Knowledge valorization around academic medical centers

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Summary

Knowledge valorization, a process in which value is added to new knowledge in order to transform it into a new (improved) product, process or service in the market, becomes more and more important in the current economy and society. In particular for the health care area this can lead to large benefits for patients and society. This study investigated to what extent investing in financial, human and social capital influences the knowledge valorization performance of academic medical centers. A total of five European academic medical centers and their related knowledge valorization actors have been studied. 28 interviews have been conducted, complemented with a review of relevant literature. Firstly, all knowledge valorization landscapes have been mapped. This illustrated which actors are involved in the knowledge valorization process. It became clear that the process involves the deployment of fifteen knowledge valorization activities and that investing in financial capital, human capital, and social capital is needed to be able to deploy those activities. Regarding the knowledge valorization performance it became clear that all cases perform quite close to each other. In general human resources appeared to be most important for knowledge valorization around academic medical centers. The human resources have such a large influence on the valorization process mostly because of the broad range of needed expertise and the ability to bridge scientists with the industry. Financial capital and social capital alternate with each other regarding their importance for knowledge valorization. The importance of the social network of actors is mainly due to the possibility of adding expertise and the ability of testing ideas. The financial resources mainly contribute to knowledge valorization through the possibility to buy additional expertise and through the use of seeding money to invest in promising ideas. It also can be concluded that the three resources are dependent on one another, as one resource can help to get access to another resource. Several recommendations can be made for academic medical centers and their related actors:

- Invest most in developing human resources by training of employees in several skills and by hiring employees with a diverse set of qualities.
- Make sure that employees can make a career in the knowledge valorization field as reward and incentive. For instance a researcher could be promoted to associate professor or professor.
- Lobbying with governmental actors for financial resources meant for supporting knowledge valorization to avoid opportunities that remain unused.

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1 Introduction

Nowadays it is widely accepted that the creation and application of knowledge is the main drive for economic growth (Agrawal, 2001). Therefore, the transfer of knowledge from universities to industry, or in other words knowledge valorization, is of great interest (Agrawal, 2001). In line with Geenhuizen (2010; p1) knowledge valorization in this study is defined as "a process in which value is added to new knowledge in order to transform it into a new (improved) product, process or service in the market". This valorization of knowledge is particularly interesting for Europe because of the so-called European Paradox (Audretsch, 2007; Bonnet & Cussy, 2010; Debackere, 2012). The European Paradox refers to the idea that European countries are globally strong in scientific output but lag behind in the ability of translating this strength into value adding products for society (Dosi et al., 2005). So on the one hand Europe has a strong scientific knowledge base (King, 2004). On the other hand the average European university generates fewer inventions and patents than those in the US (European Commission, 2007) and is lagging behind the US regarding earned license income (Conti & Gaule, 2011). For knowledge in the health care area it also holds that knowledge has been widely developed, but that a large amount of this scientific knowledge remains unused (Berwick, 2003; Corrigan, 2005). University hospitals or academic medical centers can play an important role in this knowledge valorization process (Geenhuizen, 2008; NFU, 2009), as knowledge valorization is considered as one of the core tasks of academic medical centers (NFU, 2013). For this reason European academic medical centers as knowledge valorization actors are the subject of this study. Academic medical centers are defined in this study as centers that offer comprehensive, cutting-edge patient care, have large research programs, and train the healthcare professionals of the future (Oregon Health & Science University, 2013).

A lot of research has been conducted regarding knowledge valorization of universities. Most of this research focuses only on the use of spin-off companies, patents and licenses, and on the role of incubators and Technology Transfer Offices (TTO's) (Agrawal & Henderson, 2002; Geuna & Muscio, 2009). Bergek & Norrman (2008) for instance developed a framework describing three incubator model components - selection, business support, and mediation - on which the performance of incubators may be based. Siegel et al. (2003; p27) analyzed the performance of TTO's and state that this is mostly influenced by "reward systems, TTO staffing/compensation practices, and cultural barriers between universities and firms". Thursby et al. (2001) explain that the number of licenses increases when the TTO's are larger and when medical schools are involved.

However, some important aspects of knowledge valorization are overlooked this way. This because only a small fraction of the research conducted at universities can be codified in patents and because the patenting channel accounts for only a small part of all knowledge valuable for commercialization (Cohen et al., 2002; Geuna & Muscio, 2009). Consequently, Landry et al. (2013) identified many additional activities that contribute to knowledge valorization, such as helping firms to specify their needs, or to help firms with prototype design. Aiming to build further on this knowledge, this study takes on a broader perspective on knowledge valorization as well. When analyzing the functioning of the broad knowledge valorization process it is important to know what kinds of aspects influence this process. These are elaborated on below.

Several scientific articles point to the importance of resources for universities for valorizing knowledge (Santoro & Gopalakrishnan, 2000; Siegel et al., 2007). A variety of resources has been identified, but their importance can be situation dependent. Lockett et al. (2003) state that financial capital may be crucial for knowledge valorization. Furthermore, Xu (2000) explains that nations cannot benefit from technology transfer without a certain degree of human capital. Landry et al. (2002) state that marginal increases in social capital make a larger contribution than any other explanatory variable to increase the likelihood of innovation in firms and knowledge valorization. Because of this, financial capital, human capital, and social capital are expected to be the most important resources for knowledge valorization and are therefore included in this study. These resources are now discussed in short. Financial capital may be important for knowledge valorization, as the knowledge valorization process could be constrained by financial limitations (Santoro & Gopalakrishnan, 2000; Lockett & Wright, 2005). Limited financial capital could for instance lead to a lack of investment money. Human capital involves people with expert knowledge and talent (Powers & McDougall, 2005). For instance Markman et al. (2005) refer to the participation of academic inventors in the licensing process as a crucial aspect of the speed of knowledge valorization. Social capital refers to the benefits that actors are able to obtain from their social structures, networks and memberships (Davidsson & Honig, 2003). For example Yli-Renko et al. (2001) mention that social capital facilitates external knowledge acquisition which may contribute to the knowledge valorization process. Moreover, Coleman (1988) states that social capital complements the effects of human capital and financial capital. The influence of financial capital, human capital, and social capital on the knowledge valorization process can all be analyzed using the Resource Based View (RBV). The RBV explains that organizations can be seen as a combination of resources and that differences in these resources can lead to difference in an organization's performance (Wernerfelt, 1984).

When academic medical centers are compared with universities it becomes clear that they both conduct research and teaching activities, but in addition to that academic medical centers conduct a core activity of patient care (Einbinder et al., 2001). This aspect of patient care brings along practical experience which can be an important aspect of knowledge valorization (Dougherty, 2004; Charles, 2006). However, as described above, research on knowledge valorization is often conducted on the valorization performance of universities in general instead of focusing on academic medical centers. Few studies mention the importance of academic medical centers for knowledge valorization, but those only consider academic medical centers as part of a larger cluster and do not take academic medical centers as central unit of analysis (Geenhuizen, 2008; Geenhuizen, 2010). A small number of other studies address the utilization of research by nurses (Kajermo et al., 1998; Brown et al., 2009), but those do not consider the performance of academic medical centers in relation with knowledge valorization activities and therefore do not use a broader perspective regarding the valorization process. Therefore, there are gaps in literature regarding the knowledge valorization performance of academic medical centers and the broader valorization perspective involving a range of knowledge valorization activities. Moreover, as the resources financial capital, human capital, and social capital appear to be of major influence for the knowledge valorization process of universities, these resources are expected to influence the knowledge valorization performance of academic medical centers as well. Yet, the specific influence of investments in these resources by academic medical centers for the valorization of knowledge remains unknown. In an attempt to fill these gaps in existing literature the following research question has been stated: *To what extent do investments in financial capital, human capital, and social capital influence the knowledge valorization performance*

of academic medical centers? Here, it is also investigated what role the deployment of knowledge valorization activities fulfills for the valorization performance of academic medical centers.
In this study performance refers to: "accumulated results of all the organization's work activities" (Robbins & Coulter, 2012; p492). From other studies it becomes clear that performance can be conceptualized by the dimensions effectiveness (De Wit, 1988) and satisfaction (Provan & Milward 2001). This is elaborated in section 2.

To solve the research question a multiple case study has been conducted in five academic medical centers located in Europe. First, the Resource Based View (RBV) has been explained further and has been used as perspective to develop deeper understanding about the role that resources and combinations of resources can play for the knowledge valorization performance of academic medical centers. Knowledge valorization occurs through the deployment of knowledge valorization activities (Landry et al., 2013) and the before mentioned resources are needed to be able to deploy knowledge valorization activities. The deployment of these activities is expected to influence the knowledge valorization performance of academic medical centers. For instance, it could be that the more activities the academic medical center deploys, the better the performance would be. It may also be possible that there appear to be optimal combinations of knowledge valorization activities, or that some activities are more important than others for the knowledge valorization performance. Therefore, the variety of knowledge valorization activities that can be deployed by academic medical centers have been studied in more detail. The exploration of the knowledge valorization landscape made clear which actors are involved in the valorization process and helped to indicate what different kind of knowledge valorization activities are possible to invest in for academic medical centers, which contributed to analyzing the knowledge valorization performance of academic medical centers.

This research is relevant for society. By investigating the influence of investments in different resources on the knowledge valorization performance of academic medical centers, it has become clear which combination of resources is more effective than others. This has led to important implications for European policy makers in further stimulating the valorization of knowledge in the life sciences, which can contribute to a healthier society, a more efficient health care system, and additional economic benefits. Best practices have become clear for academic medical centers regarding knowledge valorization, which enables them to adapt their strategy for the valorization of their knowledge to be more beneficial for society. Furthermore, this study is of theoretical relevance. By mapping the knowledge valorization landscape around the academic medical centers the scientific literature regarding knowledge valorization activities is extended and becomes more specific. Moreover, as the Resource Based View is mostly used in relation to firms and competitive advantage (Barney, 2001), this study extends the understanding of the RBV by combining the RBV with the performance of organizations as knowledge valorization actors. This theoretical contribution can lead to further development or adaptation of concepts related to the Resource Based View.

This study continues with a theory section, section 2, in which the use of the Resource Based View is further explained and different knowledge valorization activities are discussed. The method section, section 3, elaborates the conducted research method. After this the results are presented in section 4. Finally, the research question is answered in section 5 and several recommendations are given in section 6.

2 Theory

In this theory section the Resource Based View is further explained in section 2.1. Different knowledge valorization activities are elaborated on in section 2.2, the performance dimensions are further discussed in section 2.3, and a conceptual model is provided in section 2.4.

2.1 Resource Based View

The Resource Based View (RBV) is a perspective that has been widely used to analyze differences in sustained competitive advantage of firms based on differences in resources (Barney, 2001). In this study the perspective has been used in a slightly different way, as the RBV has been used to analyze knowledge valorization performance.

The RBV entails that firms or organizations comprise a set of assets which are bounded to the organization in a semi-permanent way (Wernerfelt, 1984). The resources that an organization contains can be considered as strengths or weaknesses and differ per organization. Resources that are scarce, durable, difficult to trade, and difficult to imitate are said to be valuable resources for an organization (Amit & Schoemaker, 1993). Therefore, differences in resources can lead to differences in competitive advantage and to differences in performance. More particularly Barney (1991; p116) states that "the higher levels of performance that accrue to a firm with resource advantages are due to the efficiency of these firms in exploiting those advantages". This means that besides the presence of certain resources, it is even more important how organizations deal with exploiting those resources. Thus, the management of resources is an important aspect for achieving sustained competitive advantage (Barney, 1991). The importance of managing resources can be recognized when analyzing the performance of academic medical centers as knowledge valorization actors. Academic medical centers can manage their resources differently (Walshe & Rundall, 2001), and can for instance decide to invest more heavily in one kind of resource than in other kinds of resources.

Within the RBV different kinds of resources can be identified. These can be divided in tangible resources and intangible resources (Wernerfelt, 1984). Examples of tangible resources are plants, machinery, and finance (Grant, 1991). Examples of intangible resources are qualified people, networks, organizational culture, and reputation (Hall, 1992). Based on Lockett et al. (2003), Xu (2000), Landry et al. (2002) it is expected that financial capital, human capital and social capital are the most important resources for knowledge valorization, see section 1. Therefore, this study focuses on these three resources, which are explained below.

Financial capital is part of the tangible resources and refers to all possible monetary resources available for the discovery and exploitation of a promising idea. As a tangible resource financial capital is one of the most visible resources of organizations (Cooper et al., 1994). Financial capital can serve as a buffer against random shocks and it can lead to more financial capital-intensive strategies. Furthermore, financial capital can stimulate growth and may be beneficial in attracting additional investors (Cooper et al., 1994). Powers & McDougall (2005) state that financial capital is crucial for conducting research and mention the importance of funding to support a laboratory for university related organizations. Also for knowledge valorization it is suggested that financial capital is important (Antonelli & Teubal, 2006; Geenhuizen, 2010). For instance, Antonelli & Teubal (2006) state that financial capital can help to overcome hurdles start-up companies face when

commercializing technologies. Therefore, financial capital can be of major influence for an academic medical center, since there has to be money available to conduct research, and to exploit the knowledge as a marketable application.

Human capital is part of the intangible resources and refers to people with expert knowledge and talent (Powers & McDougall, 2005). Aspects of human capital are for instance productivity of people, problem-solving skills, management know-how, or industry know-how (Cooper et al., 1994; Davidsson & Honig, 2003). Human capital can for instance be developed internally through training of employees (Lepak & Snell, 1999). Internally developing human capital is most beneficial when the necessary skills are firm specific. Since people with firm specific skills possess abilities that are both valuable and unique, these employees can be considered as core employees, who are essential for an organization's performance (Lepak & Snell, 1999). Other ways of accessing human capital are through acquiring human capital from the market, through contractual relationships, or through alliances. Acquiring human capital from the market is most beneficial when the kind of human capital is valuable but widely available on the market, as this saves the organization the costs of developing it itself. When the kind of human capital is not of strategic value there is no need to internalize the human capital and contract relationships or alliances may be most beneficial for an organization's performance (Lepak & Snell, 1999). An example that illustrates the importance of human capital for knowledge valorization activities in general is that academic inventors may face difficulties in recognizing a commercial opportunity (Lockett et al., 2003), whereas technology transfer office staff may be more alert to commercial opportunities for universities (Lockett & Wright, 2005). This indicates that investments in human capital may be important for academic medical centers and related actors when valorizing their knowledge.

Social capital belongs to the intangible resources and can be described as "the ability of actors to extract benefits from their social structures, networks and memberships" (Davidsson & Honig, 2003; p307). Examples of social capital are networks provided by friends and family, a community, or organizational relationships (Davidsson & Honig, 2003). A distinction can be made between social capital on individual level and on organizational level, where individual social capital originates from an individual's network of relationships and organizational social capital originates from an organization's network of relationships (Inkpen & Tsang, 2005). When analyzing the knowledge valorization performance of academic medical centers both individual and organizational social capital is taken into account. Furthermore, social capital contains ties between actors which can differ in intensity. Weak ties refer to loose relationships between individuals or organizations, whereas close ties or strong ties for instance refer to those derived from family relationships (Davidsson & Honig, 2003). Both weak and close ties are valuable for strengthening social capital. The study of Davidsson & Honig (2003) indicates the value of social capital, suggesting the importance of promoting and facilitating social relations for knowledge valorization processes. Also Inkpen & Tsang (2005), state that organizations may have to manage and build social capital proactively in order to effectively and efficiently valorize knowledge.

Due to the slightly different approach on analyzing the process of knowledge valorization instead of the competitive advantage of firms, the understanding of the Resource Based View is extended by this study. The content of financial resources, human resources and the social network as a resource is enhanced extensively, indicating what aspects are particularly important for knowledge

valorization around academic medical centers. Because of this, concepts of the RBV are adapted or newly developed.

2.2 Knowledge valorization activities

As explained in section 1, knowledge valorization occurs through the deployment of knowledge valorization activities for which different resources are needed. Therefore, it is useful to know what different kind of knowledge valorization activities are possible to invest in, to obtain insight in the knowledge valorization process of academic medical centers. Organizations can deploy various (combinations of) valorization activities which can lead to differences in the valorization performance. For instance, it could be that the deployment of more activities could lead to a better performance, or that the deployment of particular activities could be more beneficial than others. Besides this, academic medical centers can invest their resources for the deployment of knowledge valorization activities differently, which can influence their knowledge valorization performance.

Landry et al. (2013) identified 21 knowledge valorization activities. Examples of activities Landry et al. (2013) mention are to help firms with patent applications or helping firms develop a business case. Furthermore, Goorden et al. (2008) refer to the importance of management activities as part of the knowledge valorization process. Providing facilities for start-up companies and providing financial assistance are examples that Hussler et al. (2010) mention as knowledge valorization activities. Combining those activities identified by Landry et al. (2013) with knowledge valorization activities identified by Goorden et al. (2008) and Hussler et al. (2010) leads to an adapted list of knowledge valorization activities suitable for this study, see Table 1.

Table 1: Knowledge valorization activities; adapted from Landry et al. (2013).

No.	Knowledge valorization activity
1	Provide assistance with setting up collaborations
2	Provide assistance with managing collaborations
3	Provide assistance with specifying firms' needs related to technologies, production equipment, and patents
4	Provide assistance with specifying firms' needs related to research
5	Provide assistance with developing a prototype design and tests of technical feasibility
6	Provide assistance with product and process safety certification
7	Provide assistance with patent applications preparation
8	Provide assistance with creating spin-offs in order to exploit inventions
9	Provide assistance with the negotiation and management of contractual agreements
10	Provide assistance with accessing commercial bank loans, angel investors, or venture capital, or subsidies linked to the development of new or improved products and processes
11	Provide own financial capital investments
12	Provide start-up companies with office space
13	Provide assistance related to product positioning
14	Provide assistance with developing a business case
15	Provide assistance with accessing markets/distribution channels

The above described list of knowledge valorization activities in Table 1 is used to indicate what academic medical centers and their related actors actually do. This enhances the insight in the knowledge valorization process of academic medical centers.

2.3 Knowledge valorization performance

In this research performance is defined as "accumulated results of all the organization's work activities" (Robbins & Coulter, 2012; p492) relating to knowledge valorization. In line with other studies performance is conceptualized by the dimensions effectiveness (De Wit, 1988) and satisfaction (Provan & Milward 2001). Effectiveness refers to the degree to which objectives have been met (De Wit, 1988). Therefore, the goals regarding knowledge valorization that have been set by the academic medical centers are studied and it is analyzed whether the academic medical centers have achieved those or not. This can be complemented with another dimension; satisfaction, which takes into account the experience that knowledge valorization actors perceive about the process. This enhances the insight into the performance, as it can be explained why an organization can still be satisfied despite unachieved goals or the other way around.

2.4 Conceptual Model

From Table 1 can be deduced that different knowledge valorization activities can involve investments of different resources. For instance, providing own financial capital or providing assistance with patent applications preparation may require financial capital. Providing assistance with specifying firms' needs may require human capital, whereas providing assistance with setting up collaborations may require social capital. Therefore, investments in financial capital, human capital and social capital are expected to enable the deployment of knowledge valorization activities, which may vary among academic medical centers. The combination of investments in resources and the deployment of activities is then expected to influence the knowledge valorization performance of academic medical centers. This leads to the following conceptual model, see Figure 1.

Figure 1: Conceptual model.

3 Methods

In this section the methodology that has been used is described. The research design is explained and the approach for selecting cases is elaborated. Furthermore, the method for collecting data, the operationalization of concepts is described, and the method for analyzing the data is discussed. Lastly, attention is paid to the reliability and validity of this study.

3.1 Research design

Because of the relative new field of knowledge valorization around academic medical centers an exploratory character is suitable for this study. Therefore, it is tried to explore the knowledge valorization process of academic medical centers and the relation between the Resource Based View and knowledge valorization performance. Due to the exploratory nature of the study a multiple case study has been chosen as research design. Yin (2003) explains that a multiple case study design is most appropriate when the research contains a why or a how question. In this study it is investigated to which extent financial capital, human capital, and social capital influence the knowledge valorization performance of academic medical centers. This can be considered as analyzing how those resources influence the knowledge valorization performance, which makes a multiple case study a suitable design for this research. Furthermore, multiple cases likely lead to a more robust analysis than if the results would be based on only one case (Yin, 2003).

Due to the exploratory character of this study, rich and in-depth insights are needed. These are best obtained through a qualitative approach, which therefore is used in this study. In this way a better understanding about the influence of investments in resources on the knowledge valorization performance of academic medical centers is obtained. Moreover, it is stated that the influence of intangible resources like human capital and social capital on the performance of an organization are best measured in a qualitative way (Rouse & Daellenbach, 1999). This is because a qualitative approach adds richness of detail which is needed to reveal the differences and strengths of intangible resources that influence the performance of an organization (Rouse & Daellenbach, 1999). Because of the detailed level of analysis, a qualitative approach provides the possibility of adapting or developing concepts related to the Resource Based View. This is needed due to the slightly different approach of combining the RBV with knowledge valorization instead of analyzing the competitive advantage of firms. Lastly, using a qualitative approach makes it possible to enhance the insight about the specific content of knowledge valorization activities.

3.2 Case Selection

In this study European academic medical centers serve as unit of analysis. In order to obtain insight in the knowledge valorization performance, five European academic medical centers have been selected from the 21 universities which are part of the League of European Research Universities (LERU)[1]. The LERU includes the leading research-intensive universities of Europe (LERU, 2014). Due to the high quality of the conducted research at those universities, the valorization of knowledge is of particular interest for academic medical centers which are connected to the LERU. Purposive sampling has been applied to obtain the most contributing cases (Bryman, 2008). This has led to the academic medical centers in Utrecht, Leiden, Leuven, London and Cambridge as these were best accessible. These cases are discussed in detail in section 4.

[1]Universities which are part of the LERU are: Universiteit van Amsterdam, Universitat de Barcelona, University of Cambridge, University of Edinburgh, Albert-Ludwigs-Universität Freiburg, Université de Genève, Ruprecht-Karls-Universität Heidelberg, Helsingin yliopisto, Universiteit Leiden, Katholieke Universiteit Leuven, Imperial College London, University College London, Lunds universitet, Università degli Studi di Milano, Ludwig-Maximilians-Universität München, University of Oxford, Université Pierre et Marie Curie, Université Paris-Sud, Université de Strasbourg, Universiteit Utrecht and Universität Zürich (LERU, 2014).

3.3 Operationalization of concepts

To be able to collect data and analyze the influence of the concepts, the concepts needed to be operationalized. The operationalization of the concepts financial capital, human capital, social capital, and performance is presented in Table 2 and is based on prior scientific literature. The deployment of knowledge valorization activities is operationalized by asking whether an organization deploys the activities presented in Table 1 or not. Furthermore, there has been asked in interviews for examples to illustrate the deployment of those activities and for the importance of each activity.

Table 2: Operationalization.

Concept	Dimension	Indicator
Financial capital		Seeding money
		Money for valorization activities
Human capital	Education	Formal education
		Training
	Experience	Work experience
		Managerial experience
Social capital		Social network
Performance	Effectiveness	Goal achievement
	Satisfaction	Experience of satisfaction

To analyze the influence of financial capital on the knowledge valorization performance there has been focused on seeding money to invest in promising ideas and on money available for the deployment of knowledge valorization activities. Seeding money is an important factor to overcome the financial gap that research based start-ups can face (Heirman & Clarysse, 2004). Furthermore, Landry et al. (2013) state that money is needed to conduct valorization activities. In particular financial capital is meant as money to buy a product or service, and not as money that is needed to pay personnel. The payment of personnel has been excluded here because that aspect is better suited to the human capital.

The most common dimensions of human capital are education and experience (Kim et al., 2006). Therefore, these are the dimensions of this study as well. Regarding the dimension education both formal education and informal education, like training, are taken into account. Regarding the dimension experience both work experience and managerial experience are included.

Uzzi (1999) analyzed the influence of social capital on benefits for organizations. In that study social capital has been operationalized as the social network of the organization and its employees (Uzzi, 1999). The social network, including both weak and strong ties, indeed resulted in benefits for organizations (Uzzi, 1999), which makes the social network a sufficient indicator for social capital. Therefore, the influence of social capital on the knowledge valorization performance has been analyzed using the social network of academic medical centers and its related actors.

The concept of knowledge valorization performance is operationalized by the dimensions effectiveness (De Wit, 1988) and satisfaction (Provan & Milward 2001). For the effectiveness this study focuses on the goals regarding knowledge valorization that have been set by the academic

medical center or related actors, and on the degree to which these have been met. For satisfaction this study focuses on the experience of satisfaction that knowledge valorization actors perceive about the valorization process.

3.4 Data collection

The data of this study has been collected by means of a literature study - including scientific articles, annual reports, and information at relevant websites or brochures - and by conducting semi-structured interviews. Access to scientific articles has been obtained through Scopus and Google Scholar. Search terms that have been used mostly are: knowledge valorization, technology transfer, resources, financial capital, human capital, social capital, performance, academic medical centers, university hospitals, valorization activities, or various combinations of these. Annual reports have been obtained from websites of the academic medical centers and related actors and have been checked for data related to knowledge valorization. Relevant websites are websites of academic medical centers and related actors, and here information regarding their valorization mission, vision, and their valorization process has been obtained. Several brochures have been provided by academic medical centers and related actors to illustrate their valorization process in more detail. Interviews have been conducted with board members and several other employees of the selected academic medical centers. Furthermore, interviews have been held with individuals who conduct knowledge valorization activities outside the academic medical centers but are still related. The interviews have all taken place face-to-face, on site. In total 28 interviews have been conducted with an average length of fifty minutes, during the months February, March, and April, of the year 2014. A list of the corresponding cities and functions of all interviewees is provided in appendix 1. Due to agreed anonymity the names of the interviewees have been excluded.

Conducting semi-structured interviews made it possible to identify underlying motives of academic medical centers about why they choose to invest in different kinds of resources and how these investments influence their knowledge valorization performance. Furthermore, conducting interviews offers interviewees the possibility to clarify and explain their answers. Semi-structured questions are more appropriate than entirely structured questions, because in this way the researcher is still able to provide some guidance while on the same time the interviewees are able to provide new and unexpected insights. Besides this, semi-structured questions are more appropriate than entirely open questions, because in a semi-structured way it is better possible to compare the results and it provides advantages for the way the data can be analyzed. This leaves for instance the possibility to ask directly for a five-point Likert scale in some questions. The operationalization of the concepts, see section 3.3, has led to the set of interview questions. Examples of interview questions are: ‘Can you indicate which of the knowledge valorization activities of Table 1 your organization deploys?’, ‘How would you describe the role that human resources have for the knowledge valorization within your organization?’ or ‘Can you indicate to which degree you have accomplished your goals using a five point scale?’. During the research the interview questions have been adapted when necessary. A list of interview questions is provided in appendix 2. The data obtained through the interviews has been complemented with data of the before mentioned literature study. For each case, data has been gathered until no new concepts emerged, and saturation has been reached (Glaser & Strauss, 2009).

3.5 Data analysis

The conducted interviews have all been transcribed. In order to analyze the data, the obtained data has been coded soon after it has been collected (Bryman, 2008). For this coding NVIVO has been used which is a software for analyzing qualitative data. NVIVO is useful for this purpose as it provides a systematic analysis of qualitative data by making sure that all taken methodological steps can be traced back. Coding data is an iterative process although there still can be different phases identified. In line with the method described by Corbin & Strauss (1990) the coding has started with a process of open coding. Open coding contains the analytically breaking down of data, which can provide the researcher with new insights due to breaking through standard ways of thinking. This open coding led to the discovery of aspects that were not expected beforehand. In this process, data events have been compared with others for similarities and differences. Then, conceptual labels have been developed and similar events led to the development of initial categories and sub-categories. The necessary constant comparison enabled the researcher to break through subjectivity and bias (Corbin & Strauss, 1990). After this, with axial coding a deeper understanding has been developed as categories have been related to subcategories and relationships have been explored among categories. Lastly, selective coding has been conducted, which refers to the process of unifying all categories around a core category and filling in the categories with descriptive detail that needed further explication (Corbin & Strauss, 1990). The entire process of collecting and analyzing data has been iterative in order to obtain a thoroughly understanding of the knowledge valorization performance of academic medical centers. Therefore, when the first interviews were analyzed these served as guidelines to indicate which additional data needed to be collected (Bryman, 2008). The process of collecting and analyzing data has continued until theoretical saturation has been reached. The data has been constantly compared with the theoretical framework of the Resource Based View and with the identified knowledge valorization activities from literature. This helped to interpret the data and helped to better understand how the data can contribute to the existing theoretical framework.

3.6 Reliability and validity

Bryman (2008) explains that concepts of reliability and validity can be adapted for qualitative studies. These aspects are now elaborated below for this study.

The external reliability, which refers to the degree to which a study can be replicated, is difficult to address for qualitative studies (Bryman, 2008). As the situation for the selected academic medical centers can change over time, it will be hard for another researcher to obtain the same results. Still, all interviews have been transcribed and all used literature and data has been carefully documented. The internal reliability has been addressed in this study by having the reasoning and analyzing checked by two other researchers. Furthermore, the coding reliability has been checked with two other researchers. 21 randomly selected codes from interview 20 have been coded by each researcher separately. Then, the similarity of codes has been analyzed which led to an agreement of on average 84%, see appendix 3. This level of agreement is acceptable in most situations (Lombard et al., 2002) and can be generalized for all other codes. This illustrates that this study contains a reliable coding system which contribute to a more solid analysis.

Internal validity contains to what extend causal relations are valid (Yin, 2003). Triangulation is a sufficient method to increase the internal validity (Bryman, 2008). Triangulation refers to “the use of more than one method or source of data in the study of a social phenomenon so that findings may be cross-checked” (Bryman, 2008; p700). In this study several ways of triangulation have been used. Firstly, five academic medical centers have been investigated, which means that the findings have been checked between these cases and the possible bias has been reduced. Secondly, the data of interviews with members of academic medical centers has been compared and checked with each other and with data from interviews with other persons that conduct knowledge valorization activities related to academic medical centers. Furthermore, the findings of the conducted interviews have been compared with findings from literature, such as scientific articles, annual reports, and relevant brochures. This contributed to better understanding the relations between resources, the deployment of knowledge valorization activities, and the knowledge valorization performance.

The external validity contains the degree to which the findings of the study can be generalized across social settings, which can be hard for qualitative studies (Bryman, 2008). As the knowledge valorization performance of academic medical centers can be context dependent the external validity is likely to be low for this study. However, since the selected cases are all part of the LERU, the results could be generalized to some degree for all academic medical centers connected to the LERU.

4 Results

In this section the results are described. Firstly, the five cases and the obtained knowledge valorization landscapes are elaborated on to make clear which actors can contribute to knowledge valorization. Secondly, the results regarding the knowledge valorization performance are described. After this, the three resources, financial resources, human resources, and the social network as a resource are discussed thoroughly to understand the content of those resources better. Lastly, the relation between the analyzed resources and the knowledge valorization performance, the relation between the analyzed resources and the deployment of valorization activities, and the relation between the deployment of valorization activities and valorization performance are discussed. Thus, the more descriptive results are presented first, followed by the results containing the relation between concepts. This is also illustrated with Figure 2.

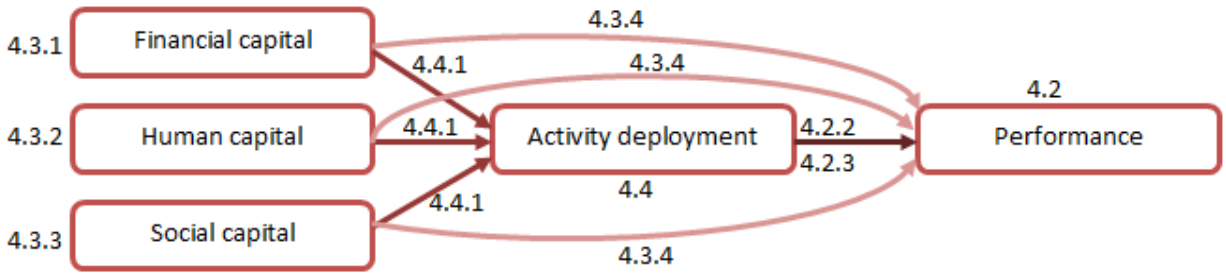

Figure 2: Conceptual model including corresponding sections of results.

Figure 2 contains the conceptual model, including section numbers which represent the corresponding section in which the results are presented.

4.1 Description of the cases

In this study five cases have been analyzed and these cases are all described in this section. This makes clear how the process of knowledge valorization around each analyzed academic medical center has been organized and what the organizational similarities and differences are amongst the cases.

4.1.1 Key figures cases

In this study five academic medical centers have been analyzed regarding their knowledge valorization process. Table 3 provides an overview of some key facts on these academic medical centers.

Table 3: Key facts of the analyzed academic medical centers. (Obtained from: UMC Utrecht, 2014a; UMC Utrecht, 2014b; LUMC, 2013; LUMC, 2014a; De Tijd, 2014; UZ Leuven, 2013a; UZ Leuven, 2013b; UCLH, 2013; CUH, 2014a; CUH, 2014b)

Case	Number of FTE's	Revenue (million €)	Mission
Utrecht	8100	1028	Being a prominent, international university medical center where knowledge about health, disease and care, for patient and society is created, tested, shared and applied.
Leiden	5680	688	Playing a nationally and internationally recognized leading role in improving the quality of health care.
Leuven	6404	760	Providing patients with qualitative, safe, and customer oriented top clinical care.
London	7617	1041	Delivering top-quality patient care, excellent education and world-class research.
Cambridge	7000	714	Being one of the best academic healthcare organizations in the world excelling in patient care, teaching and biomedical research.

4.1.2 Utrecht

University Medical Centre Utrecht (UMC Utrecht) values the encouragement of its employees to think about innovation. This because employees know best what they need to do their job effectively and they are able to specify the demands of patients (UMC Utrecht, 2014c). UMC Utrecht has three core activities: providing state-of-the-art healthcare that requires special knowledge and expertise, carrying out cutting-edge scientific research, and offering excellent healthcare programs and training to students, doctors, researchers and other healthcare providers (UMC Utrecht, 2014d). The Utrecht University faculty of medicine is fully integrated in UMC Utrecht (UU, 2014a). Besides this, UMC Utrecht closely collaborates with Utrecht University in several large-scale research programs (UU, 2014b). Furthermore, UMC Utrecht together with University Utrecht (UU), Hogeschool Utrecht (HU), and Rabobank Utrecht has established the Utrecht Valorization Center (Utrecht VC) in order to stimulate the valorization of knowledge. They have received a grant of five million euros from the Dutch government to accomplish this (UMC Utrecht, 2011). Several other organizations stimulating knowledge valorization are connected to UMC Utrecht as well. These are all shown in Figure 3. As the

focus of the research is on the academic medical centers, UMC Utrecht has been put central. However, all related actors can also interact with each other.

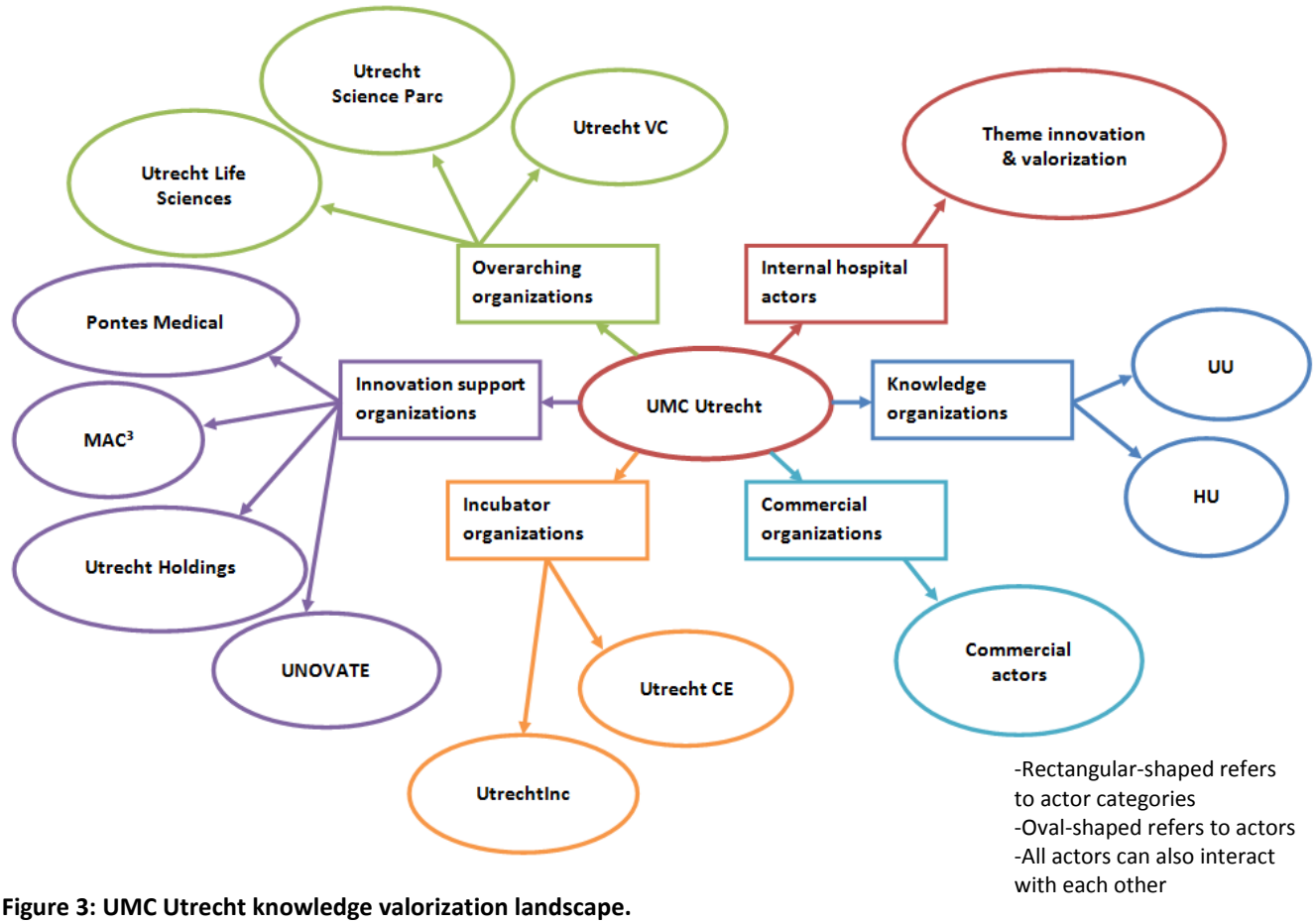

Figure 3: UMC Utrecht knowledge valorization landscape.

UNOVATE facilitates the connection between UMC Utrecht and the industry, and its focus lies on healthcare service innovations without patentable medical technological developments (UMC Utrecht, 2014e). Utrecht Holdings, containing UMC Utrecht Participations and UU Holding BV, control the entire portfolio of both UMC Utrecht and Utrecht University and are responsible for the successful commercial exploitation of its intellectual property (UMC Utrecht 2014f). Pontes Medical stimulates knowledge creation and valorization through co-creation regarding medical devices. They focus on products for affordable care, products for safer care, and products for care close to the patient's home (Pontes Medical, 2013). MAC³ is about the integral developing, testing, and researching health related applications (Smart Health, 2013). UtrechtInc is a business incubator with an accelerator program (UtrechtInc, 2014). They focus on stimulating startup companies in the IT and healthcare, IT and sustainability & environment, and IT and education areas (UtrechtInc, 2014).

4.1.3 Leiden

The Leiden University Medical Centre (LUMC) states it operates with its research practices among the top of the world (LUMC, 2014b). As it operates within a triangle with Leiden University and the Leiden Bio Science Park, the LUMC creates unique possibilities for medical innovation in Leiden and surroundings (LUMC, 2014b). The LUMC intends to contribute to the solution of health problems and thereby enlarge the quality of life. The protecting and commercializing of knowledge gained through

academic research is of increasing importance for the LUMC to realize maximum clinical impact with its research activities (LUMC, 2014c). The collaborating actors related to knowledge valorization around the LUMC are shown in Figure 4.

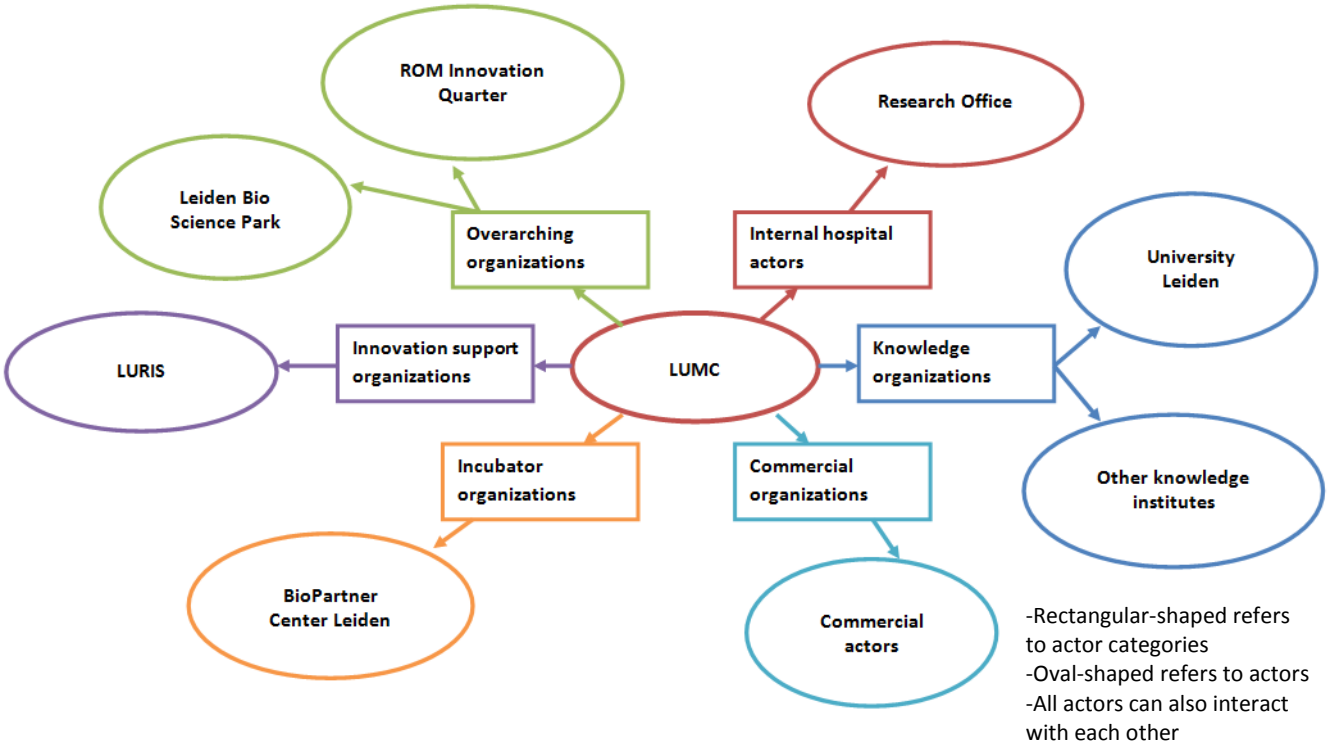

Figure 4: LUMC knowledge valorization landscape.

Also the faculty of medicine in Leiden is fully integrated within the LUMC (LUMC, 2014d). Furthermore, the LUMC is intensifying their collaboration with the University Leiden in the framework of the strategic partnership between the Universities of Leiden, Delft and the Erasmus University Rotterdam (Universiteit Leiden, 2014). Another regional network is called Medical Delta. Medical Delta focusses on stimulating life sciences and medical technology in the west of the Netherlands, the region Delft-Leiden-Rotterdam (Medical Delta, 2014). The knowledge valorization process of LUMC is coordinated by the Research Office. The Research Office helps the academics identify new technologies and offers assistance in the filing of patents (LUMC, 2014c). The office works closely together with Leiden University Research & Innovation Services (LURIS), the Technology Transfer Office for Leiden University. LURIS has several key activities. For instance LURIS assists with the evaluation and protection of intellectual property, the identification of licensees, the negotiation of license agreements, and the establishment of spin-off companies (LURIS, 2011). Furthermore, LURIS provides assistance in identifying major funding opportunities and facilitates access to academic expertise and university facilities for commercial organizations (LURIS, 2011). Leiden Bio Science Park includes over 85 medical life science companies and institutions, many bioscience start-ups, various multinationals, and some knowledge institutes. Therefore, Leiden Bio Science Park provides a well-developed environment for health related actors (Leiden Bio Science Park, 2014). The business center BioPartner Center Leiden is located on the Leiden Bio Science Park. BioPartner Center Leiden provides starting companies with office space, lab space, many supporting facilities, and a broad range of networking contacts (BioPartner Center Leiden, 2014).

4.1.4 Leuven

University Hospital Leuven (UZ Leuven) has as mission to provide patients with qualitative, safe, and customer oriented top clinical care (UZ Leuven, 2013b). High standard academic education and innovative scientific research are prominently present. Furthermore, UZ Leuven states it values translational research. This means that fundamental research goes hand in hand with clinical research, which results in effective and useful research for the patient. Regarding this fundamental and clinical research UZ Leuven and the Catholic University Leuven (KU Leuven) continuously collaborate (UZ Leuven, 2013c). However, the faculty of medicine belongs still to KU Leuven and not to UZ Leuven (KU Leuven, 2012a). The cooperating actors regarding knowledge valorization related to UZ Leuven are shown in Figure 5.

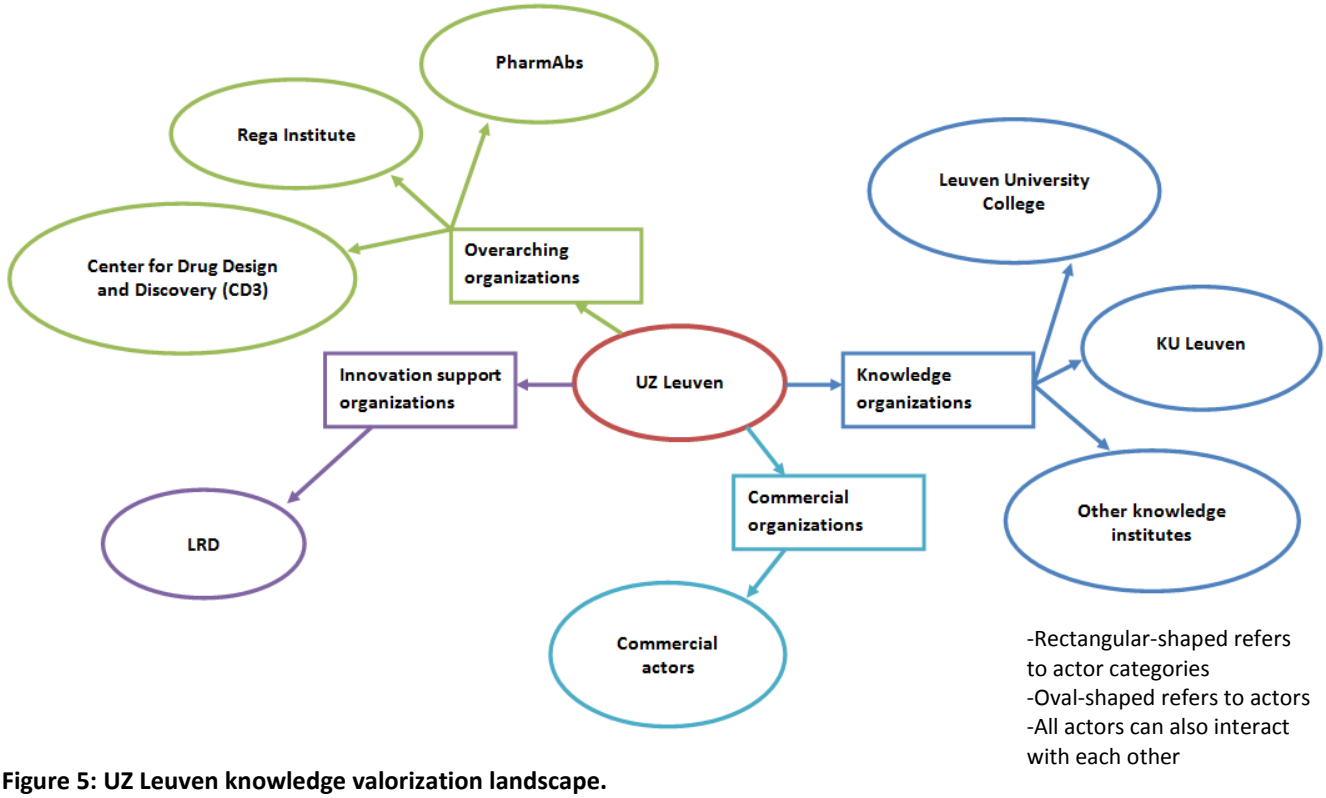

Figure 5: UZ Leuven knowledge valorization landscape.

Regarding knowledge valorization there is no particular organization which focusses exclusively on research at UZ Leuven. KU Leuven Research and Development (LRD) is the Technology Transfer Office which stimulates the valorization of knowledge related to KU Leuven as well as UZ Leuven (KU Leuven, 2012b). LRD is considered as the most important knowledge valorization actor and conducts several knowledge valorization activities (Interviewee 18). These activities contain research collaboration, intellectual property rights management, creation of new research oriented spin-off companies, promoting innovation by stimulating networking initiatives, and regional development (KU Leuven, 2012b). Center for Drug Design and Discovery (CD3) is an investment fund and technology transfer platform. By providing the necessary expertise and financial resources, CD3 contributes to the translation of fundamental biomedical research into more usable results for all kinds of new medicines (CD3, 2014). PharmAbs and the Rega Institute are both research centers who contribute to valorization in several medical technology areas like antibody-based diagnostics, virology and chemotherapy (PharmAbs, 2014; KU Leuven, 2014).

4.1.5 London

University College London Hospitals (UCLH) state as their mission to deliver top-quality patient care, excellent education and world-class research (UCLH, 2014a). UCLH consider themselves as a world-class leader in clinical research. The faculty of medicine is still a part of University College London (UCL) but the scientists at UCL closely cooperate with UCLH (UCL, 2014a; UCLH, 2014b). Figure 6 shows the collaborating actors around UCLH regarding knowledge valorization.

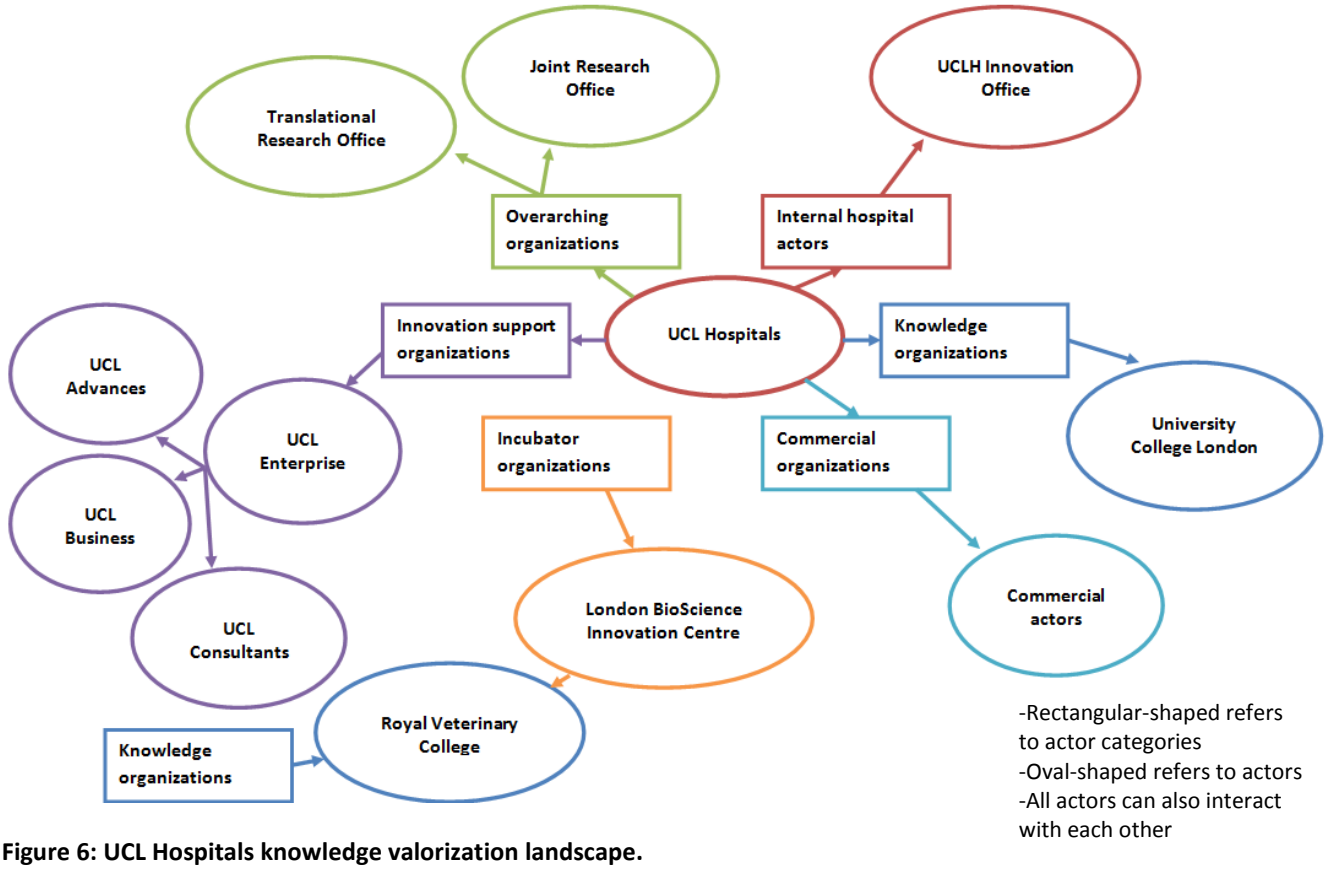

Figure 6: UCL Hospitals knowledge valorization landscape.

UCL Enterprise assists UCL and UCLH with business for commercial and societal benefit (UCL Enterprise, 2014). It includes three units: UCL Advances, UCL Business and UCL Consultants. UCL Advances, the center for entrepreneurship, offers training, networking and business support for staff, students and external entrepreneurs to help new enterprises getting started (UCL Enterprise, 2014). UCL Business is a Technology Transfer Office which supports and commercializes research and innovations related to UCL and UCLH. UCL Business licenses technologies and creates shared-risk joint-venture businesses (UCLB, 2014a). UCL Consultants offers support for academics wishing to carry out consultancy work and it provides contractual and administrative advice related to commercializing innovation (UCL Enterprise, 2014). The Joint Research Office (JRO) supports the development of clinical research at UCL, UCLH and Royal Free Hampstead. The JRO provides professional expertise in research management, biostatistics, finance, contracts, regulatory affairs, commercialization of research and professional development (UCL, 2014b). The UCLH Innovation Office is co-located with the JRO and closely collaborates with the JRO and UCL Business. UCLH Innovation Office is the first contact point for all staff when they have an innovative idea. They help staff develop any novel ideas that may have commercial potential and advice on other intellectual property matters (UCLB, 2014b). The Translational Research Office (TRO) aims to enhance the

translational culture within UCL and UCLH and strives to facilitate the translation of the basic and clinical research into therapies, techniques and medical products with therapeutic value (TRO, 2014). London BioScience Innovation Centre (LBIC) operates as a business incubator that is owned by the Royal Veterinary College (LBIC, 2014). Therefore, the London BioScience Innovation Center only collaborates with UCLH on an ad hoc basis.

4.1.6 Cambridge

Cambridge University Hospitals (CUH) strive for being one of the best academic healthcare organizations in the world and they want to excel in patient care, teaching, and biomedical research. In doing this they focus on working in a kind, safe, and excellent way (CUH, 2014b). The collaborating actors regarding knowledge valorization around the university hospital are shown in Figure 7.

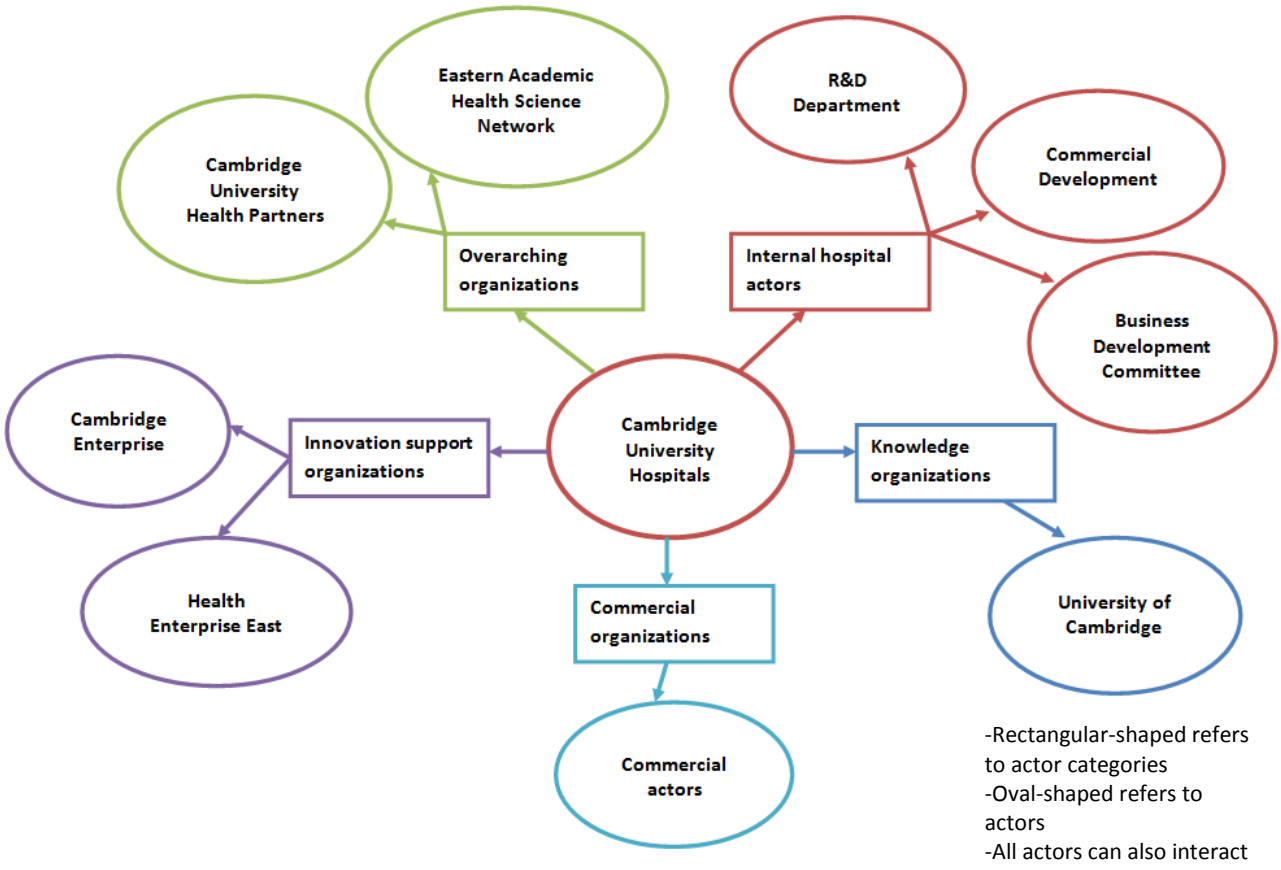

Figure 7: Cambridge University Hospitals knowledge valorization landscape.

The faculty of medicine is fully integrated in Cambridge University Hospitals (CUH) and the University of Cambridge is stated as one of the partners of CUH (University of Cambridge, 2014). Together they are able to conduct high quality medical education and research (CUH, 2014c). The R&D Department, Business Development Committee, and Commercial Development are internally located in Cambridge University Hospitals. Cambridge Enterprise is a wholly owned subsidiary of the University of Cambridge and is responsible for commercialization arrangements for university discoveries (Cambridge Enterprise, 2014). Health Enterprise East (HEE) is a regional NHS Innovation Hub for the East of England and has been mentioned explicitly as partner by interviewees in Cambridge. Due to its geographical focus HEE could also collaborate with the University College London Hospitals, although none of the interviewees in London has mentioned HEE. HEE supports the accelerating of

the development and the uptake of innovative medical technology products and services that improve the quality of healthcare delivery (HEE, 2012). Cambridge University Health Partners (CUHP) is a strategic partnership with the goal to improve patient care, patient outcomes and population health through innovation and the integration of service delivery, health research and clinical education (CUHP, 2014). Eastern Academic Health Science Network (EAHSN) is a network established to stimulate the adoption, diffusion and spread of innovation into and throughout the NHS (EAHSN, 2014).

The above shown valorization landscapes illustrate which different actors are all involved with knowledge valorization around the analyzed academic medical centers. Some similarities and differences can be identified. For instance, all landscapes contain one or more innovation support organizations and all academic medical centers also collaborate with the corresponding universities. Furthermore, it became clear that in some landscapes, namely in Leuven and Cambridge, a separate incubator organization is lacking. The tasks of such an organization are then deployed by other organizations related to the academic medical centers.

4.2 Knowledge valorization performance

In this section the results regarding the knowledge valorization performance are provided. The dimensions effectiveness and satisfaction are both discussed and the cases are compared to one another.

4.2.1 Effectiveness

To obtain data about the knowledge valorization effectiveness the interviewees have been asked for their valorization goals and the accomplishment of these goals. Sometimes a specific number of licenses is mentioned: *'We have individual performance measures. And I have to help a certain number of spin-offs a year. Also I have a certain number of licensing, and that is it. So the number of spin-offs a year is two. And the number of licenses is about five a year.'* (Interviewee 23). However, more often interviewees refer to overarching goals without targets or quantification, like Interviewee 27 puts it*: 'Essentially it is about providing a sustainable ecosystem for development, innovation and commercialization. That is what we want to do. So it is about a sustainable reinvestment for innovation and building expertise and investment, and about building a name, a brand. And ultimately the goal is to provide better care for the patient.'*. Also Interviewee 17 states: *'But our mission is initially knowledge spreading. We also want to make sure that the spreading of knowledge has great utility value, and here is valorization involved. And for me it's just the immediate objective that at the patents that we continue after a year, I expect the majority of those will find its way into the industry to valorization. Either through a spin-off, or simply a cooperation contract with industry, or a license.'*. Furthermore, some goals can be considered as quite ambitious*: 'Our aim is to do more and more of that. And to be seen as the leading center in the country for innovating and commercializing.'* (Interviewee 19) or for instance *'But we want to be the most innovative university hospital in Europe / the world, why not. So I expect that we will do better and better.'* (Interviewee 1). This ambition can be recognized across all five cases.

About two-thirds of the interviewees state that they have accomplished their goals to a high degree (a four), where a very high degree (a five) is the maximum value and a very low degree (a one) would be the lowest possible value. In this case the interviewees often state that their knowledge

valorization process is going well, but that there is still some space for improvements. *'Eventually I think it can always be better, because as I myself actually drop by the scientists, I think that should be done more. And I think that one should listen even better to what the researcher wants. But when I see that we still have an increasing demand, I think we're on the right track. So it's a four, our goal has been largely achieved. And it may be possible to do things even better, but we have an upward trend, so that's good.'* (Interviewee 15). Furthermore, about one-third of the interviewees have evaluated their goal accomplishment as neutral, a three. Some of these state a neutral degree of goal accomplishment because their organization or function is quite new. Therefore, they perceive it as quite difficult to estimate the situation: *'So because of the circumstances, namely that I am employed only a short period, I cannot reflect back yet. Therefore, I rate this as neutral now.'* (Interviewee 12). Others have just set ambitious goals and therefore they have accomplished those to a neutral degree*: 'Then I say for […][2] it is neutral now, because we have set a very high bar and we are not going to jump over it. But we will accomplish a lot.'* (Interviewee 3). Whereas some explain that they just could have done better: *'I would say it has to be neutral because we have good examples but the overwhelming sense is that we ought to be doing so much better.'* (Interviewee 19). Only two interviewees evaluated the accomplishment of their goals with a very high degree: *'I think we do pretty well. I mean […] is often held as an exemplar of how to get it right. So I would say to a very high degree.'* (Interviewee 26). However, in general still the majority of the interviewees considered that they have accomplished their goals to a high degree.

4.2.2 Satisfaction

Regarding the feeling of satisfaction the perception of the interviewees is divided in roughly two groups. About half of the interviewees state that they are satisfied with their knowledge valorization to a neutral degree, a three. Here, a very high degree, a five, is the maximum value whereas a very low degree, a one, would be the lowest possible value. For example Interviewee 28 states*: 'I think we could probably do more. So I consider that as a neutral degree. We have done a lot, but we could probably achieve more. And we are trying to improve communication etc. to do so.'*. About the other half of the interviewees state that they are satisfied to a high degree about their knowledge valorization process. *'Yes for […] I'm satisfied to a high degree. This also has to do with having […] as Vice Chairman Dean, who also breathes innovation. Who has guts to innovate, and who is not afraid to speak out.'* (Interviewee 1). Three interviewees are satisfied with their knowledge valorization process to a very high degree. *'I think it is very high actually, because we have been very successful since we were established in terms of supporting companies. We have had very few companies who have failed while they were being in here.'* (Interviewee 21). Only two interviewees state they are satisfied to a low degree. *'So I'm satisfied to a low degree, a two, because I think all sorts of things could be better, like how we deal with patents and license agreements. And it is now going to be changed, so for that we can be happy.'* (Interviewee 13). All in all, the feeling of satisfaction is in general between neutral and to a high degree.

4.2.3 Performance compared for cases

Figure 8 illustrates the knowledge valorization performance of all cases. Here the corresponding standard deviations have been included, which in general can be considered as quite low. When comparing the valorization performance for the five cases, it is remarkable that Leuven scores the

[2] […] is used to anonymize the quote.

highest on goal accomplishment, but evaluates the feeling of satisfaction as lowest of all cases. When analyzing the reason for the somewhat lower degree of feeling of satisfaction, it becomes clear that the interviewees of Leuven are all very critical and although they are accomplishing their goals and are held as exemplar they want to do even better than that. For all other cases there is only a very small difference between the degree of goal accomplishment and the feeling of satisfaction. For Cambridge it appears to be exactly the same on average, for London the average feeling of satisfaction is even a bit higher than the degree of accomplishment of goals, and for the other cases the average feeling of satisfaction is a bit lower than the average degree of accomplishment of goals.

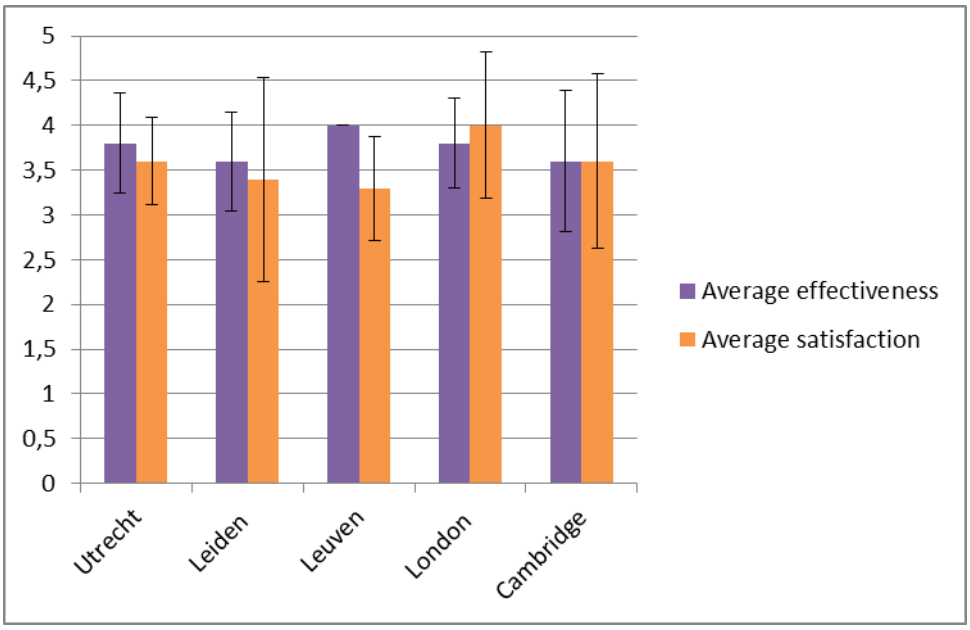

Figure 8: Knowledge valorization performance (1-5) compared for cases.

4.3 Resources

In this section the content of the three analyzed resources; financial resources, human resources, and the social network as a resource, is further elaborated. This makes clear what aspects are involved in the knowledge valorization process.

4.3.1 Financial resources

Analyzing the data regarding the theoretical concept of financial resources made clear that several aspects have been mentioned repeatedly by several interviewees. These are: financial resources as precondition, as bridging the gap, as buying expertise, as seeding money, the acquirement of financial resources, and the lack of financial resources. Lastly, some points of improvement are identified.

Financial resources are commonly considered as a precondition for valorization. *'Eventually everything is about money. Money can buy knowledge and can create networks.'* (Interviewee 12). *'Everything starts with a solid support, which just costs money. So money is the basis.'* (Interviewee 16). Therefore, according to several interviewees across all five cases knowledge valorization would not be possible without financial resources.

Financial resources are used for several purposes. One important purpose is bridging the gap between the invention itself and bringing the invention to the market. This is also described as the need of money to bridge the scientist and the industry. *'So the gap, the bridging in finance, that is a very important aspect for the success of valorization.'* (Interviewee 5). In the city […][3] there is a yearly fund of between seven and nine million euros available which contributes to bridging the valley of death. Although this money is available to invest, they still invest it in a conscious way (Interviewee 16).

Another purpose of financial resources is buying expertise. Examples of the buying of expertise are hiring a patent attorney, hiring trainers, consulting strategic advice, or hiring an account manager. This buying of expertise occurs both within the academic medical centers itself and within supporting actors like a Technology Transfer Office or an incubator. The buying of expertise also contributes to expanding the range of valorization activities that are deployed by an actor. Hiring specialists enables actors to deploy activities which would otherwise not be possible to deploy as the needed expertise is lacking in the organization itself. An example is given by Interviewee 20 who explains the importance of financial resources for providing assistance with developing a prototype design and tests of technical feasibility: *'So this process involves all resources I would say. I think money is the most important, because we relatively often go external and hire expertise.'.* This illustrates the use of financial resources to buy additional expertise.

Furthermore, financial resources are used as seeding money across all five cases. *'And sometimes outside funders may not exactly fund the part that the researcher needs to bring it along the translational path. Here, having a sort of seed funding, some sort of funding that could help them, that could be very useful and could speed up the process.'* (Interviewee 22). Interviewee 9 states: *'We have also money from the board of directors to invest in projects. So we are also able to put money in developing a prototype or something else.'*. Another example is given by a Technology Transfer Office: *'So organizing the money is an important task, but actually investing yourself in these companies is also important. Most venture capitalists see it this way. And not all academic medical centers have the opportunity to invest in something itself. However […] is able to do this and that means you are a very important sparring partner from day one for such an investor.'* (Interviewee 4). Therefore, financial resources as seeding money can be important for knowledge valorization in several ways.

Financial resources can be acquired in different ways. One way is the money that is available through subsidies and funds of the government. Another way interviewees stated is that they could cut back on operational costs in order to increase the available financial resources. Furthermore, the acquirement of financial resources is among all five cases considered as a revolving fund. This means that the investments made in valorization flow back through financial benefits which can be reinvested in new opportunities. *'And in the end you hope that valorization leads to real money. So then you get money flows from and to the […],the department, and possibly commercial parties. And with that money you are able to fund new research, which ultimately benefits the […] and the […] and enables you to pick up other things.'* (Interviewee 13). However, when this is compared with the stated knowledge valorization goals, see section 4.2.1, it can be noticed that the knowledge

[3] […] is used to anonymize the statement.

valorization goals are mostly overarching goals, without financial targets. Therefore, it can be that the concept of a revolving fund for knowledge valorization, where there has to be financial revenue to reinvest, is more a desire or ambition instead of a reality. Lastly, it became clear that for acquiring financial resources the social network is considered to be important. *'I think you have to understand where you can get cheap money so to speak. Whether you get it from ground funding bodies, or charities, and how their priorities work. I think also you have to make sure you have networks into how funding sources like venture capitalists work, so that you know that you have got potential ways of funding, a variety of things.'* (Interviewee 20). This illustrates that resources can be dependent on one another. Another example of this is provided by Interviewee 22: *'So basically it is about private actors, public actors, and the university, putting funding together. That is what we are trying to reach, to get more funding through this way. So it is influencing the strategies of government, influencing the strategies of university, and then working with industries to be able to make that part of money available for the researchers.'* (Interviewee 22). So it has become clear that for acquiring financial resources it is not just about knowing the right people, but also about influencing actors to acquire funding.

Although there are several ways of acquiring financial resources several cases point to the lack of financial resources. *'So these are very limited as you have already noticed. This is not to say that you do not need money, because I think you definitely need it. Specific for that depth funding, the gap between the invention and marketing of it. Because that's just a shortcoming in […][4], we do not really have financial resources.'* (Interviewee 11). Also Interviewee 19 refers to the lack of financial resources: *'And I think the fact there hasn't necessarily been that much funding around, leads to that we probably have not innovated or developed as much as we would like to or could do.'.* This illustrates how more financial resources could lead to more knowledge valorization.

The various purposes of financial resources, as described above, illustrate why financial resources are important for knowledge valorization. This is confirmed when the interviewees directly were asked for the importance of financial resources for knowledge valorization. The corresponding results are presented in section 4.3.4.

Overall, some aspects can be improved related to financial resources. Several interviewees stated that because of a lack of finance some knowledge valorization opportunities remain unused (Interviewee 19; Interviewee 24). Also, interviewees would like to make more money with valorization which could then be reinvested in new opportunities (Interviewee 14). Therefore, the principle of valorization as a revolving fund can be improved as well.

4.3.2 Human resources

The obtained data indicates several aspects to be important regarding the concept of human resources. These are: being able to bridge academics and the business community, the broad range of expertise people need, the experience people have, the presence of valorization key persons, and the acquirement of human resources. Furthermore, some points of improvement are identified. All these aspects are elaborated on below.

[4] […] is used to anonymize the quote.

Many interviewees refer to the capability of people active in the valorization field to serve as bridge between the academics and the business community. *'And to ensure that the core task of valorization is nevertheless achieved, it is important to make sure that you understand where academics stand for, and what the commercial actors on the other side want, and to merge them with each other so that they both create a win-win situation with each other. So our people within […] take a large part in this.'* (Interviewee 15). Also Interviewee 19 refers to this: *'And those people need to be able to bridge the scientist with industry.'.* Therefore, it is important to form the bridge between the researcher and the industry, as otherwise there a missing link can remain between those two aspects which can impede the knowledge valorization process.

Another remarkable aspect of human resources is the broad range of expertise people need to contribute to knowledge valorization. This broad range of needed expertise is a result of an open question and is listed below:

- Ability to create awareness of valorization (Interviewee 10, 16, 17, 19)
- Ability to critically assessing ideas (Interviewee 1, 4, 9, 14, 15, 16, 17, 20, 27)
- Business skills (Interviewee 1, 4, 6, 9, 11, 13, 14, 16, 17, 19, 20, 21, 22, 23, 24, 25, 27)
- Being insistent (Interviewee 3, 9, 24)
- Coaching skills (Interviewee 6, 16, 22)
- Collaboration skills (Interviewee 5, 9, 15, 17, 19, 20)
- Finance expertise (Interviewee 4, 6, 10, 13, 16, 24)
- Negotiation skills (Interviewee 11, 16, 24)
- Project management expertise (Interviewee 1, 4, 6, 8, 9, 10, 17, 19, 20, 21, 22, 24)
- Social skills (Interviewee 3, 5, 7, 9, 11, 12, 15, 16, 19, 20, 22)
- Substantive knowledge (Interviewee 1, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 26)
- Technical skills (Interviewee 1, 4, 6, 8, 9, 11, 12, 14, 15, 16, 18, 22, 23, 24, 27)

As this list is a result of an open question, it does not have to be that the more interviewees that have mentioned an expertise the more important that expertise is. It can also be that the less often mentioned expertise is just not that obvious.

Related to the broad range of needed expertise is the experience people have built over time. When explaining the importance of human resources for valorization Interviewee 9 refers to the experience of people developed over time: *'And we have a kind of gut feeling about such a project, based on experience.'*. This illustrates that employees can learn from former projects which can make them better able to handle a comparable project the next time.

Furthermore, the obtained data indicate that valorization champions or valorization key persons are part of the human resources contributing to knowledge valorization. These valorization champions can both be trained internally (Interviewee 22) and be recruited externally (Interviewee 3) and are usually people who have already contributed to knowledge valorization successfully. *'And then on each faculty, on each department, they have enterprise champions. So that they would inspire their own department and connect them to the right people.'* (Interviewee 22). Or how Interviewee 1 puts it: *'You also need role models and examples. It only begins to run when things succeed, and people become aware that it is possible after all.*'. Another example is given by Interviewee 28: *'So we have*

every other month or so, we go to innovation show case events, and we have a couple of speakers, internal to the trust, people who have actually achieved good ideas, protected that, and took the innovation forward. So what we are doing, is structuring that, to support innovation, and share ideas. So we make use of those people as a kind of role model, to inspire others to do so as well.'. Therefore, valorization champions or valorization key persons are sort of role models who inspire other people to contribute to valorization.

Human resources are acquired or developed mostly by the training of employees. Many interviewees across all five cases refer to several training courses, as Interviewee 24 states: *'There are specific technology transfer and intellectual property management courses in […] such as practice courses, and we send all of our development management on those as well, so they are learning practical skills.'*. Some interviewees state that those skills are hard to develop and that it is better to have selection criteria for hiring people: *'Training and education for the knowledge and experience, you either can analyze and adapt, or you cannot. So maybe we look more for selection criteria, we try to recruit people with that skill base'* (Interviewee 26). This illustrates that human resources can both be acquired by training of current employees and by hiring new employees using particular selection criteria.

Furthermore, mainly the cases Cambridge and Utrecht point to the value of a good functioning team. *'And the team, you need to assemble that in a certain way. You need to have a mix of different types of people.'* (Interviewee 7). Also interviewee 3 refers to the importance of a good functioning team*: 'I always say, a good idea with a bad team never gets it done, and a good team with a bad idea can accomplish a lot. And that is truly the case.'*. These examples indicate that team members are able to complement each other and that together they contribute to the process of knowledge valorization.

The above mentioned need of a broad range of expertise of people and the presence of valorization champions illustrate why human resources are of importance for knowledge valorization. Also when asked the interviewees directly, it becomes clear that human resources are important for knowledge valorization. The corresponding results are presented in section 4.3.4.

Regarding human resources in relation with knowledge valorization some points of improvement can be identified. Firstly, when investing in human resources, organizations need to make sure that valorization expertise is put close to the practitioners (Interviewee 2). Otherwise important details can be overlooked and people cannot know what is actually going on. Here, it is also important to provide practitioners with more time to spend on valorization (Interviewee 20). Due to lack of time valorization opportunities can remain currently unused.

Furthermore, academic medical centers can invest in attracting board members who have a clear valorization strategy and who consider knowledge valorization to be crucial. It is stated that in the end knowledge valorization can only truly happen when it is stimulated and supported by the decision makers and leaders of the academic medical center (Interviewee 1; Interviewee 22). This can contribute to creating a valorization culture and creating valorization awareness which both can stimulate knowledge valorization (Interviewee 22; Interviewee 28).

Lastly, academic medical centers need to take good care of their employees. Rewarding contributions made to knowledge valorization can help to motivate employees to participate in knowledge valorization (Interviewee 2; Interviewee 7). The possibility to make career in knowledge valorization is an example of rewarding employees for their contributions. In this way, a researcher could be promoted to associate professor or professor by contributing to knowledge valorization, which can stimulate employees to participate in valorizing knowledge.

4.3.3 Social network as a resource

The social network as a resource also contains several important aspects, namely: the possibility of adding expertise, the source of inspiration, connecting different actors with one another, the ability to test ideas, and the acquirement of the social network. Furthermore, some points of improvement became clear. These aspects are all discussed below.

Across all five cases the use of the social network is referred to as the possibility of adding expertise: *'We have now licensed 120 products, and done quite a few spin outs. I can think of no technology or no spin out where we have not involved a third party. Every single product development, we have to get people involved. Whether that is a product design company, whether it is an angel investor, or a legal affairs consultant to give you advice. So that social network is really important, because you need to pull in people from different places. To be able to help you develop the idea.'* (Interviewee 24). Related to this is the social network considered as source of inspiration explained by Interviewee 1: *'So I consider the network as a great source of inspiration, promising to develop something.'*. This shows that the social network can also lead to the initiation of new ideas.

Furthermore, the social network can be important for connecting different actors with each other, which is a bit different from the already discussed aspect of adding expertise. Instead of using the social network for your own organization, the connection between two external actors is made. For example the network of several venture capitalists enabled an interviewee to connect a researcher who was looking for finance with a venture capitalist who was looking for a new opportunity to invest in. In this way the social network of the interviewee contributed to further progress in the valorization of knowledge.

Another use of the social network for knowledge valorization is the ability to test ideas. Interviewee 16 states: *'From the moment we want to set up a new company, something in the market, we always attach great value in testing the market thoroughly in advance. So we will get in touch with quite a lot of people and we explain that we are thinking of an idea in a certain direction, and we ask whether that is something they would be interested in, whether that is something they possibly would want to invest in, and whether they see some pitfalls that we did not thought of.'*. Also interviewee 10 refers to this as *'I consider the social network as a mirror of what the needs are in society.'*. Therefore, the social network can provide feedback on existing ideas, which contributes to the entire process of knowledge valorization.

To be able to obtain benefits from the social network people first need to invest time and effort to acquire or develop the social network. Most often people across all five cases mention the attending to network events in order to build their social network. Interviewee 24 states: *'And we also attend to lots of social network events. Also we hold our own.'*. Another interviewee even makes a

comparison between The Netherlands and the United Kingdom*: 'And particularly in the UK, because I have also experience of working in the Netherlands for more than 10 years, in the UK it is very much networking events, very much. At work you just really do your work, and after work you go to the networking events. You meet up with people and you talk and discuss. In the Netherlands it was much less. In the Netherlands you would not go out much for the networking events in the evenings.'* (Interviewee 22). However, Dutch interviewees state that they do attend many network events as well: *'We hold large networking events, with 250 people, and also we visit a lot of network events.'* (Interviewee 6). Also coincidental meetings can appear to be very valuable. Besides this, several interviewees state that they invest in their visibility, in order to make sure that they are known and others are aware of their existence. Moreover, when talking about developing their social network some interviewees refer to keeping a database of contacts. In this way they ensure that they are able to track their relations and make connections in an efficient way.

The possibility of adding expertise and the ability to test ideas indicate why the social network as a resource is important for knowledge valorization. This is confirmed when the interviewees directly were asked for the importance of the social network as a resource for knowledge valorization. Again, the corresponding results are presented in section 4.3.4.

One point of improvement regarding the social network as a resource that became clear is that it is useful to keep a database of network contacts (Interviewee 9; Interviewee 24). Only one actor in Cambridge and one actor in Utrecht stated they keep such a database, which indicates that many others can learn from this. By keeping a database of network contacts, actors are able to connect people in a more efficient way and they can use their existing network contacts for similar cases again.

In addition, the use of the social network as a testing environment can contribute to the knowledge valorization process (Interviewee 10; Interviewee 13; Interviewee 16). It is stated that the social network can provide free advice and that those free advices can be very valuable for further developing and implementing ideas. Therefore, making more use of the social network as testing environment can improve the knowledge valorization process.

4.3.4 Importance of resources for knowledge valorization

In the previous sections the content of financial resources, human resources, and the social network as a resource have been analyzed in relation to knowledge valorization. In this section the importance of the resources for knowledge valorization is discussed for each resource separately and it is compared with one another in several ways.

4.3.4.1 Importance financial resources

Overall the importance of financial resources for knowledge valorization is considered to be between important and very important by the interviewees, where very important (five) is the maximum score possible and very unimportant (one) would be the lowest score possible. For instance Interviewee 2 states: *'I think these are actually very important. That has to do with, at the moment you show that you are also investing money, so you put your money where your mouth is, it shows that you are really dedicated to go for it. If you want to valorize, then you also need to put money into that.'*. Only one interviewee considered financial resources unimportant for valorization. *'Unimportant, I think. I*

do not see so why that should be important. I think anyway that money is never something that is in our considerations.' (Interviewee 15). However, in general financial resources are still considered to be between important and very important for knowledge valorization. This importance of financial resources for knowledge valorization is further illustrated with Figure 9, Figure 10, and Figure 11, presented in section 4.3.4.4.

4.3.4.2 Importance human resources

The large majority of the interviewees consider human resources as very important for knowledge valorization, where very important (five) is the maximum score possible and very unimportant (one) would be the lowest score possible. Interviewee 20, part of a Technology Transfer Office, refers to the importance of people who support the valorization process: *'I would say a five, very important, because I think the people who have the ideas don't have the expertise, and they might get there by luck, but it is not straightforward. So you really need to have people who are able to support this process to go on.'*. One interviewee evaluated human resources as unimportant. He states: *'So from […] point of view, the human part is less important for valorization. I rate that with a two, to a low degree are human resources important for valorization. For valorization in general people are very important, but those people are not part of […].'* (Interviewee 12). The reason for this low rating is the modest role that particular incubator has for knowledge valorization. Therefore, in general human resources are still considered to be very important for knowledge valorization. This importance of human resources for knowledge valorization is further illustrated with Figure 9, Figure 10, and Figure 11, shown in section 4.3.4.4.

4.3.4.3 Importance social network as a resource

The interviewees rated the social network just as often as important as they rated it as very important, where very important (five) is the maximum score possible and very unimportant (one) would be the lowest score possible. For instance Interviewee 20 explains: *'I would say it is maybe only important and not very important, because you could look people up without knowing them much. And you could do okay.'*. On the other hand Interviewee 8 explains: *'It is becoming more and more important, both the network internally and externally with commercial parties and also with other research institutions. Because things are so big that you cannot do it on your own. You need to do a lot of things together, also with the major European funding programs, for instance Horizon 2020, which is entirely focused on networking and collaboration. So I rate it as very important.'*. Therefore, in general the social network as a resource can be considered to be between important and very important for knowledge valorization around academic medical centers. This importance of the social network as a resource for knowledge valorization is further illustrated with Figure 9, Figure 10, and Figure 11, presented in section 4.3.4.4.

4.3.4.4 Importance resources in comparison

The first way that some insight about the difference in importance of the resources for knowledge valorization can be obtained is by comparing the scores of the importance of the resources asked independent of one another. The importance of each of the resources separately has been evaluated on a five point scale. The score five refers to very important and the score one refers to very unimportant. These independent scores are shown in Figure 9.

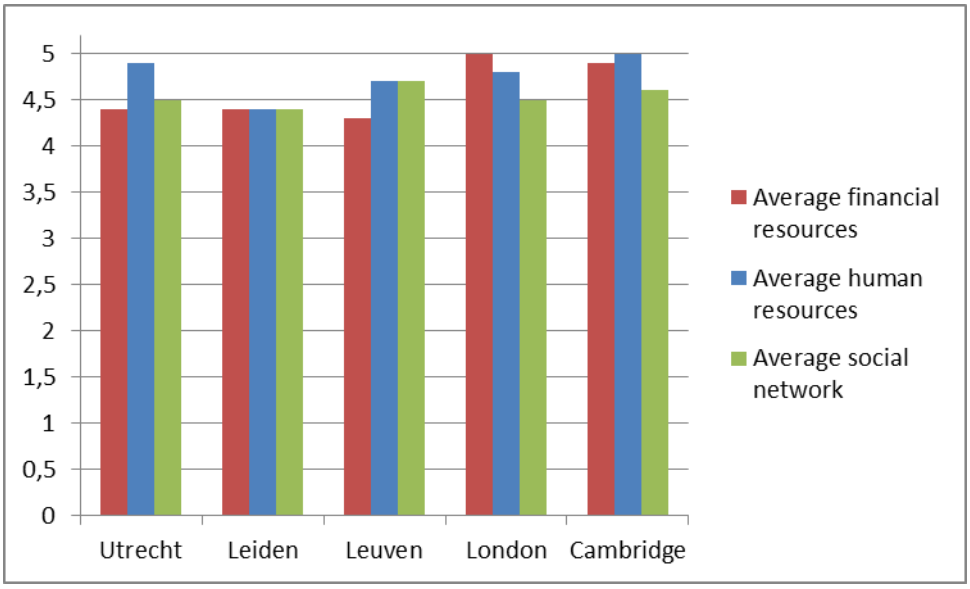

Figure 9: Independent importance of the resources (1-5) for knowledge valorization compared for cases.

In Figure 9 it can be seen that a few times the three resources, financial resources, human resources, and the social network as resource, have been rated equally important or very close to one another. Also all resources have been rated between important, a four, and very important, a five.

Another way the resources have been compared with one another is by asking to rank the importance of the three resources relative to one another. It has been asked which resource is most important, which one comes second, and which is considered to be in third place. This is illustrated with Figure 10. The higher the value is, the higher the importance of the resource is. Consequently, value three refers to the most important resource and value one refers to the least important resource relative to one another.

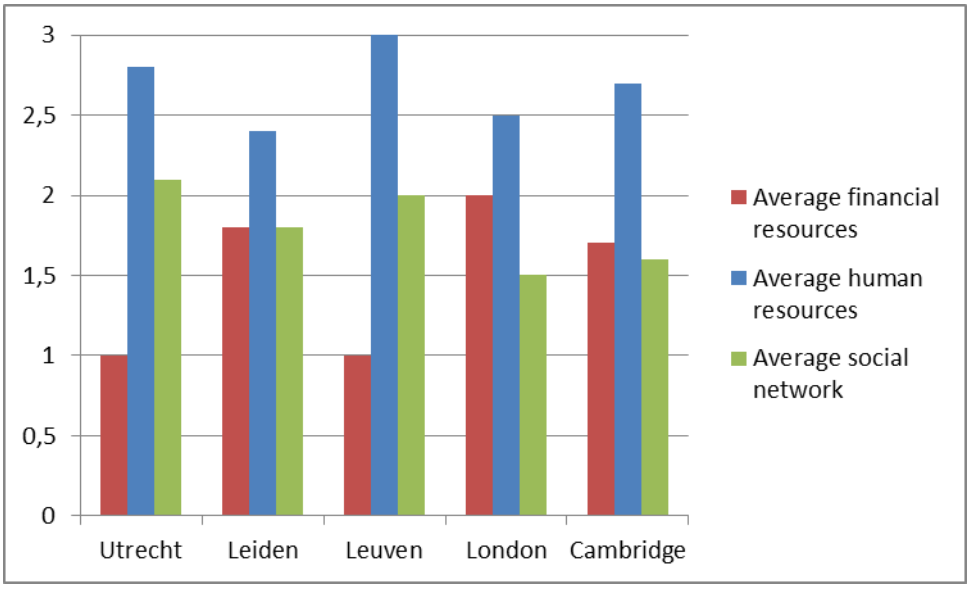

Figure 10: Priority of resources (1-3) compared for cases.

In Figure 10 can be seen that all cases rated the human resources as most important on average. This is a bit contradicting with Figure 9, as for the independent importance of the resources in London the financial resources have been rated on average as more important than the human resources, see Figure 9. This contradiction is due to one interviewee who considers the independent importance of human resources differently compared to all other London interviewees. In Utrecht and Leuven the social network as a resource has been rated on average as the second most important resource and the financial resources as least important. In London and Cambridge on the other hand the financial resources have been rated on average as the second most important resource and the social network as a resource as least important. Again this is remarkable as an interviewee from the United Kingdom pointed to the major role of attending to network events compared with the Netherlands.

To obtain a more precise insight into the differences between the importance of the resources for knowledge valorization, the interviewees have also been asked to divide ten points between the three resources so that they add up to ten. A higher amount of points refers to a higher importance of the resource relative to one another. This is illustrated with Figure 11.

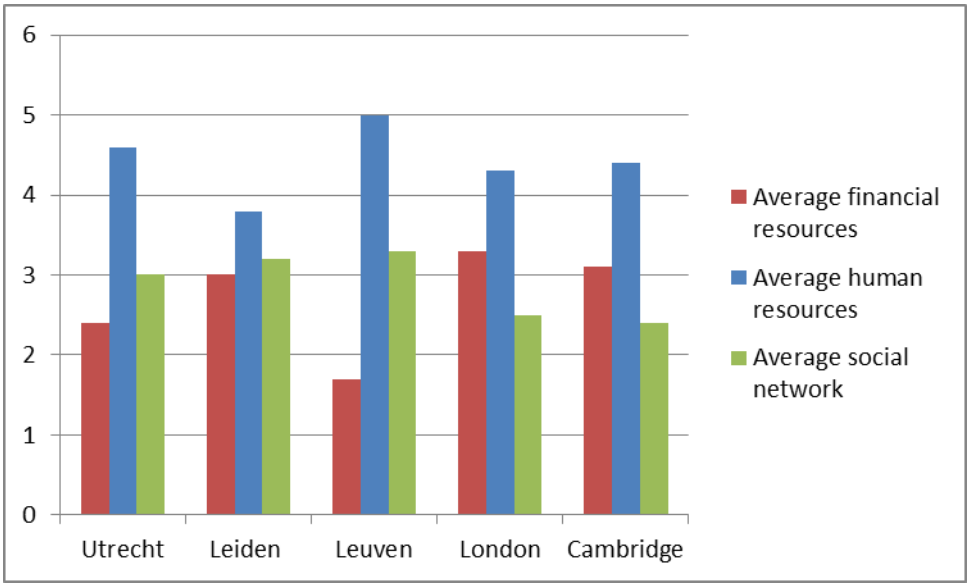

Figure 11: Points allocated to resources (1-10) compared for cases.

In Figure 11 can be seen that all cases allocated points consistent with their rated priority as illustrated with Figure 10. Of the five cases Leuven is most pronounced in the difference between the importance of the resources. The case Leiden is least pronounced in the difference between the importance of the resources. From Figure 11 can be deduced how much time and effort actors are likely to invest in each resource. The human resources are likely to get most attention, whereas financial resources and the social network as a resource seem to compete more with one another.

4.4 Deployment valorization activities

Knowledge valorization around academic medical centers takes place through the deployment of knowledge valorization activities, see Table 1 in which fifteen knowledge valorization activities are listed. This section includes several analyses regarding the deployment of knowledge valorization activities. These include the importance of resources for the deployment of valorization activities, the

influence of importance of the valorization activities on the valorization performance, the influence of the number of deployed activities on the performance, and the one-on-one influence of the deployment of each analyzed knowledge valorization activity. Furthermore, the deployment of valorization activities has been compared for similar actors. With the analysis of the deployment of valorization activities only results of activities that actually have been deployed are taken into account. This has been assured by asking for an example every time an interviewee stated to deploy an activity. It has become clear that all cases cover all fifteen analyzed knowledge valorization activities with one or more actors.

4.4.1 Importance of resources for the deployment of valorization activities

Regarding the deployment of fifteen knowledge valorization activities the importance of financial resources, human resources, and the social network as a resource has been analyzed. All interviewees who deploy knowledge valorization activities have been asked to evaluate which resource is most important for deploying that activity, which resource is second important and which resource is least important for deploying that activity. It became clear that across all five cases human resources are on average most important for the deployment of valorization activities, followed by the social network as resource, whereas financial resources appeared to be the least important for the deployment of knowledge valorization activities. This is remarkable as London and Cambridge considered financial resources as second most important instead of the social network as a resource when asked to compare the resources directly with one another, see Figure 10 and Figure 11. The reason for this inconsistency cannot be explained using the obtained data. The degrees of importance of financial resources, human resources, and the social network as a resource for the deployment of valorization activities are illustrated with Figure 12. The higher the value is, the more important the resource is, with a three as maximum value and a one as minimum value.

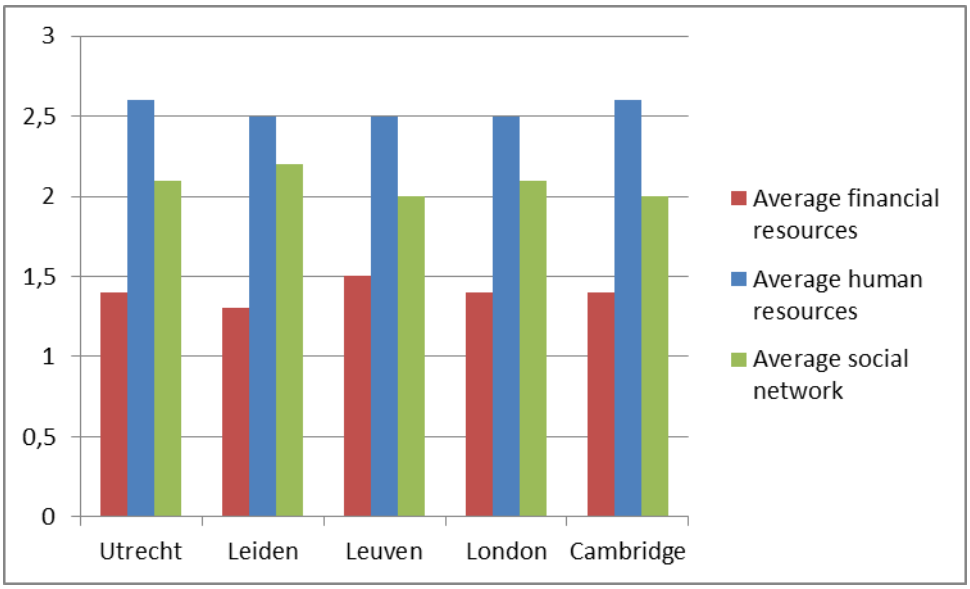

Figure 12: Importance of resources (1-3) for the deployment of knowledge valorization activities compared for cases.

4.4.2 Importance of knowledge valorization activities

Interviewees have been inquired as to whether some activities are more important than other activities for knowledge valorization. Furthermore, it has been analyzed how the importance of activities relates to the valorization performance.

More than half of the interviewees stated it is not possible to make a distinction between the activities regarding their importance: '*So regarding the list of activities, I find it very difficult to give it a priority. Everything is important.'* (Interviewee 14). They explain that it is the combination of all activities that leads to successful knowledge valorization. From the interviewees who were able to make a distinction between the importance of the deployment of activities the average result of all cases is provided below. Interviewees rated the most important activities with a three, medium important activities with a two, and the least important activities with a one.

The on average most important activities appear to be:

- A1: Provide assistance with setting up collaborations
- A3: Provide assistance with specifying needs related to technologies, production equipment, and patents
- A7: Provide assistance with patent applications preparation
- A8: Provide assistance with creating spin-offs in order to exploit inventions
- A14: Provide assistance with developing a business case

The on average medium important activities appear to be:

- A2: Provide assistance with managing collaborations
- A5: Provide assistance with developing a prototype design and tests of technical feasibility
- A9: Provide assistance with the negotiation and management of contractual agreements
- A10: Provide assistance with accessing commercial bank loans, angel investors, or venture capital, or with accessing subsidies linked to the development of new or improved products and processes
- A11: Provide own financial capital investments
- A13: Provide assistance related to product positioning

The on average least important activities appear to be:

- A4: Provide assistance with specifying needs related to research
- A6: Provide assistance with product and process safety certification
- A12: Provide start-up companies with office space
- A15: Provide assistance with accessing markets/distribution channels

In Table 4 the average importance of knowledge valorization activities per case can be seen, including only the interviewees that actually deploy activities with their organization themselves. A three is the maximum score and refers to the most important activities and a one is the lowest possible score which refers to the least important activities. Therefore, a green background refers to most important, an orange background refers to medium important, and a red background refers to least important activities. The interviewees of the case Leuven were all unable to make a distinction in importance, therefore no data is available for the case Leuven. The missing data for the case

Leiden and Cambridge means that only the interviewees that were not able to evaluate the importance of the activities deployed that particular activity.

Table 4: Importance of knowledge valorization activities on average per case.

No.	Activity	Utrecht	Leiden	Leuven	London	Cambridge
1	Provide assistance with setting up collaborations	2.3	2.5	N/A	2.5	2.7
2	Provide assistance with managing collaborations	2	2	N/A	2.5	2
3	Provide assistance with specifying needs related to technologies, production equipment, and patents	2.7	2.5	N/A	3	1.7
4	Provide assistance with specifying needs related to research	1	1	N/A	2	1
5	Provide assistance with developing a prototype design and tests of technical feasibility	2.5	N/A	N/A	3	1.3
6	Provide assistance with product and process safety certification	1.3	2	N/A	2	1
7	Provide assistance with patent applications preparation	2.5	3	N/A	3	2.7
8	Provide assistance with creating spin-offs in order to exploit inventions	2.8	2	N/A	3	2.3
9	Provide assistance with the negotiation and management of contractual agreements	2	3	N/A	2.5	2.3
10	Provide assistance with accessing commercial bank loans, angel investors, or venture capital, or with accessing subsidies linked to the development of new or improved products and processes	2	N/A	N/A	1.5	2.5
11	Provide own financial capital investments	1.8	N/A	N/A	2	3
12	Provide start-up companies with office space	1.3	3	N/A	1	1
13	Provide assistance related to product positioning	2.5	N/A	N/A	1.5	1.7
14	Provide assistance with developing a business case	2.8	1	N/A	2.5	2
15	Provide assistance with accessing markets/distribution channels	2	1	N/A	1	N/A

For each of the five cases the considered importance of the valorization activities and the corresponding valorization performance scores can be compared with one another. In this way it can become clear whether the considered importance of valorization activities influences the valorization performance of a case. The performance scores of each case are shown in Table 5, where a five is the maximum possible score and refers to the best performance whereas a one is the lowest possible score and refers to the worst performance. Again with these scores only the interviewees that actually deploy activities with their organization themselves are included, this to be able to better compare the results with one another. Table 5 shows that according to their own evaluation London

performs on average the best and Utrecht on average the worst, although the difference is quite small. Therefore, London is hold as reference case. Furthermore, the number of equally evaluated activities of the other cases with the London case is shown in Table 5. It becomes clear that although Utrecht deviates the most regarding the performance score, Utrecht resembles the case of London the most regarding the evaluation of the importance of knowledge valorization activities. With a consistent relationship between the evaluation of the importance of activities and the knowledge valorization performance, one would expect the more the considered importance of activities are equal, the more the valorization performance would be alike. As this is not the case, no consistent conclusion can be given regarding the relation between the evaluation of the importance of the knowledge valorization activities and the knowledge valorization performance. The case of Leiden approximates Utrecht as well and therefore illustrates the same.

Table 5: Average performance per case and shared evaluation of importance of activities.

	Utrecht	Leiden	Leuven	London	Cambridge
Average performance	3,7	3,8	3,8	4,2	3,9
Number of shared most important activities with London	5	4	N/A	N/A	2
Number of shared medium important activities with London	1	1	N/A	N/A	0
Number of shared least important activities with London	1	1	N/A	N/A	1
Total number of shared activities with London	7	6	N/A	N/A	3

As already stated, all five cases deploy all fifteen analyzed knowledge valorization activities. However, it could be that the perceived core activities of actors obtain the large majority of the valorization effort of actors. Then, it could be that when analyzing only the perceived core activities of actors, one knowledge valorization landscape covers a completer set of activities than other valorization landscapes. This could influence the knowledge valorization performance. Unfortunately, as only less than half of the interviewees were able to identify their most important activities, the obtained data is not suitable to carry out such an analysis.

4.4.3 Number of knowledge valorization activities and one-on-one influence

It has been analyzed whether it holds that the more activities are deployed the more successful knowledge valorization can take place, or whether the deployment of some particular activities is more successful than others.

When analyzing the number of actually deployed activities in relation with the knowledge valorization performance it becomes clear that the number of deployed activities appears not to matter for the knowledge valorization performance. Interviewees that deployed almost all knowledge valorization activities scored both low and high on the knowledge valorization performance. Also interviewees that deployed a low number of knowledge valorization activities scored both low and high on the knowledge valorization performance. This has been analyzed for the overall performance scores and also for the effectiveness and satisfaction separately. Both analyses led to the same result. Appendix 4 consists of an overview of the obtained data that has led to this conclusion.

Furthermore, the performance has been analyzed for the deployment of each activity separately. For each of the 18 interviewees that deployed valorization activities with their own organization is the deployment of each activity compared with the corresponding valorization performance of that organization using the matrix presented in Table 6.

Table 6: Matrix for analyzing the deployment of each activity and the corresponding performance.

	High performance	Low performance
Deployed		
Not Deployed		

It could be that the deployment of a knowledge valorization activity contributes to a better performance. Therefore, the interviewees that do deploy that activity and have a higher performance than the average score, and the interviewees that do not deploy that activity and have a lower performance than the average performance, are considered as confirming cases. The interviewees that do deploy the activity but have a lower than average performance, and the interviewees that do not deploy the activity but have a higher than average performance, are considered as deviant cases. The matrixes for the activities that have the least deviant interviewees are presented below, see Table 7, 8, and 9. An overview of the matrixes of all analyzed knowledge valorization activities is shown in appendix 5. The numbers within the matrixes refer to that particular interviewee.

Table 7: Matrix for activity 12; Provide start-up companies with office space.

	High performance	Low performance
Deployed	3b; 6; 16; 20; 21; 22; 26;	4; 12; 17;
Not Deployed	5; 11; 24;	3a; 9; 15; 23; 27

Table 8: Matrix for activity 13; Provide assistance related to product positioning.

	High performance	Low performance
Deployed	5; 6; 11; 16; 20; 22; 24; 26	3a; 4; 9; 23;
Not Deployed	3b; 21;	12; 15; 17; 27

Table 9: Matrix for activity 15; Provide assistance with accessing markets/distribution channels.

	High performance	Low performance
Deployed	3b; 5; 6; 11; 16; 20; 21; 22;	4; 9; 12; 15;
Not Deployed	24; 26;	3a; 17; 23; 27

For activity 12, 13 and 15 it holds that a majority of two thirds shows that the deployment of these activities could lead to a better knowledge valorization performance. For all other activities too many deviant cases have been identified to be able to indicate the possible effect of the deployment of those particular activities on the knowledge valorization performance.

Although it appeared to be hard to indicate the exact relationship between the deployment of particular knowledge valorization activities and the knowledge valorization performance, all interviewees agreed that the deployment of knowledge valorization activities in general contributes to a better knowledge valorization performance. For instance Interviewee 23 states: *'Yes, of course, the deployment of those activities is important and contributes to a better commercializing innovation performance. That relationship is present.'*. Or as Interviewee 22 explains: *'Yes, of course, the deployment of those activities is very important for the commercializing innovation performance. I think it is really a one to one relation, because for commercializing, these activities are one aspect of it. There is so much complication within the market, within the business cases, funding, etc., etc., and therefore, I think this part, the support part, has to move really smoothly. So that we don't have any complications here and that we could focus on the other problems. So it is important to deploy these activities to have a better performance at the end.'*. Therefore, the relation between the deployment of knowledge valorization activities and the knowledge valorization performance, as presented in the conceptual model, is confirmed.

4.4.4 Deployment of valorization activities compared for similar actors

Furthermore, some similar actors have been compared with another regarding the deployment of knowledge valorization activities. Interviewee 4, 11, 16, 20 and 26 are employed within a Technology Transfer Office (TTO) in each of the five cases. The obtained data shows that all these interviewees deploy the suggested cluster of activity 7, 8, and 9 by Landry et al. (2013). These activities are: proving assistance with patent applications preparation, providing assistance with creating spin-offs in order to exploit inventions, and providing assistance with the negotiation and management of contractual agreements. Moreover, the TTO interviewees deploy on average a high number of knowledge valorization activities, namely thirteen activities. Another group of similar actors, interviewee 6, 12 and 21, consists of interviewees employed at incubators in three of the five cases. These interviewees deploy on average a lower number of knowledge valorization activities, namely eight activities. Regarding the valorization performance only minor differences exist among all comparable groups.

5 Conclusion

In this conclusion first an outline of the conducted research is given. Then, conclusions about the influence of the three analyzed resources and the deployment of knowledge valorization activities on the knowledge valorization performance are provided.

5.1 Research outline

Knowledge valorization, a process in which value is added to new knowledge in order to transform it into a new (improved) product, process or service in the market, is becoming more and more important. Especially in the health care area knowledge valorization is important due to the large

benefits for patients and society. Academic medical centers can play a major role in this process and several resources are involved in this. Therefore, this study investigated *to what extent investments in financial capital, human capital, and social capital influence the knowledge valorization performance of academic medical centers*. Knowledge valorization occurs through the deployment of knowledge valorization activities. The before mentioned resources are needed to be able to deploy those knowledge valorization activities. Therefore, the conceptual model of this study comprises the influence of financial capital, human capital, and social capital on the deployment of knowledge valorization activities, which together influence the knowledge valorization performance. In this study the Resource Based View (RBV) has been used as theoretical framework, although with a slightly different approach. This is because the RBV is usually about firms and their competitive advantage, where in this study it is about academic medical centers and knowledge valorization performance.

A multiple case study has been conducted including the cases Utrecht, Leiden, Leuven, London, and Cambridge. 28 interviews and a literature study have been conducted which have led to a rich data set. The mapping of the knowledge valorization landscapes of the five cases showed the involved knowledge valorization actors and provided insight in how knowledge valorization has been organized in all cases. The analysis of the deployment of fifteen knowledge valorization activities made clear what all actors actually do and how they contribute to the knowledge valorization of the academic medical centers. The extensive analysis of the content of the selected resources; financial resources, human resources, and the social network as a resource enhanced the insight in the influence of those resources on the knowledge valorization performance. The obtained data confirmed that financial resources, human resources, and the social network as a resource are all needed to be able to deploy the valorization activities. Regarding the knowledge valorization performance both the accomplishment of goals and the feeling of satisfaction about the process have been studied.

5.2 Performance for cases compared

When the knowledge valorization performance of each case has been compared with one another, it became clear that all performance scores are quite close to each other. The effectiveness scores, containing the accomplishment of goals, vary from on average 3.6 to on average 4.0 between the five cases, where the score one would be the lowest possible and a score of five would be the best score possible. The satisfaction scores vary from on average 3.3 to on average 4.0, where again one would be the lowest possible and five the best score possible.

5.3 Influence of resources on performance

The conducted interviews provided one-on-one insight in the importance of the three resources for knowledge valorization. It became clear that the human resources are considered to be most important for knowledge valorization and therefore have the largest influence on the knowledge valorization performance. Mostly because of the broad range of needed expertise, the ability of people to bridge scientists with people from industry, and because of the presence of valorization champions, have human resources such a large influence on the knowledge valorization process. The social network as a resource is considered as the second most important resource to be able to deploy valorization activities. However, in general, the social network as a resource and the financial

resources alternate with each other regarding their importance for the knowledge valorization process. The importance of the social network of actors is mainly due to the possibility of adding expertise and the ability of testing ideas. The financial resources mainly contribute to knowledge valorization by the possibility to buy additional expertise and by the use of seeding money to invest in promising ideas.

Furthermore, based on the results a trend has been discovered across all interviews, namely that all three resources are dependent on one another. For instance when attracting financial capital by the use of venture capitalists, the social network as a resource appears to be very important. When a valorization actor has good contacts and is familiar within a network of venture capitalists, the actually acquiring of additional financial capital becomes more likely. Also for acquiring different kinds of expertise both the social network as a resource and financial resources can be very useful. This is because the social network can be used to make the connection and makes it easier to find the needed expertise, whereas financial resources can be used to pay for that expertise. Furthermore, the present human resources are connected to the other two resources. For example, for exploiting the social network, people with well-developed communication skills are needed. Also for getting access to additional financial resources human resources are useful. This is because some level of financial knowledge and project related knowledge can be beneficial for this which can be part of the different kinds of expertise belonging to the human resources.

When the results are analyzed on an even more advanced level another find can be deduced. Several interviews indicated that investments in the financial resources, human resources, and the social network as a resource appear to be trade-offs with one another. This means that when for instance an actor decides to invest a certain amount in the development of human resources, this amount cannot be invested in another resource anymore. Therefore, decisions to invest need to be made consciously and well balanced.

5.4 Influence of valorization activities on performance

The last important contribution of this study contains the influence of the deployment of knowledge valorization activities on the valorization performance. It became clear that about half of the interviewees were able to make a distinction between the importance of each activity. Providing assistance with setting up collaborations, providing assistance with patent applications preparation, and providing assistance with creating spin-offs in order to exploit inventions are the most important activities. However, no relation could be confirmed between the evaluation of the importance of knowledge valorization activities and the knowledge valorization performance. Also no relation could be confirmed between the number of knowledge valorization activities that are deployed and the knowledge valorization performance. Besides this, no relation between certain sets of activities and the performance could be identified. Although these specific relations could not be confirmed, it has been acknowledged by all interviewees that the deployment of the analyzed knowledge valorization activities in general contributes to a better knowledge valorization performance.

6 Discussion

In this study some research limitations can be identified. Furthermore, several recommendations can be provided and theoretical and practical implications can be given. These are elaborated on below.

6.1 Research limitations

The first research limitation that can be identified comprises the external validity of this study. Due to the limited number of cases and the qualitative nature of this study, the results cannot be generalized to all other academic medical centers aiming to valorize their knowledge. However, as all analyzed cases are part of the League of European Research Universities (LERU), some degree of external validity can be obtained as other members of the LERU are likely to resemble the selected cases (LERU, 2014). Therefore, other members of the LERU can learn the most from the obtained results of this study. Furthermore, Gröne & Garcia-Barbero (2001) identified that the health systems in Central and Eastern European countries show the same demographic and epidemiological trends as the Western European countries. This also implies that the results of this study could be generalized to some degree for other academic medical centers in Europe. Still, future research can be done including more cases to increase the degree the results can be generalized to other academic medical centers.

Another research limitation contains the internal validity. Mainly the evaluation of the knowledge valorization performance of the academic medical centers can be biased. Although the evaluation of the performance on a five-point Likert scale by the interviewees themselves reduces bias from miss-interpretation of the researcher, this could have led to socially desired answers given by those interviewees. As the interviewees have been asked to evaluate themselves one can question how critically they have assessed their own performance. The performance scores are all quite close to one another and predominantly positive. Also, the standard deviations are quite low. This indicates only small differences between the analyzed cases and it implies that the performance scores could be positively biased. However, each interviewee has been asked to illustrate his performance assessment with examples, and follow-up questions have been asked when the reasoning of the performance evaluations was not clear, both to try to reduce that bias. Besides this, several ways of triangulation have been used to further reduce the chance on the possible bias.

Future research can complement this study regarding the knowledge valorization performance of academic medical centers by having other actors evaluate the performance of the academic medical centers. Examples of other actors could be medical practitioners or entrepreneurs who actually obtained support from the academic medical centers and related actors when valorizing their ideas. In this way an additional manner of triangulation could be used which could make the study more objective. Therefore, a performance analysis in such way could lead to additional insights.

6.2 Recommendations and theoretical and practical implications

The results of this study confirm several findings of prior research. Prior studies already suggested the importance of financial capital (Santoro & Gopalakrishnan, 2000; Lockett & Wright, 2005), human capital (Xu, 2000), and social capital (Landry et al., 2002) for knowledge valorization. These findings are all supported by this study, as it became clear that the analyzed resources are all important for knowledge valorization. Moreover, as research about the influence of the chosen resources on knowledge valorization specific for academic medical centers was mostly lacking, this study extended the current insights by confirming the importance of those resources specific for academic medical centers and related actors.

Furthermore, prior research is extended by the finding that human resources are most important for the deployment of knowledge valorization activities and for knowledge valorization in general around academic medical centers. Therefore, it is recommendable for academic medical centers to invest most in human resources in order to stimulate the valorization of their knowledge. Academic medical centers and related actors could provide particular training courses to develop the needed expertise like finance knowledge, project management expertise, and business skills. In addition, they could invest in hiring a diverse group of employees with different valorization qualities like social skills, technical skills, and the ability to critically assess ideas.

Besides this, the financial resources, human resources, and the social network as a resource appear to be interdependent on one another. Hence, it is advisable for academic medical centers and related actors to be aware of this and to use each resource also for complementing the other resources. This could result in an optimal use of all resources which could lead to a more efficient and effective way of valorizing knowledge around academic medical centers. Future research could further delve into what an optimal use of all resources comprises.

Another recommendation that can be made relates to the use of human resources. This involves the rewarding of employees that contribute to knowledge valorization. In line with Siegel et al. (2003) and Armstrong & Taylor (2014) this study made clear that it is important to reward employees that contribute to knowledge valorization. For instance, academic medical centers can offer the possibility to make career in the knowledge valorization field. A researcher could be promoted to associate professor or professor by contributing to knowledge valorization, which can stimulate employees to put effort in the valorization of knowledge.

Furthermore, as academic medical centers and their related actors mentioned a lack of financial resources several times, a few actions can be recommended to increase the financial support in particular for knowledge valorization. Firstly, academic medical centers and related actors can try to increase the financial resources available for supporting knowledge valorization by lobbying more with governmental actors. According to García (2005) and Georgiadou et al. (2014) there can be a lack of awareness of governmental actors for the need for valorization support. By lobbying with governmental actors these could become more aware of the needed financial support for knowledge valorization and they could increase their financial support for academic medical centers and related actors. Here, it is important for academic medical centers and their related actors to illustrate that the money actually will be spent on knowledge valorization support, to assure governmental actors that the money will be invested in a proper way. Secondly, making more use of available subsidies for research and valorization can help to increase the financial resources available for supporting knowledge valorization. Here, both ways of increasing access to financial resources can help to avoid opportunities remain unused.

Related to the lack of financial resources is the concept of a revolving fund for knowledge valorization. This means that the investments made in valorization flow back through financial benefits which can be reinvested in new opportunities. As this currently appeared to be more a desire instead of a reality, it is recommendable for academic medical centers and related actors to keep striving for accomplishing this. Ultimately, this could lead to a self-maintaining knowledge valorization process, which again could prevent opportunities remaining unused.

Regarding the deployment of knowledge valorization activities the identified activities by Landry et al. (2013) are confirmed by this study and additional valorization activities have been identified. A first attempt has been made to identify patterns and sets of activities that are most beneficial for the knowledge valorization performance. Unfortunately the results of this study are not conclusive regarding this. Therefore, additional research is needed to obtain more insight in the relation between particular valorization activities and the valorization performance.

All in all, this study contributes to the understanding of the Resource Based View (RBV) regarding knowledge valorization. It has become clear that the RBV is an appropriate framework to analyze the process of knowledge valorization. This is because the insight in the specific content of the analyzed resources has been extensively enhanced regarding knowledge valorization and appeared to be well applicable to knowledge valorization around academic medical centers.

With the above mentioned recommendations this study contributes to benefits for society. When European policy makers, board members of academic medical centers, and related organizations implement the suggested recommendations, more knowledge can be valorized in a more optimal manner. In this way less opportunities remain unused, which can lead to better care for patients and a more efficient health care system.

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Appendix 1: List of interviewees

In this appendix a list including all the interviewees of this study is provided, see Table 1. Due to anonymity wishes only the corresponding city and function is stated.

Table 1: List of interviewees.

Interviewee code	City	Function
Interviewee 1	Utrecht	Innovation ambassador UMCU; Program director joint venture UMCU & AVL
Interviewee 2	Utrecht	Valorization officer UMCU
Interviewee 3a	Utrecht	Board member Eureka Institute for translational medicine
Interviewee 3b	Utrecht	Director UNOVATE
Interviewee 4	Utrecht	Director UMCU Holding BV
Interviewee 5	Utrecht	Director Utrecht VC
Interviewee 6	Utrecht	Managing director UtrechtInc
Interviewee 7	Utrecht	Dean and vice chairman of the board UMCU
Interviewee 8	Utrecht	Strategy director UMCU
Interviewee 9	Utrecht	Business developer Pontes Medical
Interviewee 10	Utrecht	Managing director Utrecht Life Sciences
Interviewee 11	Leiden	Business developer and commercialization advisor LURIS
Interviewee 12	Leiden	Director BioPartner Leiden; Director Leiden Bio Science Park
Interviewee 13	Leiden	Operations Manager Division 2 LUMC
Interviewee 14	Leiden	Officer of European research grants and strategic alliances LUMC; Member of the daily board at Medical Delta
Interviewee 15	Leiden	IP executive LURIS
Interviewee 16	Leuven	Director division and project management LRD
Interviewee 17	Leuven	IP executive LRD
Interviewee 18	Leuven	Medical director UZ Leuven
Interviewee 19	London	Director research support UCLH
Interviewee 20	London	Senior business manager ULCH Innovation Office, UCL Business
Interviewee 21	London	Chief executive London BioScience Innovation Centre
Interviewee 22	London	Industrial partnership manager Translational Research Office
Interviewee 23	Cambridge	IP manager Biomedical Research Centre
Interviewee 24	Cambridge	Head of medical technology Health Enterprise East
Interviewee 25	Cambridge	Business consultant
Interviewee 26	Cambridge	R&D solicitor CUH
Interviewee 27	Cambridge	Clinical engineer R&D CUH
Interviewee 28	Cambridge	Assistant director Commercial Development

Appendix 2: Example of a set of interview questions

This appendix shows an example of a set of interview questions.

Introduction

My name is Robin Leinarts. I am currently writing my master thesis for the Master program Science & Innovation Management in Utrecht. At the same time I am following a traineeship with the University Medical Center Utrecht at the department Pontes Medical. Pontes Medical is about stimulating the knowledge valorization related to medical technology. My thesis is about knowledge valorization around academic medical centers in Europe. More specific, I am investigating the relation between the knowledge valorization process and investments in financial resources, human resources, and the social network as a resource.

Financial resources are defined as all various monetary resources available for knowledge valorization. In particular I mean the money one spends to buy a product or service, and not the money that is needed to pay for personnel, because this aspect is part of human resources.

Human resources refer to individuals with the expertise to do something, people with talent and experience.

The social network as resource is in this study defined as the ability of actors to extract benefits from their social structures, networks and memberships. Examples of the social network as resource are networks provided by friends and family, something like University College London Business, commercial partners, knowledge institutes, etc.

Do you have any questions? Otherwise we can now start with the interview questions.

1. Can you shortly explain your function within the organization?

Knowledge valorization landscape

For this university hospital I have tried to map the knowledge valorization landscape, see Figure 1.

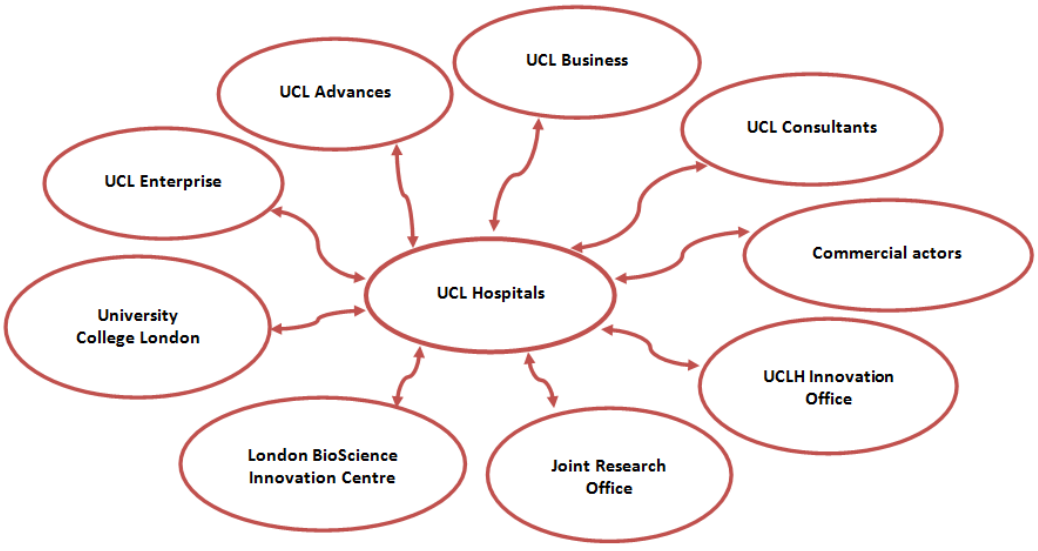

Figure 1: Proposed knowledge valorization landscape UCL Hospitals.

2. Can you indicate if this figure matches reality?
    a. Are some aspects overlooked, for instance actors, departments, or relations? If yes, which aspects, and where should they be located in Figure 1?
    b. Are some actors or relations more important than others? If yes, can you explain why?
    c. Are some actors or relations less important than others? If yes, can you explain why?

Deployment of knowledge valorization activities

Table 1 shows an overview of activities that could be important for knowledge valorization.

Table 1: Knowledge valorization activities; adapted from Landry et al. (2013).

No.	Knowledge valorization activity	Deployment: yes / no?
1	Provide assistance with setting up collaborations	
2	Provide assistance with managing collaborations	
3	Provide assistance with specifying needs related to technologies, production equipment, and patents	
4	Provide assistance with specifying needs related to research	
5	Provide assistance with developing a prototype design and tests of technical feasibility	
6	Provide assistance with product and process safety certification	
7	Provide assistance with patent applications preparation	
8	Provide assistance with creating spin-offs in order to exploit inventions	
9	Provide assistance with the negotiation and management of contractual agreements	
10	Provide assistance with accessing commercial bank loans, angel investors, or venture capital, or with accessing subsidies linked to the development of new or improved products and processes	
11	Provide own financial capital investments	
12	Provide start-up companies with office space	
13	Provide assistance related to product positioning	
14	Provide assistance with developing a business case	
15	Provide assistance with accessing markets/distribution channels	

3. Can you use Table 1 as check list and indicate which of the knowledge valorization activities of Table 1 your organization deploys?
    a. How is the deployment of those activities organized? Can you elaborate what you do specifically for each activity? (Ask for the aspects of financial resources, people with expertise, the social network as resource)
    b. Could you indicate a priority of the resources (financial resource, people with expertise, and social network) for each activity that you deploy? So which one is most important, which is in second place, and which one comes third, and why?

Resources

I am now going to ask some more open questions about the resources: financial resources, human resources, and the social network as a resource. Several times I will ask you to evaluate something on a five point scale, see Figure 2.

1 Very unimportant	2 Unimportant	3 Neutral	4 Important	5 Very important

Figure 2: Illustration five point scale.

Financial resources

4. How would you describe the role that financial resources have for knowledge valorization within your organization?
    a. Can you provide examples to illustrate the use of financial resources?
    b. How do you develop or extend the financial resources within your organization?
    c. How do you decide to divide your financial resources?
    d. How important do you consider investments by your organization in financial resources for knowledge valorization on a five point scale?

Human resources

5. How would you describe the role that human resources have for knowledge valorization within your organization?
    a. Can you provide examples to illustrate the use of human resources?
    b. How do you develop or extend the human resources within your organization?
    c. How do you decide to divide investments in human resources?
    d. How important do you consider investments in human resources for knowledge valorization on a five point scale?

The social network as resource

6. How would you describe the role that the social network as resource has for knowledge valorization within your organization?
    a. Can you provide examples to illustrate the use of the social network as resource?
    b. How do you develop or extend the social network as resource within your organization?
    c. How do you decide to divide investments in the social network as resource?
    d. How important do you consider investments in the social network as resource for knowledge valorization on a five point scale?

Ranking resources in comparison with one another

7. Can you rank the importance of financial resources, human resources, and the social network as a resource in comparison with one another for knowledge valorization? Can you elaborate your choice?
    a. Could you also divide 10 points between financial resources, human resources, and the social network as a resource to illustrate their importance in comparison with one another?

Knowledge valorization performance

To obtain insight in the performance of knowledge valorization the scientific literature indicated two aspects. The first one is effectiveness. I think that an organization can have goals regarding knowledge valorization and that these goals can be accomplished to a certain degree. The second aspect is satisfaction. I think that the degree of the feeling of satisfaction can provide additional insight in the performance of the process.

Effectiveness

8. What are the goals of your organization regarding knowledge valorization?
    a. Can you elaborate this with examples?

9. Can you indicate to which degree you have accomplished your goals using the adapted five point scale of Figure 3?
        i. Can you provide some numbers or figures to illustrate this?

1	2	3	4	5
Very low degree	Low degree	Neutral	High degree	Very high degree

Figure 3: Illustration adapted five point scale.

10. Can you provide a priority of the importance of the deployment of activities for accomplishing those goals? So can you indicate which activities from Table 1 you consider most important, which activities you consider as medium important and which activities you consider as less important?

Satisfaction

11. Can you indicate to which degree you are satisfied with your knowledge valorization performance using the adapted five point scale?
    a. What are the reasons for your satisfaction or dissatisfaction?
        i. Can you elaborate this with examples?

12. Can you indicate some points of improvement regarding knowledge valorization within you organization?

Direct influence

13. How does the deployment of activities influence your knowledge valorization performance? Do you think such a relation is present, or not?
    a. Can you elaborate this with examples?

Appendix 3: Coding reliability

In this appendix the coding reliability is further explained. 21 randomly selected codes from interview 20 have been coded by two additional researchers. Table 1 shows the codes which are used to calculate the level of agreement of coding which is needed to guarantee the coding reliability.

Table 1: Content of codes by three researchers

Code number	Codes researcher 1	Codes researcher 2	Codes researcher 3
1	Function	Function information	Personal information
6	Assistance specifying research needs	Supporting research	Activity: specifying research needs
11	Assistance contractual agreements	Contractual agreements	Activity: contractual agreements
16	Assistance business case	Business case	Activity: business case
21	Assistance office space	Office space	Activity: office space
26	Assistance managing collaborations	Managing collaborations	Activity: managing collaborations
31	Assistance specifying research needs priority	Needed expertise	Required knowledge
36	Assistance patent application	Patent application	Activity: applying for a patent
41	Assistance spin-off creation priority resources	Spin-off creation resources	Facilitating a spin-off
46	Assistance access financial capital	Financial support	Activity: access financial capital
51	Assistance office space	Office space	Activity: office space
56	Financial resource buying expertise	Financial resources hiring expertise	Facilitating a spin-off
61	Financial resource bridging the gap	Access to financial resources	Financial resources: bridge function
66	Financial resource acquirement	Access to financial resources	Financial resources: development
71	Human resource skills	Valuable human resources skills	Human resources: variety of skills
76	Human resource development	human resources development	Human resources: development
81	Social network creation	stagnated acceleration	Social network creation
86	Resources in comparison	Resources compared with each other	Importance of resources compared
91	Activity high importance	Activities most important	Activity most important
96	Activity medium importance	Activities medium important	Activity medium important
101	Activities needed for innovation performance	Activities needed for innovation performance	Relation commercialization with activities

In Table 2 the agreement on codes between researchers is provided. The number 1 indicates agreement between the researchers en the number 0 refers to disagreement between researchers. Also to total percentage of agreement and the average percentage of agreement between the researchers can been seen.

Table 2: Agreement between researchers.

Code number	Agreement researcher 1 / researcher 2	Agreement researcher 1 / researcher 3	Agreement researcher 2 / researcher 3
1	1	1	1
6	1	1	1
11	1	1	1
16	1	1	1
21	1	1	1
26	1	1	1
31	0	0	1
36	1	1	1
41	1	0	0
46	1	1	1
51	1	1	1
56	1	0	0
61	0	1	0
66	1	1	1
71	1	1	1
76	1	1	1
81	0	1	0
86	1	1	1
91	1	1	1
96	1	1	1
101	1	1	1
Total % agreement	86%	86%	81%
Average agreement	84%		

To determine the reliability of the coding system 21 codes were systematically randomized selected (code number 1, 6, 11, 16, see Table 1) and coded by two additional researchers. Of the 21 codes, the three researchers completely agreed on 17 of them (illustrated by 1 1 1 in Table 2). For four codes only two researchers agreed on the same code (illustrated by 1 0 0 or a variation of this). There were no codes for which there was no agreement at all. On average, an agreement of 84% has been reached. Lombard et al conclude that a level of agreement between 80% and 90% is acceptable in most situations (Lombard et al., 2002) and can be generalized for all other codes. Therefore, this research contains a reliable coding system which leads to a solid analysis.

Appendix 4: Overview activity deployment and performance scores

This appendix shows an overview of the results regarding the deployment of knowledge valorization activities, its importance, and the knowledge valorization performance scores, see Figure 1.

		Utrecht						Leiden			Leuven		London			Cambridge				
No.	**Activity / Interviewee code**	3a	3b	4	5	6	9	11	12	15	16	17	20	21	22	23	24	26	27	**Average**
1	Provide assistance with setting up collaborations	2		2	X	2	3	X	2	3	X	X	2	X	3	2	3	3	X	2,5
2	Provide assistance with managing collaborations		2	1	X	2	3			2	X	X	2		3		2		X	2,1
3	Provide assistance with specifying needs related to technologies, production equipment, and patents		3	2			3	X	3	2	X	X	3		3	1	3	1	X	2,4
4	Provide assistance with specifying needs related to research		1	1	X		1	X		1	X	X	2	X	2	1			X	1,3
5	Provide assistance with developing a prototype design and tests of technical feasibility	3					2	X			X	X	3			1	2	1	X	2,0
6	Provide assistance with product and process safety certification	2		1			1		2		X		2			1	1	1	X	1,4
7	Provide assistance with patent applications preparation			3			2	X		3	X	X	3	X		3	3	2	X	2,7
8	Provide assistance with creating spin-offs in order to exploit inventions		3	3		3	2	X		2	X	X	3	X		2	3	2	X	2,6
9	Provide assistance with the negotiation and management of contractual agreements	2		3	X	1	2	X		3	X	X	3		2	1	3	3		2,3
10	Provide assistance with accessing commercial bank loans, angel investors, or venture capital, or with accessing subsidies linked to the development of new or improved products and processes		3	2		1	2	X			X	X	2	X	1	3	2		X	2,0
11	Provide own financial capital investments		3	2	X	1	1	X				X	1		3	3	3			2,1
12	Provide start-up companies with office space		1	2		1			3		X	X	1	X	1			1		1,4
13	Provide assistance related to product positioning	3		1	X	3	3	X			X		2		1	2	2	1		2,0
14	Provide assistance with developing a business case	3		2	X	3	3	X	1		X	X	3	X	2	2	2	2	X	2,3
15	Provide assistance with accessing markets/distribution channels		1	1	X	3	3	X	1	1	X		1	X	1				X	1,5
	Effectiveness	3	4	3,5	4	5	3	4	3	4	4	4	4	4	4	3	4	5	3	
	Satisfaction	3	4	4	4	4	3	5	4	3	4	3	4	5	4	3	4	5	4	
																				Average
	SUM performance	6	8	7,5	8	9	6	9	7	7	8	7	8	9	8	6	8	10	7	7,7
																				Average
	Number of activities			14				12			14		15					10		13
						10			6					8						8
	Legenda:																			
	X: activity has been deployed but rating of importance was not possible																			
	Rating of activities: the higher the more important (3 = most important, 1 = least important)																			
	Rating of effectiveness and satasfaction: the higher the better performance (5 = best performance, 1 = worst performance)																			
	SUM performance: the higher the better (10 = best possible, 2 = worst possible)																			
	Red background: on average least important/worst performance																			
	Orange background: on average medium important/medium performance																			
	Green background: on average most important/best performance																			
	Blue background: comparable TTO's among cities																			
	Purple background: comparable incubators among cities																			

Figure 1: Overview of activity deployment and knowledge valorization performance scores.

Appendix 5: Total overview of matrixes regarding the deployment of activities and performance

In this appendix an overview of the matrixes regarding all analyzed deployed activities and the corresponding knowledge valorization performance scores is provided, see Table 1. The numbers in the matrixes refer to the corresponding interviewees.

Table 1: Matrixes regarding all deployed activities and the corresponding performances.

No.	Activity	Matrix		
1	Provide assistance with setting up collaborations		High performance	Low performance
		Deployed	5; 6; 11; 16; 20; 21; 22; 24; 26	3a; 4; 9; 12; 15; 17; 23; 27
		Not Deployed	3b	
2	Provide assistance with managing collaborations		High performance	Low performance
		Deployed	3b; 5; 6; 16; 20; 22; 24	4; 9; 15; 17; 27
		Not Deployed	11; 21; 26	3a; 12; 23
3	Provide assistance with specifying needs related to technologies, production equipment, and patents		High performance	Low performance
		Deployed	3b; 11; 16; 20; 22; 24; 26	4; 9; 12; 15; 17; 23; 27
		Not Deployed	5; 6; 21	3a
4	Provide assistance with specifying needs related to research		High performance	Low performance
		Deployed	3b; 5; 11; 16; 20; 21; 22	4; 9; 15; 17; 23; 27
		Not Deployed	6; 24; 26	3a; 12
5	Provide assistance with developing a prototype design and tests of technical feasibility		High performance	Low performance
		Deployed	11; 16; 20; 24; 26	3a; 9; 17; 23; 27
		Not Deployed	3b; 5; 6; 21; 22	4; 12; 15
6	Provide assistance with product and process safety		High	Low

	certification		performance	performance
		Deployed	16; 20; 24; 26	3a; 4; 9; 12; 23; 27
		Not Deployed	3b; 5; 6; 11; 21; 22	15; 17
7	Provide assistance with patent applications preparation		High performance	Low performance
		Deployed	11; 16; 20; 21; 24; 26	4; 9; 15; 17; 23; 27
		Not Deployed	3b; 5; 6; 22	3a; 12
8	Provide assistance with creating spin-offs in order to exploit inventions		High performance	Low performance
		Deployed	3b; 6; 11; 16; 20; 21; 24; 26	4; 9; 15; 17; 23; 27
		Not Deployed	5; 22	3a; 12
9	Provide assistance with the negotiation and management of contractual agreements		High performance	Low performance
		Deployed	5; 6; 11; 16; 20; 22; 24; 26	3a; 4; 9; 15; 17; 23
		Not Deployed	3b; 21	12; 27
10	Provide assistance with accessing commercial bank loans, angel investors, or venture capital, or with accessing subsidies linked to the development of new or improved products and processes		High performance	Low performance
		Deployed	3b; 6; 11; 16; 20; 21; 22; 24	4; 9; 17; 23; 27
		Not Deployed	5; 26	3a; 12; 15
11	Provide own financial capital investments		High performance	Low performance
		Deployed	3b; 5; 6; 11; 20; 22; 24	4; 9; 17; 23
		Not Deployed	16; 21; 26	3a; 12; 15; 27
12	Provide start-up companies with office space		High performance	Low performance
		Deployed	3b; 6; 16; 20; 21; 22; 26	4; 12; 17
		Not Deployed	5; 11; 24;	3a; 9; 15; 23; 27

13	Provide assistance related to product positioning		High performance	Low performance
		Deployed	5; 6; 11; 16; 20; 22; 24; 26	3a; 4; 9; 23
		Not Deployed	3b; 21	12; 15; 17; 27
14	Provide assistance with developing a business case		High performance	Low performance
		Deployed	5; 6; 11; 16; 20; 21; 22; 24; 26	3a; 4; 9; 12; 17; 23; 27
		Not Deployed	3b	15
15	Provide assistance with accessing markets/distribution channels		High performance	Low performance
		Deployed	3b; 5; 6; 11; 16; 20; 21; 22	4; 9; 12; 15
		Not Deployed	24; 26	3a; 17; 23; 27