we strive to have much more standardized products. products that we are tired of making ourselves or that we have in our portfolio that acts as a reseller. One of the examples are the universal robots, if you know that it's, you could say our collaborative robots that we sell. It could be autonomous guided vehicles, your robot that can drive around, so… And so on. So we have different products also that we sell. fifth third pillar is our service business, basically where we offer service to our customers ensuring that whatever we have delivered runs 24/7. Because that is very critical in the manufacturing industry of course they can continue to manufacturer and they don't have any breakdowns. Because if you have a breakdown fine line, then yeah… Production stop means lack of turnover of course. where we have a hotline so you can call 24/7 and we have you could say robot ambulances where we just drive out and fix the problems. So that is basically the three Pillars that we have.

M: what industry is do you work with?

2: we work within, you could say, the metal industry. within the food sector within the general industry, yeah… so we also have a bit of business within the pharma industry as well.

M: Could that be milking industry?

2. Oh, no it is in relation to pharma… But yes, we have a collaborations with Arla and Cheesy. We count around 370 employees by now, not all of them are located here in Mors, but yeah we have different offices around. So that is a bit about the company. My role, Have a multitude of roles, business development, concept development, product management, basically in a new digital era, looking into new business opportunities. Not on really selling robots and solutions, but how we can integrate our solutions within the customers digitized set up. And how basically, we can help harvest and create value out of the solutions that we provide, in terms, you could say of,

52 data. So that could be data providing data, showing very clearly, how much, let say, the equipment
53 has to be running, when probably it needs to be changed, and so on and so on… So basically,
54 trying to create value out of the data. From the offerings we have. That was a short story.

56 M: And you are from electronic engineering, from Aalborg University?

58 2: No, I am actually from computer science. Math and computer science. So, I am one of the
59 nerds. So I am very focused on software, obviously.

61 B: If you look half a year, or a year back, could you describe the situations, where you and your
62 enterprise, needed to find a researcher within the university, in order to collaborate on a research
63 project?

65 2: Yes, I have done that multitude of times, actually. Have quite good cooperation with Ole
66 Madsen, from manufacturing, what's it called, the department (fakultet).

68 M: I think it is production…

70 2: Yes, and Mikkela, one of the PhD students. And I've also been in contact with Thomas, down by
71 the harbor, what's it called, visual… vision, multi… media thing.

73 M: Aah, medialogy?

75 2: Yes, Thomas is also a professor there… But an actual research project, no, I have not really
76 engaged in that yet. But we have a lot of times discussed with Ole Madsen, whether we should
77 actually try to go into you could say, a research project, of course funded by whatever… funding
78 organizations. But we have never executed one. No.

80 M: but when you are in contact with these people you mentioned, that is part of your every day,
81 problem, universe…?

83 2: Yes, it is, it is… Problems that we have, it could also be opportunities, actually, that we would
84 like to discuss. Does it seem well, would that we kind of a joint value, objective here… That of
85 course could bring X enterprise something, but obviously also Aalborg. So I am regularly in contact
86 with…

88 M: So that is a kind of research or development collaboration, between you, when you look for
89 opportunities?

91 2: Yes, that is one track. Another track is when you look for, for the last two year more or less, I've
92 continuously has a project team, collaboration, from Aalborg, it could be bachelor students, it could
93 also be Master students. So for instance, last year, or actually, I have that also now, I have a
94 person, a guy, from Ole's department, being in, as a trainee here, on his 9th semester, but actually
95 also now, he is on 10th semester. Of course, where he approaches and addresses specific product
96 problems or opportunities, that we identify, and via that student basically collaborate. Yes, so
97 whether we can call that a research project, not really, but still a collaboration, right. So we
98 basically done that continuously for the last two years.

100 M: but just to be sure, we are not only talking about research. We are actually talking about
101 enterprises, companies wanting, for some reason, to get into contact with researchers or, yeah…
102 staff at the university.

103
104   2: Good, yeah…

105
106   B: During these collaborations, were there any challenges that occured?

107
108   2: Hm…

109
110   B: Or more related to identifying an expert?

111
112   2: No, i think that addressing, or basically being able to find, a person at Aalborg that has a
113   knowledge, really has not been a problem. I think actually, if there has been any obstacles or
114   challenges that basically has been on the enterprise side, on our end. In relation to being able to
115   timely allocate resources and get back information basically, that Aalborg requested.

116
117   B: okay…

118
119   2: So we have actually been a "bottom like", I would say sometimes, right. Where the students and
120   someone worked on something and had some lack or they had a need for information, that we
121   would provide, or I would provide. That sometimes has been a bottom. Yeah… m… because I
122   think that, of course, you need to commit to collaboration. And also to understand, that from our
123   end it actually requires some effort. That you need to allocate and actually commit. And, it doesn't
124   let say the allocation doesn't really flow, you could say, regularly you need to allocate one or two
125   days suddenly. That requires a schedule that we probably have not be good at.

126
127   M: How do you find the persons you want to collaborate with?

128
129   2: Basically this has been via main contact, in this case this has been via Ole or by Mikkel. So
130   when we have addressed something, or propose something, so basically they have, let say, found
131   whatever persons, that could be suitable or project team that could be suitable. So I have not been
132   picking the guys myself.

133
134   M: So they find the persons for you. And when you say Mikkel, you refer to Mikkela?

135
136   2: Yes, the italian Mikkela.

137
138   M: So they are your entrance and you have them to find appropriate students or colleagues that
139   can help you.

140
141   2: Yes, exactly, and often it has been more students than staff, you could say. And of course when
142   it comes to the students and the project teams, they proposed the persons and then of course we
143   have discussed it and always had the opportunity to say no.

144
145   M: Yes, it is a common discussion or decision.

146
147   2: Yes, of course…

148
149   B: So then if you were to find an expert on your own, and have been introduced to these types of
150   Research Information Systems, where you would have profile and expertise and contacts. I would
151   like to hear your feedback on the such system… the experience.

152

153 M: What this Elsevier is also do it, is that they actually make some kind of database or experts.
154 And of course, most universities in the world have a database of all their employees, slash experts,
155 in order to provide a picture or their skills and qualities, interests, whatever.

156
157 2: I actually have browsed Aalborg system, that's the VBN, right?

158
159 M: Exactly. So you knew it?

160
161 2: Yes, it was just the operation I didn't know.

162
163 B: So this is the Pure Portal, and it is using VBN data, so Aalborg University's Research
164 Management data. So it has all the Aalborg university researchers and other users, that uses the
165 system. This is a Pure Portal visual representation.

166
167 2: Pure Portal, what does it mean by Pure?

168
169 B: Pure Portal is a name for Research Management System, that is created by Elsevier. Because
170 currently Aalborg University is not using this sort of interface.

171
172 2: Okay, so just to understand, this is just a different platform, kind of a prototype, that has not
173 been deployed, but…

174
175 M: We are actually going to deploy it these days.

176
177 2: Okay.

178
179 B: It is working, many of the universities around the world is using this solution. With this specific
180 interface. So if you were to identify a an expert, or you were looking for specific expert, what sort of
181 category would fit for the industry?

182
183 2: If I was so, if my key was that I have a specific name and.. Is that the case?

184
185 B: Mmmm, or you are looking for an expertise.

186
187 2: Okay, so basically, domain area?

188
189 B: Yes

190
191 2: Then your question is, which of the categories then I would probably use. Okay.

192
193 M: You could also search a subject term, couldn't he?

194
195 B: A subject term…

196
197 2: Yes, that would probably be my approach.

198
199 M: Could we type in something now?

200
201 2: Yes, yes. Let's do that. So for instance, if I were to look for specific person attached to a specific
202 area, let's say augmented reality, or whatever, then I would actually search for it. And i would try to
203 click any categories.

204

205 B: So now we have results of a profiles *(profile list)* that are related with your search concept. So if
206 you were to look at this list, how would you identify a right expert? What information would be
207 useful for you?

208

209 2: Yeah, let's see… first I need to look at what information is presented. So we have a name, e-
210 mails, we have titles, a departments, role…

211

212 M: I can see that Ole Madsen is there, maybe we should click on him?

213

214 2: I would probably look at not really that much on the role, but maybe more you could say the
215 departments, right. And a kind of an area where he is opposed to.

216

217 B: You do you understand this? (points at the small book icon with the relevant number of
218 publications indicated)

219

220 2: Now I can see it. I actually would have not related it to that. So i would have not guessed, that
221 free matches would correspond to research output. Or whatever research… No I would not. At first
222 stands, I really would have not understood what it ment. But now I know. And now it makes sense.
223 He probably has made 3 publications in relation to that area.

224

225 B: Yes.

226

227 2: But I think i would not have correlated that at first. So yeah, I think I would look at the text, and
228 see very much well, if he is attached to a domain that seems relevant in relation to augmented
229 reality.

230

231 M: So it is saying, for instance, for Ole Madsen that he is in robotics and automation that's a
232 keypoint?

233

234 2: Yes, exactly. Because that's a domain I know is related to this area. So that would probably be
235 my keypoint to look for.

236

237 B: I don't know if it would be okay to chose a person we know…

238

239 M: You can decide, Thomas.

240

241 2: Oh, here it is another Thomas that I have talked about.

242

243 B: So here, this is a fingerprint engine that mines the abstract of a certain publications of this
244 specific author. Then it extracts the terms that appeared the most in his publications. So these
245 terms are then weighted and… How do you understand this visualization?

246

247 2: First of all, I would still relate it to my key and that would be augmented reality. So it would still
248 be within that scope. That would be my expectations. And not just generally whatever they have
249 done. Then there are different…

250

251 B: And we can see the full fingerprint here. *(opens the full fingerprint visualization)*

252

253 2: Okay, and it is still within the scope that we have put in?

254

255 M: No, this full is the full, his full, based on his full publication.

256

257 2: Okay, good. Then I would understand this, it is also visually quite representative. The focus the
258 weight of his work, right, in relation to yeah... These different titles, areas, topics or whatever. But
259 how the weighting is done of course I don't know.

260

261 M: but what does it mean for you, these words? Do they tell you anything?

262

263 2: Yeah, I think, I think. The topics of course are not self-explained, but it gives kind of a clue, right.
264 Of an area, of a scope, of a discipline. I think. Whether that could be a lot of other, or whether that
265 could be a substitute I don't know, but first glance it seems like "okay, well, there are a lot of topics
266 here, a lot of domains and which one for me is the most relevant and how much does this person
267 actually been involved in that area". *(augmented reality)*
268 And I think there is a nice graphical representation as well.

269

270 M: What do you mean, when you say graphical representation?

271

272 2: Basically that, it would be my expectation, right, that the above here, the top line would be those
273 with the highest weighting, you could say. And the graphical representation is that, for me, maybe
274 it is just an optical illusion, but for me they seem with the bigger font, than those. But also the
275 assets seems bigger. But maybe it is an optical illusion, I don't know. It works.

276

277 B: And how useful is to see the weight representation, on each of these subject terms?

278

279 2: Okay, so there is a number on the weight and there is an additional text "engineering & material
280 science". Okay, so maybe that is the area of research, probably, right. Yeah, it gives you further
281 information.

282

283 B: How relevant is it to see this weight percentage?

284

285 2: First of all for me, I do not know the interpretation and the definition of the weight, right. So for
286 me I think it would be sufficient to just to see the graphical representation of whether it is half full or
287 fuller, whatever. But the specific numbers, whether it's 44% I don't know… It is not really a detail,
288 that is relevant for me. I can't navigate in these numbers, cause I really don't know what they
289 mean. For me it is just, is it much relevant, less relevant or a big relevant. That would be
290 sufficient.

291

292 B: We move on to a network presentation, here you can see all the different persons, that Thomas
293 have collaborated with. How do you understand this presentation?

294

295 2: Well, it basically shows the network, right. So, all the correlations from this persons to other
296 persons'. But the definition of "has been working with", I don't know really… Maybe that's, with
297 whom he has made publications, with whom he has 'whatever', I don't know. But it gives a kind of
298 an idea of right… So he is he attached to. And then actually I would also expect that I could click
299 on the other persons' to get further information.

300

301 B: If we click…

302

303 2: Okay, yeah… Then I get some information here. Okay, mhm.

304

305 B: There is also a circle network presentation. How would you compare this to a previously shown
306 visualization?
307
308 2: I think if you don't click on the individual persons and just leave it there, then it is just a mess. It
309 is. I can't navigate in that. But actually, when you have a mouse over on a person, right, then I
310 would expect that these are… Within those scope of persons, that these persons are also attached
311 independent of Thomas.
312
313 M: Is it useful information from your perspective here in X enterprise?
314
315 2: I think… Maybe it is overkill. That from our point of view we are not really… We don't have a
316 lead of explore a lot of different persons to find the specific area.
317
318 M: Why?
319
320 2: It is typically sufficient, or it has always been sufficient to take the phone, call Ole or Mikkel,
321 whomever, and then they just resumed, right. So I have not had a need so far to explore, you
322 would say, all the different staffing and find out who is related. And then, yeah… use that as an
323 offset. No, so I don't think I would.. Probably not use it.
324
325 B: What about if it would be a research units, that this particular expert has been involved in?
326
327 2: So it is not individuals now, but units?
328
329 B: Yes.
330
331 2: Okay… That could actually be interesting. The reason why I am saying this is that when we talk
332 about, of lets say, this area we are working within, Industry 4.0. Area, right. It is really so
333 multidisciplinary, accross a lot of different disciplines, right. From economy, financial, to computer
334 science to robotics to whatever, you name it. And that actually sometimes been navigating within
335 the different faculties and who is working with whom and so on. So, if this was not just general, you
336 could say, a general description of what faculties have been working with whom, but if it could be
337 narrowed down within this subject I type, of augmented reality. Then, which departments have then
338 had any kind of collaboration. Then it actually would be useful.
339
340 M: Yeah…
341
342 2: So it could be as subset of this specific area. Then it really would bring some value to at least
343 specific, to our case.
344
345 M: Could you describe any situation where this kind of information could be valuable, useful?
346
347 2: Yes, for instance when it comes to specifically, within the industry 4.0., when it comes to for
348 instance advanced analytics or artificial intelligence or whatever, right. Well, have that been any
349 collaboration for instance from the faculty of production with Ole, with cassiopeia, the computer
350 science department and maybe also with Thomas Moeslund mediology department. Have they
351 had any cooperation in relation to that, I think that would be quite interesting. It could also apply to
352 augmented reality, have there been any joint projects between those departments, yeah… I think
353 that would be quite…
354
355 M: And if you, then you saw a connection, such a collaboration, what could a next step be then?

356

357   2: For me, it would be to see then are there any research papers on that. Are there any
358   publications they have made. Because that would really be specific. And deliverable.

359

360   M: Yes.

361

362   2: Exactly. And then would actually be a stepping stone.

363

364   B: We also have a research output also visualized.

365

366   2: Okay. So that is the number of yeah, research outputs per year, og, he is increasing his
367   productivity.

368

369   B: How does a research output visualization effect your opinion about an expert?

370

371   2: For me, it probably show his activities, so how active has he been. Is he quite active currently,
372   on whatever output. Or is the person has another person, or whatever. So that would give me a
373   kind of idea of that. Plus it would also give me a kind of background, his history, right. Very quick
374   overview of how much ballast has the person had and how experienced is he, in terms of volume
375   of research.

376

377   M: But saying this, I assume, it is an open question, that then actually you see value in research
378   publications?

379

380   2: Yes, I do.

381

382   B: So now when you were introduced to a Pure Portal, how would you say that visualizations on
383   Pure Portal promote University - Industry interaction?

384

385   2: I would say much better than the current set up. The VBN, or whatever it is called. I think
386   actually, that the graphical exposure, it is quite good. I am not sure of the big value of this one here
387   (individual network). But i think that the, where actually you could explore and navigate through
388   relations either from faculties, departments or through individuals. It is quite interesting, especially
389   between the departments. And especially if it would be interconnected, not just within the scope of
390   the university, but across, inter-universities or whatever.

391

392   M: So, information about networks, that is important.

393

394   2: Yes, exactly. Who has collaborated, right. Who's networking. And especially, if it could be
395   narrowed down to publications, or specific subjects. Has Department of Computer Science in
396   Aalborg being, working together with Fraunhofer in Germany on this specific topic right, that has
397   my interest.

398

399   M: And again, this is a clarifying question, it is because, to be good in your business in your
400   industry multidisciplinarity is an important factor?

401

402   2: Yes, it is. Very important, I think we recognized that, not recently, but yeah… That is not just a
403   question of nerd technology and computer science or electronics, but it is also the process around
404   the business, a lot of stuff really in this area.

405

406   M: Yes.

407

408 B: Here we can see a collaborators of a certain publications that are placed in the system…

409

410 M: Is it around the publications or around a researcher? Why is this specific cluster? How did you
411 get it?

412

413 B: It is the filter option of collaborators.

414

415 M: Could you for instance take this virtual reality… and look for collaborators. Let me show what I
416 mean. Because that is actually what Thomas is asking for.

417

418 2: Is it because that was actually a filter that was active.

419

420 M: Yes, that could be. Then I click it away. Clear all first maybe to be sure. Where did you see that
421 one?

422

423 2: Augmented reality, that is also fine.

424

425 M: Augmented reality… And then we want to see research units.

426

427 2: Where did you find the collaborators?

428

429 B: It was under the filter, but it was under the category projects.

430

431 2: Under the filter!

432

433 2: Okay, let's try projects.

434

435 M: No, that is not possible!

436

437 B: These are the ones, that had projects within this area. Sometimes they have a fingerprint
438 assigned to publications, but they don't have it now.

439

440 2: Okay, so research project is that mnt as current ongoing project?

441

442 M: It can probably… We register research projects so it closed be closed projects and ongoing
443 projects.

444

445 2: Okay, so it could be both.

446

447 M: Yeah

448

449 2: Okay, so when we do this search, maybe I would be a bit confused on the numbers
450 here. *(numbers on each subject)*

451

452 B: So, it indicates one finished project…

453

454 M: But it is not collaborations?

455

456 B: No.

457

458   M: Okay.

460   M: Let's just stop, I saw some opportunity to find a feature, that support, what you were looking for.
461   To see this set of collaborators. That you wanted.

463   2: Would I also be able to when I click on a person to get a picture? And get kind of a visual…
464   Something that I can remember.

466   B: Yes. You would, but not in this prototype.

468   2: Yes, but it would be available.

470   2: Because that's for me often, you know, the visual thing getting kind of a figure who is the
471   person. Otherwise, it would just be characters.

473   M: But a little bit to sum up, before we go to my project. For you, the topic is important, the unit is
474   more important than the individual, multidisciplinarity is important and especially to see
475   collaboration between disciplines.

477   2: Yes, exactly.

479   M: And then when we go down to one particular, is to know the department that it belongs to and
480   for instance have a photo.

482   2: Yes.

484   M: What will you use the photo for?

486   2: Just to… For my memory basically. That's what it's for. Because otherwise, again, it would just
487   be character in a word ride and I really can't recall that.

489   M: Yes, it will also give you an idea whether you have met a person before, I could imagine that's a
490   part.

492   2: It would kind of a personal, right. And i would remember, I would persist it in my memory.

494   M: But what Brigita look is the graphical displays, and we could also understand that you liked it.
495   Maybe you could tell why you liked it and why it means something for you that they are graphical
496   instead of just text?

498   2: Yes, because for me, when it is graphical, I will have, you could say, a much quicker and parallel
499   interpretation of information, right. So I don't have to, you could day, secountiely try to reach,
500   understand whatever. By visually, that could be the graphs, whatever, right. It gives me kind of a
501   parallel quick information overview. Yeah, basically that's what it brings to me. So I don't have to
502   do any interpretation of words, but just can by one picture getting some information. And by simple
503   means, again, maybe it is just an illusion trick, but something bigger means more important or
504   higher weighting, or whatever. So do not have to read numbers and interpret them.

506   M: Yeah, and implying to what you are saying here and also what you have said before, again to
507   confirm, that we heard it. It is actually too detailed or even complicated the number itself, but to

508   have sort of graphical representation indicating whether it is a lot or less, it is much more easy to
509   understand?
510
511   2: Yes, it is much easier to understand, and it gives me a baseline, sort of to understand, should I
512   go left or right. And if I chose to dive into it, right, then I can get the numbers. Of whether what's
513   44% or whatever. So it gives me a divide and conquer, so that is what graphical representations
514   are suitable for. At least for me.
515
516   M: Yes, good.
517
518   B: Yes.
519
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529

A.8 Interview transcription C

1   Interviewer indicated as "B"

2   Secondary interview "M"

3   Informant indicated as "3"

4   Interview length: 37.40

5

6   B: Could you describe your professional functionalities in relation to your enterprise that you are
7   working in?

8   3: Right, so I am director research, which means that I have corporate responsibility for our
9   research activities. And I have a research groups consisting of seven, eight, nine, depending.
10   Some of them sometimes work on other projects as well. But basically we have nice researchers in
11   the group. And then, in addition to the nine researchers, we have four or five interns every
12   semester and we have typically one or two PhD students or post docs for period of, post docs are
13   3-4, PhD 3 years. So basically we are a group of 15+ people. And we mainly work in the area of
14   acoustics, signal processing, a bit on user interfaces. So that's sort of very shortly.

15   B: And what are you specifically doing, what are your day-to-day tasks?

16   3: Manage research group, supervising PhDs' and post docs here, when they are here at X
17   enterprise. And then participate in the management group, that is strategic decisions for the
18   company in addition to research. So, that is sort of my daily work. I also do a lot of work in various
19   councils and advisory boards, but I don't know whether that should be included in my job
20   description.

21   M: What kind of boards? Is it in connection to the university or is it as part of industry?

22   3: I am on the GN, the company GN, the scientific advisory board. I am a member of the Danish
23   council for science and innovation, we advise the minister and the parliament. And what else…
24   Then I am on the board of the local high school, gymnasium. And I just stepped out of think tank
25   called DEA. And I am also heading the Danish sound network, which is used to be an innovation
26   network, but we lost our funding last year and now we are continuing on different funding schemes
27   and I am chairman of the board of that organization.

28   M: Yes, but it is all relevant also in relation to what Brigita is going to talk about.

29   B: Yes. So during your work, have you ever looked for specific academic experts in relation to
30   some projects, that were happening at X enterprise?

31   3: Well, I have not been looking unfortunately, we get applications from all over the world, because
32   we run this internship program. Were the interns are typically in their last or… Close to doing their
33   master thesis project. And what we usually do, that if they are good, we will either hire them to a
34   PhD project, or hire them directly. We just hired two of them directly. As for members in the
35   research group, that consists of people who have done PhDs with us, so I hire them after they did
36   they PhDs. And others have applied directly to me. So we never announced for positions in the
37   research group.

38   B: So it means you never were in a need of specific academic expert, to solve a specific problem?

39   3: No, because we have a fairly board research group, so all of them can sort of work within the
40   area and have knowledge of acoustics, which means, that they can sort of help out as a team they
41   can usually solve the problems. So we have never looked for a specific person to a specific job in
42   the research group. I usually hire them with very broad competences. Of course they all have a
43   PhDs, so they have done a PhD in a specific domain, but in addition they are being trained, so
44   they know all about other domains as well.

45   M: Where do they, the master students, applying for internship, you say they come from all over
46   the world?

47   3: Yeah.

48   M: So it is all over the world… Both developing and undeveloped or more undeveloped countries?

49   3: I mean we have from China, I have a lot of application from Iran, Iraq, the former East countries,
50   Russia. So, it is basically from EU countries and the rest of the world. Predominantly we hire from
51   EU countries. Because it is quite costly to get non-EU student into the country. We use an external
52   company to help us with all the immigration papers and that costs us around 20000kr per student,
53   to get them into the country. So unless, they have really specific, you know, really highly highly
54   talented people, or students, we will go for those within the EU. Right now we have close
55   collaboration with NTU in Singapore and Shanghai Chautong university in China. And those two
56   universities are number one and or number two in the countries in China and Singapore. So the
57   student, coming from there are really, really high quality, so we will spend the 20000kr in order to
58   get them into the country.

59   B: How familiar are you with the Research Information Management Systems, like VBN for
60   example?

61   3: I report my publications in VBN, but that's about it.

62   M: But that's a good thing.

63   3: But we have to do it in order to fulfil the requirements at the university. But that's about it.

64   B: So you never used VBN to look up an expert?

65   3: No.

66   B: But today I will show you a prototype, that is now actually is live and running, but when we
67   made it or developed it a month ago, it wasn't running. So, it has all VBN data, researchers and all
68   activities, publications. All that the current system has now. So, I would like to present it to you
69   and afterwards ask some questions, along the way.

70   B: If you look at the small icons here and the categories, if you were to look for a specific subject
71   or an expert, from the industry perspective, which category would you chose in order to find an
72   expert?

73 3: I would go for the publications and find the experts in the area. I would go to the specific area
74 to see what has been published in that area. Who has published it and then try and identify
75 certain universities or research groups that are working within the area where we are interested.
76 So let's say it would be "digital sound" and then we would go and use those search words to
77 provide publications. And then I would try and identify the research groups.

78 3: And then try to find the best.

79 M: So a research groups is, in a way, more important for you, compared to the individual
80 researcher?

81 3: No, not when it comes down to starting an actual collaboration. But as you know, I mean, many
82 publications will be by PhD students with the professor or supervisor second or third author. So,
83 the actual content, I mean the topic that they are working on, that's the important point. And then
84 of course, identify, who is actually then the leader of the research group, or the leader of that
85 particular research group. And then I would contact those persons, to say "okay, we have this
86 project, are you interested in collaborating, or whatever". So, the individual persons would be the
87 next step after having identified a group.

88 B: Alright, maybe we can try and take one publication here.

89 3: Scalable algorithm, try and take that one here…

90 B: What does the fingerprint under the publications means to you?

91 3: Yeah, that's the keywords for those, for that publication I guess.

92 B: Yes, are they relevant, when trying to identify whether this publication is relevant to your
93 enterprise?

94 3: Yes, they would be, yeah.

95 B: How do you understand the weight representation, what does that tell you?

96 3: I would assume, the ranking of that particular keyword with respect to what's the content. I
97 guess the researchers have identified a specific set of keywords, that's what I usually do when I
98 publish. So the publisher ask me to identify set of keywords, in order of importance, so I guess this
99 is what this represent, but I am not sure.

100 B: It actually mines the abstract, it is an automatic engine, that uses specific thesaurus, so it mines
101 the abstract of the publication and then collects the keywords that appear the most. But how
102 relevant is it to see the weight representation, the percentage?

103 3: Not very much for me. It is difficult. But somewhat important, because it indicates the keywords
104 within the area that I was looking for, but it is the basic – I need to read the paper to find out, if it
105 is relevant or not. So I would go for the title and the authors.

106   B: Here again, we have a fingerprint. The subject areas of that particular publication. A fingerprint
107   is an engine, that mines the abstract and presents the keywords, that appear the most in the
108   abstract. So it sort of helps you to identify and area, where this publication represents the most.

109   3: Yeah, but it is only the abstract?

110   B: It is only the abstract.

111   3: Right.

112   B: Because some of the publications, when we saw it, they don't have the fingerprint underneath
113   them, it means, that they have not uploaded the abstract with the publication.

114   3: Right.

115   B: Then, we will see the authors here. We can try Søren Hold Jensen. Here the fingerprint
116   presents... How do you understand it when you look at it?

117   3: I am just reading… "based on mining the text of the person's scientific documents to create an
118   index of weighted terms, which defines the key subjects of each individual researcher." Right, so
119   now that is for Søren's research publications.
120
121   B: Yes.
122
123   3: That would be interesting. Because, as I said, you would go in and… I saw in the top there was a
124   citation index, right.
125
126   B: Yes.
127
128   3: So if I click on various authors of publications, that citation index would help to identify sort of
129   who are the key supervisors or leaders of the research group. Because the PhD students would
130   have a lower index. So I use that to identify who are sort of the key scientific persons in this
131   publication. And then the fingerprint, could help me identify is Søren a person of that research
132   group that would be the most interested in, or is it another person that would be more interesting
133   for me. So the fingerprint of the person, complete publication list seems to be quite useful.
134
135   B: But is it easy to understand in which field he is an expert at?
136
137   3: Yes, because it is listed according to weight. I see that he is in acoustics, microphone, frequency
138   estimation, hearing aids and so forth. Yes, that seems pretty obvious.
139
140   M: What about the division in sort of disciplines, material science, engineering, physics,
141   astronomy? Does it mean something for you?
142
143   3: No, not really. I mean, what I am interested is, has Søren published in areas that I am interested
144   in. Whether it is an engineer or in physics or in life sciences that is not that important.

145 B: If we click, for example, on acoustics. How do you understand this presentation and these
146 categories?

147

148 3: Is that within he whole library or that particular publisher, or yeah… I would say that particular
149 publisher I don't know. Then I would say, there are 44 profiles similar to Søren's or something.
150 That would be my impression.

151

152 3: Is that correct, or what?

153

154 B: Yes, it shows all the profiles, 44 profiles that have the same ranking in their fingerprint
155 presented by the subject 'acoustics'.

156

157 M: So it is not in the journal, it is in the VBN database?

158

159 B: Yes.

160

161 3: Okay, so in the entire database. So if you click on 44 profiles, then get those 44 people?

162

163 B: Yes.

164

165 3: Aaaa, right, right…

166

167 B: What would help you to identify the expert from this list? What would help you to choose and
168 decide that this is the right expert for me?

169

170 3: There I would need a fingerprint of each of these researchers. Just like I've seen at Søren's.
171 Okay, let's say if I take Mark, what's his fingerprint? But that would be good, because then I…
172 Otherwise I would need to click om all of the researchers. So if I somehow could have a
173 comparison of their fingerprint on this list, that would be useful. Because then I would avoid
174 having to click on each of them.

175

176 B: Do you mean right here, on this big list?

177

178 3: Yes, some kind of, perhaps on the first three or four…

179

180 B: Subjects?

181

182 3: Yes.

183

184 B: What about his one here? The research output visualization, does that help you to decide or
185 affects your judgment when choosing a person from this list?

186

187 3: It is very small… So what does it say down there?

188

189 B: It says projects between 2012-2019, and research output between 1991-2019.

190   3: Is that number projects?

191

192   M: Projects and research output. So it is papers and projects.

193

194   3: Okay, so yes, that would give an indication of whether that's a PhD student or more. Or, Mark, it
195   says professor of course. These are more senior researcher. That would definitely be helpful to
196   distinguish between publishing in this area or perhaps he is less active.

197

198   M: So what you are saying, maybe indirectly, it is not so much a title, it is whether you can see he
199   is an active person. And whether this person is working with topics that are of course relevant and
200   of interest for you?

201

202   3: Yes, exactly.

203

204   B: What the system does, it can also show his network. How do you understand this?

205

206   3: Is that co-publishers, I mean co-authors?

207

208   B: Yes.

209

210   3: Okay, yeah. But then you should write, why don't you say co-authors instead of network?

211

212   B: That is right, yes.

213

214   B: There is another one. How does this force network differ from the circle visualization? How
215   would you compare these two?

216

217   3: I prefer the first one.

218

219   B: Why is that?

220

221   3: Please call it what it is, because the network is a lot of stuff. It could be people he played
222   football with. But if it is his co-authors, then that is important.

223

224   B: Here you can see the year filter and how many times he had collaborated with each person.
225   How useful is that?

226

227   3: I guess it would tell me something about if he is a part of research group, then I guess his
228   research group members will appear in that diagram. And then you could say, okay, who is he
229   most often collaborating with in terms of publications. So it would give an indication of who are
230   his primary collaborators research wise.

231

232   B: And how is that helpful for you? Would you then contact them?

233

234 3: Yes, because I would assume that they have a common research interest. So that could be
235 useful.

237 B: What about the research units? And then we eliminate the persons and external persons here.

239   3: Oh, that is pretty fancy.

241 B: Is it easy to understand?

243 3: Well, that could be interesting. But them would indicate, I mean if we don't, for one reason or
244 another, don't want to collaborate with the Aalborg University, who could be… Because Aalborg
245 University is far from us. If there is another university close to us. Then if that university is within
246 this research group, then we could start there, talking to those guys. So that would be useful, in
247 terms of seeing it from the company point of view, the physical distance to the University is
248 actually of importance.

250 M: Could you explain why?

252 3: In terms of exchanging researchers. I mean we actually have three Aalborg University people
253 working for us 20%, they spend one day a week down here. And that wouldn't be possible if it was
254 the DTU we were collaborating or Oxford in Britain. That would be difficult to have them on a
255 regular basis. And the reason it is important to have them on a regular basis is that when they are
256 down here they are considered to be employed by X enterprise and which means, they participate
257 in you know all sorts of activities, information meetings and whatever. Which is important for
258 them in order to be and feel, understand what is going on in the company. So the distance of the
259 university, in cases like that, is pretty important.

261 M: So physical presence is important?

263 3: Yes, and also we share research facilities with Aalborg University, so we have a set up here at X
264 enterprise and more or less similar set up here in Aalborg so students could do experiments here
265 or in Aalborg. But if they have to travel, you know, far in order to do that, that would of course
266 limit the usability of their common research facilities.

268 3: So that is a pretty useful graph.

270 B: And here is the research output, visualized in a better way. You can also see the citations here
271 and the h-index, type of genres he had published.

273 M: Is it useful, relevant information?

275 3: Yeah, you know, when you write various applications for findings, you have to have h-index or
276 another index. So of course, that is important. But how it developed over the years that could
277 indicate you know, obviously Mark is an active researcher. So that is important, in order to be able
278 to see that this is a steady output of this particular person.

279   M: Yeah.

280

281   B: So it gives an impression, that he is active. He seems more attractive to contact or collaborate?

282

283   3: Yes, it shows he is active in the area. And then you of course would go and see his particular
284   publications. But as an indicator to begin with, that is pretty useful.

285

286   B: So would you say, that Pure Portal, this particular interface is useful in presenting the expertise
287   and the activeness of a researcher?

288

289   3: Yes, the first impression is good.

290

291   3: Do you have any possibility for indicating in his network, how many foreign contacts, not
292   national, but foreign contacts he had?

293

294   B: You can only see the external person he was collaborating with and on those person's, you
295   have no information. You can only see that he is an external person. These are the only filter
296   options that support this type of visualization.

297

298   3: But if you click on that particular person, you can see where that particular person belongs.

299

300   B: Yes, but only because they are in VBN database.

301

302   M: Yes, but of course it is an information that could be added to the database. And of course we
303   note that you ask for this information.

304

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