

# PRE-COMMERCIAL PUBLIC-PRIVATE INNOVATION IN THE DANISH HEALTHCARE SECTOR



INGE MARSTRAND KRISTENSEN  
SUPERVISOR: JULIANA HSUAN  
HAND-IN DATE: OCTOBER 11<sup>TH</sup>

NUMBER OF CHARACTERS: 181.786  
NUMBER OF PAGES: 79.9

## **Abstract**

The aim of this study was to investigate Public-Private Innovation (PPI) and provide insights on what factors to prioritise in addressing the problem of attracting private medico companies to engage in a two-stage model proposed by the Danish Regions. The study therefore tested a structural equation model (SEM) of factors influencing *Private Medico Companies' Propensity of Engaging in Pre-commercial PPIs with the Danish Regions*.

The proposed SEM draws upon a framework developed by Sambasivan et al. (2013), which measures the success of inter-firm strategic alliances. Based on a number of interviews the inter-firm framework was modified by changing the construct measuring *success* to a construct measuring the *propensity of engagement*. The interviews also led to the introduction of an additional construct, *Manager Motivation*. The result of the modifications was a model that better captures the aspects of PPI.

Self-administered questionnaires were used to collect data from 31 Danish medico companies and the model was estimated via Partial Least Squares.

Testing the SEM returned seven statistically significant factors influencing the propensity to engage; Environment, Strategic Alliance Motive, Asset Specificity, Perception of Opportunistic Behaviour, Interdependence, Relational Capital and Manager Motivation. These factors are able to explain 78.2% of the variance in the *Propensity of Private Medico Companies Engaging in Pre-commercial PPIs with the Danish Regions*. *Perception of Opportunistic Behaviour*, *Manager Motivation* and *Relational Capital* directly influence the propensity to engage. With a path coefficient of 0.438, *Manager Motivation* has the strongest direct influence on the propensity to engage.

Additionally, *Interdependence*, *Asset Specificity*, *Strategic Alliance Motive* and *Environment* indirectly influence the propensity to engage through *Relational Capital*.

Changing the perspective from inter-firm to Public-Private caused a proposed mediation effect of *Relational Capital* to be insignificant for the effect of *Asset Specificity* and *Perception of Opportunistic Behaviour* on the propensity to engage. Furthermore, the effect of *Asset Specificity* on *Interdependence* turned out to be insignificant.

**PRE-COMMERCIAL PUBLIC-PRIVATE INNOVATION IN HEALTHCARE**  
Table of Content

## **Table of Content**

<b>ABSTRACT</b>	<b>1</b>
<b>TABLE OF CONTENT</b>	<b>2</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>5</b>
<b>1.1 DEFINITION OF CONSTRUCTS</b>	<b>5</b>
1.1.1 PUBLIC-PRIVATE PARTNERSHIP	6
1.1.2 INNOVATIVE PUBLIC PROCUREMENT	6
1.1.3 INNOVATIVE PUBLIC PROCUREMENT VS. PUBLIC-PRIVATE INNOVATION	8
<b>1.2 THE PROCESSES OF PUBLIC-PRIVATE INNOVATION</b>	<b>8</b>
1.2.1 ONE-STAGE MODEL	9
1.2.2 TWO-STAGE MODEL	10
<b>1.3 LEGISLATION AND CONTRACTUAL MATTERS</b>	<b>13</b>
1.3.1 LEGISLATION	13
1.3.2 CONTRACTUAL MATTERS	14
<b>CHAPTER 2 FRAMING THE STUDY</b>	<b>15</b>
<b>2.1 AIM AND CONTRIBUTIONS</b>	<b>15</b>
<b>2.2 PROBLEM STATEMENT</b>	<b>15</b>
<b>2.3 OBJECTIVES</b>	<b>16</b>
<b>2.4 STRUCTURE</b>	<b>16</b>
<b>2.5 SCOPE AND DELIMITATIONS</b>	<b>19</b>
<b>2.6 THEORY AND METHODOLOGY</b>	<b>20</b>
2.6.1 THEORY	20
2.6.2 METHODOLOGY	20
<b>2.7 THE MODEL</b>	<b>22</b>
2.7.1 STRUCTURAL EQUATION MODEL	22
2.7.2 ESTIMATION METHOD	23
2.7.3 ESTIMATION TOOL	23
<b>CHAPTER 3 THE MEDICO INDUSTRY</b>	<b>23</b>
<b>3.1 MEDICAL EQUIPMENT</b>	<b>23</b>
<b>3.2 STRUCTURE OF THE PROCUREMENT OF MEDICAL EQUIPMENT IN DENMARK</b>	<b>24</b>
<b>3.3 THE DANISH MEDICO INDUSTRY IN NUMBERS</b>	<b>25</b>
<b>CHAPTER 4 LITERATURE REVIEW</b>	<b>26</b>
<b>4.1 METHODOLOGICAL CONSIDERATIONS</b>	<b>26</b>
<b>4.2 INNOVATION THEORY</b>	<b>27</b>
<b>4.3 CONTEXT SPECIFIC LITERATURE</b>	<b>29</b>
<b>4.4 LITERATURE FOR CONCEPTUAL FRAMEWORK</b>	<b>30</b>

**PRE-COMMERCIAL PUBLIC-PRIVATE INNOVATION IN HEALTHCARE**  
Table of Content

<b>CHAPTER 5 METHODOLOGY</b>	<b>31</b>
5.1 ULTIMATE PRESUMPTIONS	32
5.2 PARADIGM	33
5.3 METHODOLOGICAL VIEW	33
5.3.1 EXPLANATORY RESEARCH	34
5.3.2 COMPLEMENTARITY	34
5.4 OPERATIVE PARADIGM	35
5.4.1 METHODICAL PROCEDURES	35
<b>CHAPTER 6 QUALITATIVE DATA COLLECTION</b>	<b>37</b>
6.1 PRELIMINARY INTERVIEWS	37
<b>CHAPTER 7 THEORY OF CONCEPTUAL MODEL</b>	<b>38</b>
7.1 MODEL ASSUMPTIONS	39
7.2 PROPENSITY OF PRIVATE COMPANIES ENGAGING IN PRE-COMMERCIAL PPIS WITH THE DANISH REGIONS	39
7.3 MANAGER MOTIVATION	40
7.4 RELATIONAL CAPITAL	43
7.5 INTERDEPENDENCE LEVEL	44
7.6 PERCEPTION OF OPPORTUNISTIC BEHAVIOUR	45
7.7 ASSET SPECIFICITY	46
7.8 STRATEGIC ALLIANCE MOTIVE	48
7.9 ENVIRONMENT	50
7.10 THE MEDIATING EFFECT OF RELATIONAL CAPITAL	50
7.11 DIRECT EFFECTS	51
<b>CHAPTER 8 QUANTITATIVE DATA COLLECTION</b>	<b>52</b>
8.1 METHODICS	52
8.1.1 SOFTWARE TOOL	52
8.1.2 INTERNET-BASED SURVEY	52
8.1.3 SAMPLING METHOD	53
8.2 OPERATIONALISATION OF CONSTRUCTS	56
8.2.1 MEASUREMENT SCALE	56
8.2.2 PILOT TEST	57
<b>CHAPTER 9 DATA ANALYSIS</b>	<b>57</b>
9.1 PRELIMINARY DATA PROCESSING	57
9.1.1 DATA CLEANSING	57
9.1.2 DISTRIBUTION OF DATA	58
9.1.3 REPRESENTATIVENESS	58
9.2 STRUCTURAL EQUATION MODELLING AND ESTIMATION	59
9.2.2 TWO LEVELS OF ABSTRACTION	59
9.3 MEASUREMENT MODEL	60
9.3.1 REFLECTIVE MODELLING	60
9.3.2 QUALIFICATION FOR CONFIRMATORY FACTOR ANALYSIS	60
9.4 EVALUATION OF MEASUREMENT MODEL	61
9.4.1 INDICATOR RELIABILITY	61
9.4.2 INTERNAL CONSISTENCY RELIABILITY	61
9.4.3 CONVERGENT VALIDITY	61
9.4.4 DISCRIMINANT VALIDITY	62

**PRE-COMMERCIAL PUBLIC-PRIVATE INNOVATION IN HEALTHCARE**  
**Table of Content**

9.4.5 CROSS LOADINGS	62
<b>9.5 STRUCTURAL MODEL</b>	<b>62</b>
9.5.1 TEST OF RELATIONSHIPS BETWEEN THE LATENT CONSTRUCTS	62
9.5.2 TEST OF DIRECT EFFECTS ON RELATIONAL CAPITAL	65
9.5.3 TEST OF THE MEDIATION ROLE OF RELATIONAL CAPITAL	66
<b>9.6 EVALUATION OF STRUCTURAL MODEL</b>	<b>66</b>
9.6.1 COEFFICIENT OF DETERMINATION	66
9.6.2 GOODNESS OF FIT	67
9.6.3 PATH COEFFICIENT ESTIMATES	67
9.6.4 EFFECT SIZE	68
<b>CHAPTER 10 CONCLUSION</b>	<b>69</b>
<b>CHAPTER 11 IMPLICATIONS IN AN INTERNATIONAL PERSPECTIVE</b>	<b>70</b>
<b>11.1 FIRST ORDER IMPLICATIONS</b>	<b>70</b>
11.1.1 STRATEGIC ALLIANCE MOTIVES	71
11.1.2 PERCEPTION OF OPPORTUNISTIC BEHAVIOUR	71
11.1.3 RELATIONAL CAPITAL	71
11.1.4 MANAGER MOTIVATION	71
<b>11.2 SECOND ORDER IMPLICATIONS</b>	<b>72</b>
11.2.1 IMPROVED INTERNATIONAL COMPETITIVENESS	72
11.2.2 EXPORT FOSTERING	72
<b>LITERATURE LIST</b>	<b>74</b>

## Chapter 1 Introduction

The Danish healthcare sector is currently under pressure to deliver timely services of high quality to the Danish citizens. In order not to make capacity issues a matter of prioritising what patients receive the necessary treatment, the healthcare sector is furthermore under pressure to figure out a way to expand capacity to meet the increasing number of both acute patients and chronically ill patients resulting from what has popularly been named *The Grey Tsunami* (Diamond 2012, Ruff, Jacobsen 2012).

Developing innovative solutions for societal challenges, like the ones of the Danish healthcare sector, is launched as a focus area called “Societal Challenges shall drive Innovation” (Ministeriet for Forskning, Innovation og Videregående Uddannelser 2013b). This focus area covers an ambition to assign higher priority to the demand for solutions to concrete societal challenges in the national innovation initiatives and it is the first of three focus areas under the national innovation strategy (Ministeriet for Forskning, Innovation og Videregående Uddannelser 2013b). Thus, “Societal Challenges shall drive Innovation” has been initiated to contribute to the achievement of the national innovation strategy, which aims at transforming Denmark’s competitive strengths within knowledge and business into economic growth and job creation (Ministeriet for Forskning, Innovation og Videregående Uddannelser 2013a).

INNO+ is one of the initiatives taken to work towards having societal challenges driving innovation. The aim of INNO+ is to support a shift in paradigms from supply driven innovation to demand driven innovation (Ministeriet for Forskning, Innovation og Videregående Uddannelser 2012). Using part of the large public healthcare budget to unlock innovation can be the key to overcome the socioeconomic challenges (Ministeriet for Forskning, Innovation og Videregående Uddannelser 2012). According to the former Centre of Healthcare Innovation (Center for Sundhedsinnovation), challenges of the healthcare sector can be met by creating methods and models that will yield effective solutions to reduce the resource consumption and at the same time increase the patient focus (Ruff, Jacobsen 2012). Using innovation as a means of creating models like these has led to the introduction of Public-Private Innovation (PPI), a relatively new idea stemming from the better-known idea of Public-Private Partnerships (PPP).

From these initiatives it is evident that PPI is a topic of current interest to the Danish society and therefore also of great importance to academia.

### 1.1 Definition of Constructs

Three years ago, Public-Private Innovation was introduced in the Danish Regions as a new tool for Public-Private collaboration, but due to the recent introduction, models are still being tested in 2012 and 2013, and thus empirical data is very limited (Arlbjørn, Freytag 2012). Furthermore, as will be apparent from the subsequent literature review, the amount of literature dealing specifically with PPI is limited. For this reason, literature on the related

concept of Innovative Public Procurement (IPP) will be used to the extent that this is reasonable. The aim of the following paragraph therefore is to clarify the distinction between the concepts of Public-Private Partnerships (PPP), Public-Private Innovation (PPI) and Innovative Public Procurement (IPP) and to provide an understanding of the origin of PPI.

### 1.1.1 Public-Private Partnership

Public-Private Partnership is a broad concept covering every contractual agreement between a public agency of a public-sector authority and a private-sector entity. The aim of PPPs is to engage private companies in delivering public services or in developing an environment that improves the quality of life for the general public (Witters, Marom & Steinert 2012). The legal framework behind PPPs causes the partners to share risk, reward and responsibility, thus PPPs require full commitment from both the private and the public entity as they both pump resources into the project (Witters, Marom & Steinert 2012).

Generally, PPP allows for innovation to take place depending on the degrees of freedom included in the specifications given prior to the tendering process. However, unlike the case of IPP and PPI, innovation is not the main priority of having private organisations taking care of public services in classical PPPs (Dansk Industri 2012).

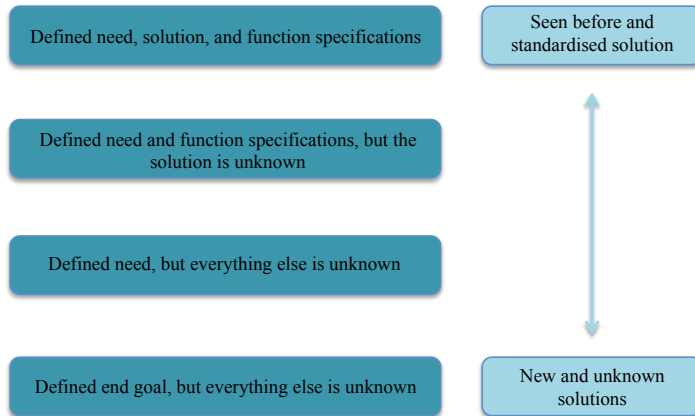
### 1.1.2 Innovative Public Procurement

Innovative Public Procurement (IPP) is sometimes referred to as Public Procurement of Innovation. As the names suggest, there are two central approaches to where the innovation occurs. It either occurs as innovation procurement or as innovative procurement (Damvad, 2011). Innovation procurement refers to the procurement of products or services that are new or significantly improved compared to existing products or services, whereas the innovative element of innovative procurement is the way in which the procurement process is undertaken (Damvad, 2011). From figure 1.1 below, it is obvious how there is a correlation between the two approaches to innovation. The more innovative the procurement process is (left side), the more innovative solutions it yields (right side). In order not to mix up abbreviations of the concepts, the concept of buying innovative products in an innovative manner is broadly referred to as IPP, whereas PPI is reserved for Public-Private Innovation.

A working group, which has been set down within the European Commission to discuss research and innovation in information and communication, has proposed an IPP scheme that is a very useful point of reference when trying to understand the different phases of IPP (Bos 2006). Referring to figure 1.2 below, IPP can generally be split into two main parts, *Pre-commercial Procurement of Innovation* and *Innovative Public Procurement*. *Pre-commercial Procurement of Innovation* stretches over three phases from *solution exploration* over *prototype* to *field test of prototypes*. These three phases follow after the *R&D tender*, whereas the process initiated by the *product/service tender* is *Innovative Public Procurement*. The latter covers the procurement of the product resulting from the pre-commercial innovation

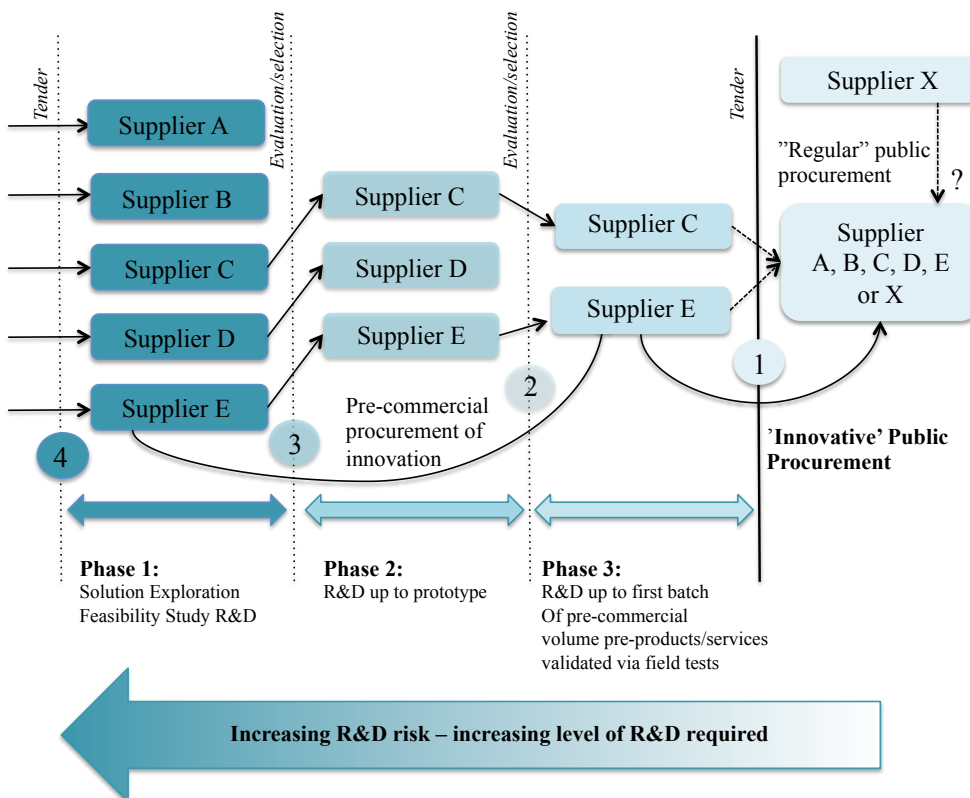
phases (Bos 2006). For later reference, it is important to note that a purchase is the result of both phases of IPP.

**Figure 1.1 - A Continuum of Innovation and Procurement**



Source: Author's creation with inspiration from (Damvad, 2011)

**Figure 1.2 - Pre-commercial Procurement of Innovation, a Phase Shared Risk/Shared Benefit Approach**



Source: Author's creation with inspiration from (Bos 2006, p.21)



**1.1.3 Innovative Public Procurement vs. Public-Private Innovation**

For the purpose of gaining a better understanding of the processes of Public-Private Innovation, presented in the next paragraph, the concept is initially compared to Innovative Public Procurement. Like IPP, the newer concept of Public-Private Innovation stems from PPP, and thus the entities in this partnership form also share risk, reward, responsibility and knowledge (Region Hovedstaden 2012). Furthermore, both IPP and PPI share the characteristic of being relevant demand-side instruments exploited in the mitigation of grand societal challenges (Edquist, Zabala-Iturriagagoitia 2012, Ruff, Jacobsen 2012). However, as both instruments are based on the process of innovation, the lines between IPP and PPI are not always clear-cut in the literature. Generally, what makes PPI different from IPP is the fact that even though both concepts include a pre-commercial phase, PPI does not necessarily include a commercialisation phase. In practice this means that the public part of a PPI can terminate the partnership after the pre-commercial phase and use the results of the innovation phase for internal purposes (Ruff, Jacobsen 2012). Another distinct difference between IPP and PPI regards contractual matters. In Innovative Public Procurement the result of the pre-commercial tender is an R&D service contract awarded to a supplier (Edquist, Zabala-Iturriagagoitia 2012). In comparison, PPIs are not necessarily contract-based, although it is recommended that the partners enter some sort of a contract. If signed, a PPI contract does not include an award of a purchase order like an IPP contract does (Ruff, Jacobsen 2012). As will be evident from the subsequent paragraph describing the processes of PPI, the pre-commercial innovation phase of PPIs under study in this dissertation is the non-contractual parallel to the pre-commercial procurement of innovation phase of IPP.

**1.2 The Processes of Public-Private Innovation**

As a response to the societal challenges introduced in the opening paragraph, a PPI program was set up in Denmark three years ago (Arlbjørn, Freytag 2012). The aim of this program is to attain more out of the public sector's budget through new solutions, while at the same time helping private firms to become more innovative and more competitive in a market that is expected to experience an increasing demand internationally (Arlbjørn, Freytag 2012, Dansk Industri 2012).

Instead of engaging private companies in the process of making specifications for a traditional tendering process, the idea is to take one step back and introduce the private companies to the project when fundamental questions of how the problem can be solved are discussed (Arlbjørn, Freytag 2012). For the purpose of engaging private companies in the innovation process, two models have been developed by the Danish Regions, a one-stage model and a two-stage model (Arlbjørn, Freytag 2012). The one-stage model and the two-stage model are only two examples of how PPI can be carried out. Although models may differ, they are all created to attract private companies while acknowledging that the advantages gained from having the private sector companies engaging in the program is equally important to public sector gains (Arlbjørn, Freytag 2012).

In order to gain a better understanding of the dynamics of the PPI models, a presentation of public and private entities of interest to the context of this dissertation is provided.

The public side of a PPI project within Danish healthcare consists of four interested parties. First of all, there are the hospitals where medical equipment is used by clinicians to treat patients. Second, the Danish Regions have the overall administrative responsibility for the healthcare system and thus make up the largest customer of medical equipment in Denmark (Danske Regioner 2013). The Regions, and not the municipalities, therefore become influential players in the discussion of PPIs (Medicoindustrien 2008). The third public source to be drawn upon in healthcare PPIs is the universities. However, as the focus of this dissertation is the private side of PPI partnerships, universities as well as hospitals and Regions are considered one entity whenever the public entity is referred to. Also included in this public unity is the fourth public institution, Videnscenter for Innovation og Forskning (VIF). By virtue of being a point of entry to knowledge and innovation in Region Hovedstaden, VIF is an intermediary that holds great knowledge of what is going on with regards to public-private partnerships (Region Hovedstaden 2013b). Among other competencies, VIF has an innovation department, which is of special interest to this research. For this reason VIF is the only public entity that will be consulted during the qualitative data collection (Appendix C.1). The innovation consultants at VIF help employees from Region Hovedstaden to find new innovative solutions that will benefit both patients and healthcare personnel (Region Hovedstaden 2013a). The innovation department also helps coordinate and facilitate the innovation process undergone in collaboration between a public party and some private parties (Ruff, Jacobsen 2012).

Focussing on societal challenges within healthcare, the units of analysis are companies from the Danish medico industry. These companies accordingly represent the private side of the PPI partnerships.

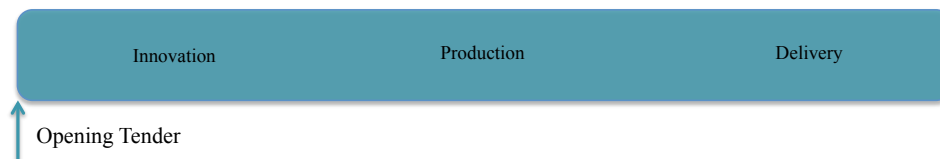
Moving on to the description of the models proposed by the Regions, it is noted that the aim of PPI is not solely for the public sector, but also for the private sector, to gain advantages, which in turn will incentivise them to engage. Therefore, the new models of collaboration that have been developed and implemented are not solely based on traditional tendering processes (Arlbjørn, Freytag 2012). As opposed to individualised tendering processes, where the connection between the organisations are very limited and where classical terms like price, payment, reliability, delivery on time and quality over time play a central role, there is an additional aspect to PPIs, namely learning and innovation, which is rarely fostered in classic tendering processes (Arlbjørn, Freytag 2012).

### **1.2.1 One-stage Model**

The one-stage model follows a fairly simple setup. The company that wins the opening tender also carries out the production and the delivery of the product/service (Arlbjørn, Freytag

2012). The advantage of this model is that winning the opening tender also opens up to production and delivery of the product/service. The companies find this setup more rewarding than having to bid for a commercial tender and therefore are accordingly easy to attract compared to the two-stage model (Arlbjørn, Freytag 2012). The disadvantage of not splitting up the stages is that funds can only be given to the innovation process and it can be difficult to determine exactly where that process ends (Arlbjørn, Freytag 2012). This potentially excludes some companies.

**Figure 1.3 – One-Stage Model**

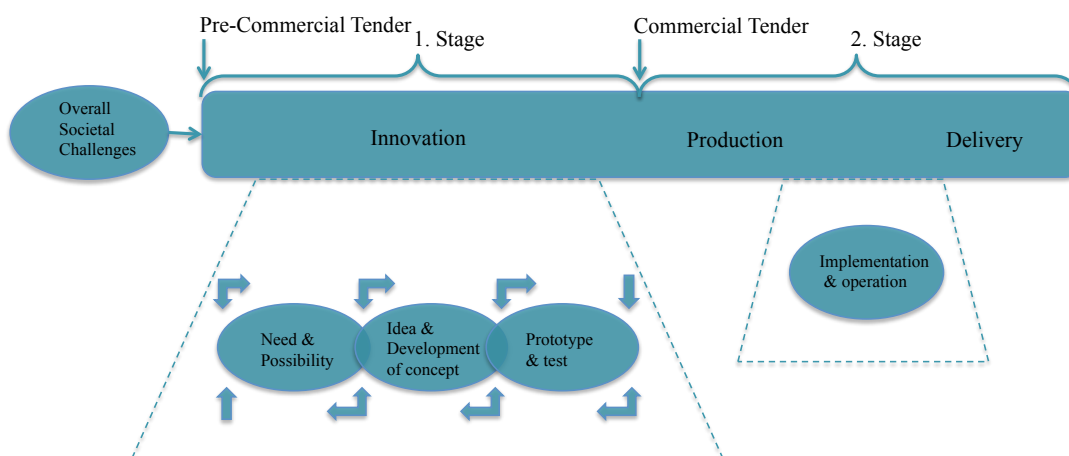


Source: Author's creation with inspiration from (Arlbjørn, Freytag 2012)

### 1.2.2 Two-stage Model

A guide developed by Ruff & Jacobsen has been published on healthcare PPIs in Region Hovedstaden containing a description of two different models (Ruff, Jacobsen 2012). The one-stage model and a two-stage model which will be described subsequently. The model without a pre-commercial tender translates to the one-stage model described by Arlbjørn & Freytag, and the one with a pre-commercial tender translates to the two-stage model described by Arlbjørn & Freytag. Of particular interest to this dissertation is the pre-commercial phase, and therefore the following PPI process description is a combination of Arlbjørn & Freytag's two-stage model and the PPI model including a pre-commercial tender described in the guide by Region Hovedstaden. Combining the two models makes it possible to take a closer look at the sub-phases of the pre-commercial innovation stage.

**Figure 1.4 – Two-Stage Model**



Source: Author's creation with inspiration from (Ruff, Jacobsen 2012, Region Hovedstaden 2012)

### 1.2.2.1 Initiation

Figure 1.4 depicts how one or more of the overall societal challenges typically initiate the innovation stage. These challenges are referred to as *The Burning Platform* (Ruff, Jacobsen 2012). Besides the examples already given in the introduction, the platform is also “burning” due to new technological opportunities, new medico technical products and because of the increasing demand for a more sustainable healthcare system (Ruff, Jacobsen 2012). The recognition that the “system” itself is not able to generate the innovative solutions has initiated the focus on PPI.

### 1.2.2.2 The Innovation Stage

The innovation stage, also referred to as the pre-commercial phase, is described in the model by Region Hovedstaden as consisting of three sub-phases, representing an iterative process,

1. *Need and Possibility*
2. *Idea and Development of Concept*
3. *Prototyping and Test* (Ruff, Jacobsen 2012).

Whereas a development process begins when the idea has taken shape and where the end goal is defined, an innovation process begins right after the need identification. The innovation process of the two-stage PPI model therefore is initiated by a *Need and Possibility* phase (Ruff & Jacobsen, 2012). A need can arise from various scenarios spanning from inexpedient working processes to a product missing in the market, a product that does not function expediently or from a demand for more state of the art technology (Ruff & Jacobsen, 2012). Generally, a need can arise on either the public or the private side, but this study is delimited to look at PPIs initiated by a need arising in the public healthcare sector<sup>1</sup>. From the PPI guide developed by Ruff & Jacobsen (2012), the authors imply that in reality this is usually the case. Having identified a need, this is now put up for a pre-commercial tender, which interested companies are invited to bid for. In this process it is crucial for the public partner to formulate the need as concrete as possible in order for specialised companies to see its relevance and get attracted. This can sometimes be a challenge (Ruff & Jacobsen, 2012).

When companies have been attracted some workshops are typically arranged to initiate the work and set down an interest group. Members of an interest group can be clinicians, patient ambassadors as well as private companies and knowledge institutes (Ruff & Jacobsen, 2012).

From the pre-commercial tender and throughout the PPI project the public partner can terminate the partnerships with some of the private partners as long as it complies with its obligation to make the selection process as transparent as possible (Ruff & Jacobsen, 2012).

---

<sup>1</sup> For a concrete PPI proposal, refer to appendix B.1. Note that this proposal is not for medical equipment.

<sup>2</sup> . The source of the total export is: (Danmarks Statistik 2013).

Some of the private partners participating in the development processes therefore will not make it to a potential commercial tender.

***1.2.2.3 Idea and Development of the Concept***

In the second sub-process of the innovation phase, the interest group works to concretise the identified need and come up with ideas that can lead to the development of a viable concept (Ruff & Jacobsen, 2012). VIF has developed a series of instruments, which can be used for workshop and innovation facilitation during this process (Ruff & Jacobsen, 2012).

In the process of developing a concept it is important to ensure the private companies' qualification for a potential commercial tender. Ensuring openness and transparency of the process helps to ensure that the companies do not disqualify, but this also gives rise to a complex of problems with regards to intellectual property rights (IPR). A patent of an idea or concept can only be filed for as long as it has not been published yet. Knowing this, the companies might be reluctant to share their ideas and thereby impede the innovation process. One way of going about this is to not come up with a complete idea, but instead define a set of requirements that the product/service must meet in order to match the need identified in the previous phase (Ruff & Jacobsen, 2012).

***1.2.2.4 Prototyping and Test***

Having undergone the development of the concept, it is now ready to be made into a prototype and tested. After the development of the prototype the public partner can take a "break" before it is put up for a commercial tender. Taking a break will enable the public part to prepare a transparent tender with equal terms for all bidding companies (Ruff & Jacobsen, 2012).

***1.2.2.5 Implementation and Operation***

A commercial tender initiates the second stage, which include the production and delivery of the product.

***1.2.2.6 Challenges of the Two-stage Model***

Before moving into challenges of the two-stage model, it should be noted that this collaboration model also enjoys some advantages. First of all, applying the two-stage approach makes it easier to direct funds because the innovation phase is clear-cut. Second, companies do not have to be capable of actually producing the product to place a bid in the pre-commercial phase (Ruff & Jacobsen, 2012).

Regarding the challenges of the model, some have already been touched upon during the description of the different processes. These were challenges like issues of clearly formulating

the need, qualification issues and issues with openness, transparency and IPR. In addition to these challenges comes the fact that the time horizons of two-stage projects are very long compared to the time horizons of the one-stage approach, as well as the fact that the pre-commercial phase can be very demanding and entail prominent economical liabilities. Having to engage in a resource-heavy innovation phase and even having to qualify for, and win, two separate tenders all add to the disincentives for private companies of engaging in PPIs (Ruff & Jacobsen, 2012). In their report on PPI in Region Hovedstanden Ruff & Jacobsen (2012) clearly state how it is difficult for the public sector to attract private companies to engage in the two-stage model for PPI. Throughout the dissertation this will be referred to as the *problem of attraction*, and the assumption that it applies to all of the Danish Regions and not only Region Hovedstanden makes up an important premise underlying the problem statement.

### 1.3 Legislation and Contractual Matters

In an attempt to explore what factors potentially add to the disincentive and to support a discussion of international implications of the results of the study, another two aspects of PPI are presented as part of this description, namely *Legislation* and *Contractual Matters*.

#### 1.3.1 Legislation

Attributable to the newness of PPI, the legal framework covering the contracts is insufficient (Ruff, Jacobsen 2012). In Denmark, there is no specific PPI legislation, and PPIs are thus currently attached to existing legislation regarding general public-private collaborations as well as the EU's Public Procurement Directive of March 2004 (Region Hovedstaden 2012, Arlbjørn, Freytag 2012). EU's Public Procurement Directive of March 2004 serves to secure that goods and services are acquired at competitive prices, and that no single firm is subsidised. More specifically recital 2 to the 2004 Procurement Directive states that,

“The award of contracts concluded in the Member States on behalf of the State, regional or local authorities and other bodies governed by public law entities, is subject to the respect of the principles of the Treaty and in particular to the principle of freedom of movement of goods, the principle of freedom of establishment and the principle of freedom to provide services and to the principles deriving therefrom, such as the principle of equal treatment, the principle of non-discrimination, the principle of mutual recognition, the principle of proportionality and the principle of transparency” (Arlbjørn, Freytag 2012 p. 207).

Whether or not this recital will have perceptible implications for the parties engaging in the pre-commercial phase of the two-stage model, it must be determined if it is subject to any of the exceptions to the Directive. In a report prepared by the European Commission on pre-commercial procurement of innovation, it is explained how public service contracts for R&D services are an exception to the Public Procurement Directive, unless the benefits of the R&D are completely for the contracting authority and fully paid by this authority (Bos 2006). Pre-commercial procurement of innovation has shared R&D risk and shared R&D benefits and therefore fall under the exemption of the Public Procurement Directive (Bos 2006). According to paragraph 1.1.3 comparing IPP and PPI, the two concepts share the

characteristics of shared R&D risk and shared R&D benefits, so it is reasonable to assume that PPIs fall under the exemption too. Although the contracts are not covered by the Public Procurement Directive, they are still subject to the fundamental Treaty principles of *transparency*, *objectivity* and *non-discrimination* (Bos 2006). In practice, this means that although the contracting authority is not obliged to European wide tender publication, it still has to accept European-wide offers and make sure to treat all bidders equally throughout the process regardless of nationality. In fact, it is proposed by the European Commission that calls for tenders are published European-wide. In addition, projects not covered by the Directive are also not covered by the WTO GPA agreement, and tenders therefore do not have to be opened up to competition from outside the EU (Bos 2006).

The fundamental Treaty principles of *objectivity*, *equal treatment* and *non-discrimination* between member states and the provision to accept European-wide offers have implications on the incentive structure of the private companies to engage in pre-commercial PPIs. These implications are the same as the ones listed as the problem of attraction. The more open and information-sharing the process becomes, the less likely the private companies are to pump resources into it due to the risk of not qualifying for the commercial tender and not getting to harvest the fruit of their effort. This schism is also captured by Vaidya et al.'s statement about the different purchasing conditions for private and public enterprises,

“Within the public sector one seeks to include as many vendors as possible to increase competition, whereas the private industry seeks to minimize this number in order to reduce risks” (Vaidya et al., 2006, as in Arlbjørn, Freytag 2012).

Having shed light on some of the issues creating disincentives for private companies to engage in PPIs, it is relevant to take a glance at the contractual framework to see if its construction eliminates some of this disincentive.

### 1.3.2 Contractual Matters

Despite the fact that PPIs are not based on a purchase contract, it is still important for a consortium, like the one often formed during PPIs, to have a clearly formulated contract that prevents the participating companies from disqualifying after the innovation stage (Ruff, Jacobsen 2012). For this reason, several provisions preventing disqualification are included in a contractual framework suggested for PPIs (OPI-Lab et al. 2012). Among the provisions to ensure qualification is for example the recommended use of the above-mentioned “break” after the innovation phase and a claim to use widely accessible standard materials in the formulation of requirements for the product/service (OPI-Lab et al. 2012).

Regarding the issues about posting resources into the innovation phase and not getting to harvest the fruit of it, it appears from the suggested contract that no economical compensation is given to the private partner. The reason for not awarding compensation is that the advantage, which the private partner enjoys from working with the public partner, must be offset. Only compensation equal to the contribution and amount of risk undertaken by the private part is allowed (OPI-Lab et al. 2012). Although ideally compensated for their resource

contribution and undertaken risk, the private companies' decision to participate in PPIs are presumably based on an assessment of different investment alternatives and therefore it is still relevant to dig deeper into the private companies' perception of pre-commercial PPIs.

Summing up, the introduction and definition of PPI outlined how the concept is different from the better-known concept of PPP in the way that it is always set up around innovation and different from IPP in the way that a commercial tender and the award of a purchase contract is not always the end goal. The assessment of the legislative and contractual frameworks leaves some issues with regards to fully incentivising private companies to engage in pre-commercial PPI left for further exploration. These issues concern the clear formulation of the need, the return on the resource investment as well as considerations about qualification for a potential commercial tender and transparency, equal treatment and non-discrimination. Collectively, these are referred to as the *problem of attraction*.

## **Chapter 2 Framing the Study**

### **2.1 Aim and Contributions**

As PPI is still in its infant stages, Centre of Healthcare Innovation has suggested that models for how private companies can work innovatively and closely together with users, patients, scientists and healthcare personnel need to be developed (Ruff, Jacobsen 2012). The aim of this dissertation therefore is to look at the problem of attracting private companies to engage in the two-stage PPI model currently proposed by the Danish Regions. To address the identified challenges of the two-stage model, the aim of the study is to contribute to the discussion by taking on the private angle, which has been underexposed in the literature so far, and provide the Danish Regions with some useful insights on perceptions gained from examining the private side.

By making an attempt to better understand private companies' perception of PPIs in general and of the two-stage model in specific, the aim is to explain how the private companies' perception of factors affects their behaviour and propensity to engage in a pre-commercial innovation phase of a PPI project.

The aim is summarised in the following problem statement.

### **2.2 Problem Statement**

*Which factors influence private medico companies' propensity of engaging in pre-commercial PPIs with the Danish Regions and thus should be prioritised in order to diminish the problem of attraction of the two-stage model proposed by the Danish Regions?*



## 2.3 Objectives

The objectives of this study make up the steps taken to answer the problem statement. As the primary objective, this study therefore proposes a research model to ascertain how private companies from the Danish medico industry perceive the two-stage PPI model proposed by the Danish Regions. The model is based on the concepts underlying strategic alliance theory, and as part of the process of setting up this model to measure perceptions of PPIs as a strategic alliance, additional dimensions of PPIs are explored and potential issues detected.

By testing a structural equation model, the study seeks to provide a greater insight into the relationships existing between the factors measuring the propensity of engagement in PPIs with the Danish Regions and the size of their effect. The results of this analysis is intended to yield some valuable insights for the Danish Regions of how they can better meet the private companies' expectations and thereby increase the chances of more PPIs being entered in the Danish healthcare system going forward.

Another objective of this study is to serve as the first step taken to extend the research and literature on strategic alliances to cover more non inter-firm alliances and to focus on the private side of these. Compared to the general interest in these types of alliances, the literary covering is highly insufficient.

## 2.4 Structure

Referring to figure 2.1 below, the study is structured around Benjamin Bloom's six taxonomies, *Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation* (Sullivan, SAGE Publications 2009). The taxonomies have been divided into three overall groups, *Exploration, Explanation and Discussion* to give a more comprehensive overview of the structure. Each of the overall groups serves the purpose of driving the study from the lowest taxonomical level towards the highest taxonomical level. These three groups will be referred to as *broad taxonomical levels* in the following. To help drive the study along this path, research questions have been formulated for every chapter of the study, except chapter 2 (*Framing the Study*), 4 (*Literature Review*), 5 (*Methodology*), 8 (*Quantitative Data Collection*) and 10 (*Conclusion*). Formulating research questions for these chapters will not directly drive the study towards answering the problem statement. According to figure 2.1, the structure of the dissertation is as follows.

The first broad taxonomic level, *exploration*, is concerned with the exploration of the PPI context. The taxonomical level includes chapter 1 through 6, which all contribute to the *knowledge and comprehension* of the concept of PPI and the Danish context surrounding it.

Chapter 1 serves as the introductory and context setting foundation of the dissertation. More specifically the description and definition of PPP, IPP and PPI adds to the knowledge base, which is the first of Bloom's taxonomies (Sullivan, SAGE Publications 2009). As such, the first and second research questions have already been answered:

1. How is PPI different from the more established concepts of PPP and IPP?
2. Which are the issues with the proposed two-stage model?

Chapter 2 includes the parts necessary for framing the study.

Chapter 3 introduces the medico industry and further adds to the exploration of the context of PPIs in Danish healthcare. The following research questions are set up to understand why the medico industry is relevant in a PPI context and why the Danish Regions are an important player:

3. Why are PPIs interesting to look at in a medico technical perspective?
4. What role do the Danish Regions play in relation to PPIs in the Danish healthcare sector?

The purpose of Chapter 4 is to unfold the literature relevant to the context of the study and illustrate how the study is intended to contribute hereto. By doing so, theory necessary for setting up a structural equation model (SEM) to answer the problem statement will be identified for the use in chapter 7. In this way, chapter 4 adds to the *Comprehension* taxonomy of Bloom's (Sullivan, SAGE Publications 2009).

Chapter 5 is the first of four chapters dealing with model development and covers methodology and all the methodological considerations that precede the structural equation modelling in chapter 7. Chapter 5 belongs to *Exploration*, but serves as the foundation of the *Application* of the methodological procedures and methodics in chapter 8 as well as the *Analysis* in chapter 9.

Chapter 6 covers the qualitative data collection, which is the first part of the data collection. Although chapter 6 is listed under *Exploration* in the subsequent flow chart, it can be argued that it spreads into the *Explanation* level as it contributes to the conceptual model covered in chapter 7. In order to make that contribution, the following research questions must be answered:

5. How do the private companies perceive the PPI opportunity?
6. Are any additional dimensions important when measuring the propensity of private medico companies engaging in pre-commercial PPIs with the Danish Regions?
7. Do the private companies see any issues in the current PPI setup?

The second taxonomic level is concerned with *Explanation* and therefore makes up the pillar of the study. This level contains chapter 7 through 9, covering the last two chapters contributing to the model development as well as the analysis part. Among other things, Bloom's taxonomies of *Application* and *Analysis* include solving, making inferences and

analysing relationships (Sullivan, SAGE Publications 2009). These disciplines are all part of chapter 7 to 9.

Chapter 7 covers an application of the framework by Sambasivan et al. (2013) moderated to fit a PPI context. The research question for this chapter therefore becomes as follows:

8. How can a SEM be set up to measure the propensity of private Medico companies engaging in pre-commercial PPIs with the Danish Regions based on the framework by Sambasivan et al. (2013) and any findings from the qualitative data collection?

Chapter 8 on quantitative data collection contains the technicalities of collecting empirical data and assessing the quality of it.

Chapter 9 deals with the data analysis and therefore is directly attributable to the *Analysis* taxonomy by Bloom (Sullivan, SAGE Publications 2009). By answering the research questions listed for this chapter, inferences can be made about private medico companies' propensity of engaging in pre-commercial PPIs with the Danish Regions:

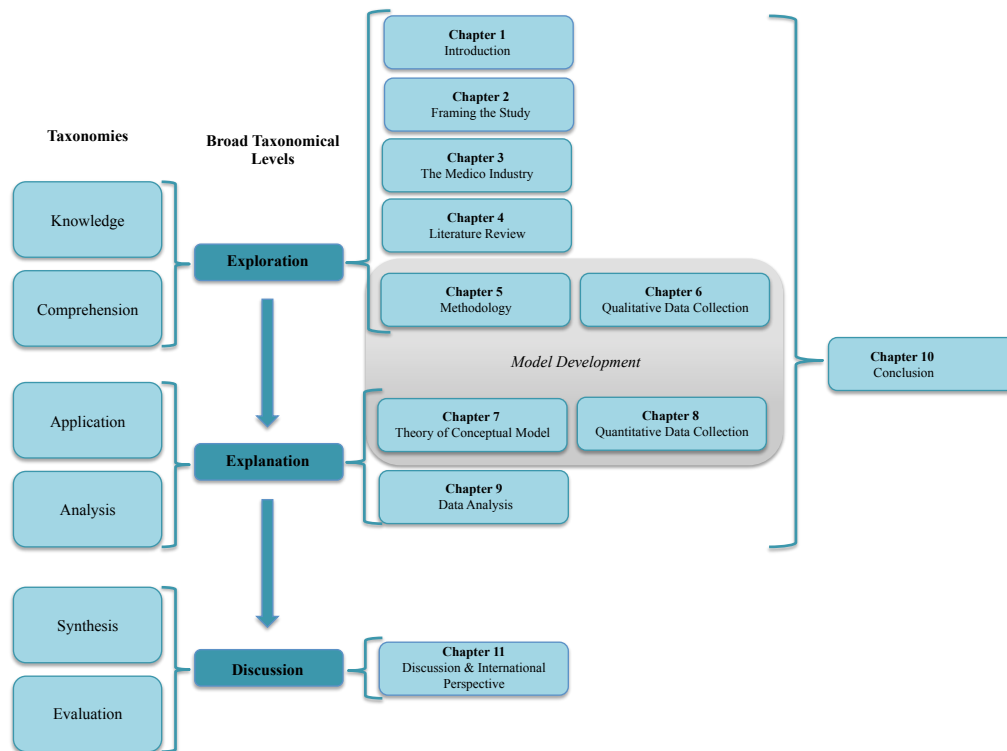
9. Which of the relationships between factors measuring private companies engaging in pre-commercial PPIs with the Danish Regions are significant?
10. What factors have the greatest influence on the propensity of private companies engaging in pre-commercial PPIs with the Danish Regions?

Chapter 10 presents the conclusion on the study and thereby wraps up the findings and provides the foundation of the discussion.

Chapter 11, presenting a discussion of the international perspective, exclusively makes up the third taxonomical level of the study, the *discussion* part. More specifically the chapter serves to situate the analysis into an international context by discussing the positive implications of the study. This is done by answering the sequent research questions:

11. What are the first and second order implications of the results in an international perspective?
12. How do the results influence the international competitiveness of the companies?

Figure 2.1 – Flow Chart over the Structure of the Dissertation



Source: Author's creation

## 2.5 Scope and Delimitations

The purpose of this paragraph is to list and discuss the delimitations made and their implications for the process and for the results of the analysis.

First and foremost, the study operates on a strategic level as opposed to lower levels of abstraction like tactical and operational levels. It is evident from the two-stage model that the decisions to engage in PPIs are strategic decision as they stretch over long-term time horizons and require a significant amount of resources. This also implies that a deeper understanding of more tactical and operational considerations like considerations of legal matters, funding and contractual matters including considerations of intellectual property rights, is not relevant to the managers' strategic perceptions of pre-commercial PPIs. These were therefore only cursorily assessed.

Second, as already indicated, this study is delimited to look at publically initiated PPIs. In this regard it is further assumed that the public incentive for engaging in PPIs is present. That is, the dissertation does not focus on the public incentive structure at neither hospital level nor personal level (clinicians). From a socioeconomic perspective it is desirable to foster innovation through PPIs and the Danish Regions and hospitals are expected to share this desire. The delimitation to focus on regions rather than municipalities is provided in the industry description.

Third, as the model explored is specific for the Danish Regions, the results of the analysis are only directly applicable to the Danish system. However, this does not necessarily prevent some of the findings from applying to healthcare sectors and medico companies in other

countries. Lastly, the study by Sambasivan et al. (2013) disregards company culture and so does this study. Company culture would be a very relevant aspect to look at when trying to explain perceptions of engaging in PPIs, but case studies of this type are very resource heavy to carry out and therefore beyond the scope of this dissertation.

The overall implications of this delimitation reveals in chapter 9, *Data Analysis*, which will not contain any tactical or operational recommendations ready for implementation, but intentionally a set of very valuable insights for the Danish Regions to use in their work of developing and reshaping models for PPIs in the Danish healthcare sector.

## 2.6 Theory and Methodology

The last part of this chapter introduces the primary theory and methodology that will be used in carefully creating a research design enabling the author to answer the problem statement.

### 2.6.1 Theory

According to research question 8, the SEM setup will be based on a framework proposed by Sambasivan et al. (2013), which builds on *The Strategic Alliance Cycle Framework* proposed by Kale & Singh (2009), and models factors influencing the outcome of strategic alliances between supply chain partners. By setting up their framework, Kale & Singh tried to explain strategic alliance success from a set of key factors relevant to each stage of the strategic alliance lifecycle. Sambasivan et al. (2013) have translated this into the SEM constituting the primary source of inspiration for this study.

The low success rate of strategic alliances was Kale & Singh's motivation for building the framework (Kale & Singh, 2009). Setting out from Sambasivan et al.'s framework also aiming at measuring the success of strategic alliances is therefore highly relevant when trying to model the propensity of private companies engaging in pre-commercial PPIs with the Danish Regions, as success of an alliance and the propensity of engagement are assumed to be highly correlated. Furthermore, looking at the perceptions for the full lifecycle of an alliance will yield some valuable insights about the perceptions of PPIs.

### 2.6.2 Methodology

For the purpose of meeting the ambition of being able to explain what factors influence private medico companies' propensity of engaging in pre-commercial PPIs with the Danish Regions, it is important to apply an appropriate methodology. The ambition to *explain* rather than *explore* a phenomenon involves the application of an analytical approach in which it is possible to test cause-effect relationships (Arbnor, Bjerke 2009). A thorough argumentation for the choice of methodology is provided in the detailed paragraph on methodology, but an introduction to the basic element of data is provided next.

The theoretical basis of Public-Private Innovation is very limited and therefore also very little academic literature exists on the concept compared to the more established concepts of Public-Private Partnerships and Innovative Public Procurement. Searching academic journals during the literature review has therefore only yielded a few articles mentioning Public-Private Innovation and only very few briefly mentioning the pre-commercial phase of PPIs. Therefore the analysis part of the study therefore relies on primary data supported by secondary data.

#### ***2.6.2.1 Secondary Data***

Secondary data is of great importance in the analytical view as reality is thought to be summative (Arbnor, Bjerke 2009). A review of secondary data therefore will be used to create the research design of the primary research. The prominent source of secondary data is reputable scientific journals, which guarantee a certain quality as well as a pre-established degree of reliability and validity. Besides consulting the prominent journals, using the most cited authors also helps to ensure a certain quality of the study. A major advantage of journal articles when studying new concepts like PPI is that they provide up-to-date information compared to textbooks. However, for the purpose of setting up and testing the SEM, textbooks will serve as useful secondary sources of information about statistical modelling.

Lastly, web pages and especially ministerial homepages will be used as another useful source of secondary information about PPI.

#### ***2.6.2.2 Primary Data***

Considering the methodological approach of this dissertation and the fact that no data tailored the specific research objectives exists, the collection of primary data plays a principal role in setting up and testing the hypotheses of the SEM. The collection of primary data can be divided into two parts, a quantitative part and a qualitative part. The quantitative part consists of a questionnaire, while the qualitative part is based on interviews and an attended networking day in the industry organization introduced in the next chapter (Appendix C.3).

#### ***2.6.2.3 Online Survey (Questionnaire)***

An online survey will serve as the most important source of collecting primary data for this study. Collecting data via a questionnaire will result in the desired type of information about the respondents' perception of a pre-commercial PPI alliance.

When collecting data via self-administered questionnaires, it is essential for the reliability of the data material that there is consistency between the respondents' understanding of the question and what the researcher thinks he/she is asking (Lavrakas, SAGE Publications

2008b). In order to better operationalise the effects of the latent constructs in multi-item scales of indicators, the online survey will therefore be supplemented by preliminary interviews to reveal any comprehensibility issues that might affect the reliability and thereby also the quality of the primary data collected.

#### **2.6.2.4 Explorative Interviews**

Besides the purpose of ensuring that the questions prepared for the questionnaire are well structured and easy to understand, the qualitative interviews also serve the purpose of exploring additional dimensions related to pre-commercial PPI. Considering the research objectives, the aim of the report is not to observe a system in depth, but rather to test a set of hypotheses. The public and the private entities therefore will not be studied as case studies. However, relevant representatives from Danish medico companies will be interviewed in order to gain a qualitative understanding of how the quantitative study can be better directed towards the central issues (Appendix C.2). The interviews therefore consist of semi-structured questions, as this form is well suited for the purpose of these interviews (Arbnor, Bjerke 2009).

## **2.7 The Model**

### **2.7.1 Structural Equation Model**

As opposed to multiple regression modelling, in which only a single relationship is tested at a time, structural equation modelling examines a series of dependence relationships simultaneously (Hair et al. 1998). In addition to the characteristic of simultaneous hypothesis testing, another noticeable characteristic of structural equation modelling is its ability to represent unobserved concepts in hypothesised relationships and account for measurement error in the estimation process. The unobserved concepts called *latent constructs* can only be approximated by measureable variables called *manifest variables* or *indicators* (Hair et al. 1998). The observable variables are gathered from respondents through different data collection methods e.g. online survey, which is the one employed in this study. Among other merits of structural equation modelling therefore is its ability to assess latent constructs at the observation level (*measurement model*) and test the relationship between latent variables at a theoretical level (*structural model*)(Hair et al. 1998). Because of the comprehensive assessment of the relationships, structural equation modelling is a useful tool for confirmatory analysis, which is the methodological ambition of this study. Structural equation modelling represents an analytical technique focussed on prediction and therefore is well suited for the purpose of answering which factors influence private medico companies' decision to engage in PPIs (Chin 2002).

### 2.7.2 Estimation Method

Several estimation methods exist for structural equation modelling, but considering the data, which will be collected, there is a strong rationale for using the iterative Partial Least Squares (PLS) method. As opposed to the well-known co-variance based LISREL and AMOS estimation methods, PLS-SEM is based on variance. Among the arguments for choosing PLS estimation is the less strict requirement that generally makes it easier to estimate the model properly. Thus, variance-based methods like PLS are robust to skewness, multicollinearity and misspecification (Haenlein, Kaplan 2006). This means that no distributional requirements will apply to the dataset. Furthermore, a variance-based estimation method does not require a large sample size, in fact Chin (2002) recommends a minimal range from 30 – 100 cases, whereas the minimal range for co-variance based methods starts from 100 (Haenlein, Kaplan 2006).

### 2.7.3 Estimation Tool

The estimation tool used in the analysis is SmartPLS 2.0.

## Chapter 3 The Medico Industry

Concentrating on PPIs in the Danish healthcare sector opens up to a number of possible industries to focus on. The industry focus selected for this study is the industry of *medical equipment* and therefore the units of analysis become Danish companies developing and producing medical equipment, referred to as medico companies. The aim of the this industry introduction is to introduce the importance of innovation as a source of competitiveness and thereby provide an understanding of the unexploited potential of PPIs in the industry as well as to describe the role of the Regions in this industry.

### 3.1 Medical Equipment

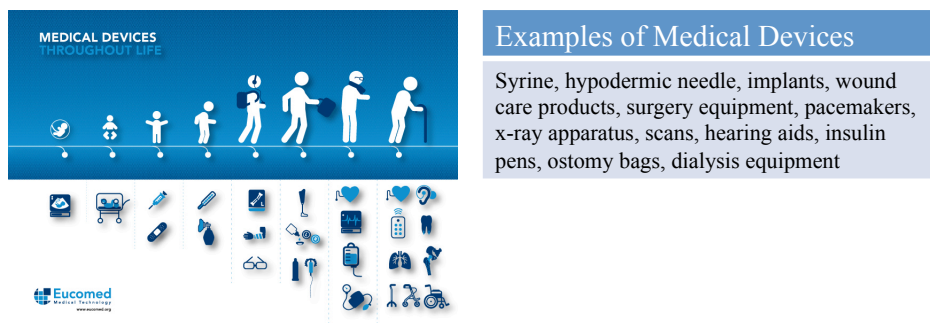
*Medical equipment* falls under the broader description, *medical technology*, which generally covers any technology used to save lives in individuals (Eucomed Medical Technology n.d.b). According to the EU Commission and its ‘EU Medical Devices Directive’, a medical device is

*"Any instrument, apparatus, appliance, software, material or other article, whether used alone or in combination, including the software intended by its manufacturer to be used specifically for diagnostic and/or therapeutic purposes and necessary for its proper application, intended by the manufacturer to be used for human beings"* (Eucomed Medical Technology n.d.b).



Products captured by this definition range from sticking plasters through hearing aids and wheelchairs to high tech products like body scanners and implant devices (Eucomed Medical Technology n.d.b). According to Eucomed, the representative of the European Medical Technology Industry, there are currently more than 500,000 medical technologies available in 20,000 different generic groups and 16 categories (Eucomed Medical Technology n.d.b). As the ambition of this study is not to cover all of the companies representing the 500,000 technologies, the scope of the study is delimited to cover only the companies producing technologies procured at a regional level in Denmark.

Figure 3.1 – Medical Devices Throughout Life and Examples of Medical Devices



Source: Author's creation with inspiration from (MedTech Europe 2013, Medicoindustrien 2008)

### 3.2 Structure of the Procurement of Medical Equipment in Denmark

In broad terms, the Danish medico industry consists of companies developing, producing and/or selling medical equipment used by G.P.s, hospitals and by public homecare staff as well as the staff in residential homes for elderly people (Medicoindustrien n.d.). However, as the products used by the latter two groups fall under the municipalities' area of responsibility, they are disregarded in this study.

In order to know what companies to include in the data collection beside the ones listed as manufacturers of medical equipment, it is essential to know the difference between the products generally referred to as *assistive products*. The designation, assistive product, includes both assistive products and treatment products, both developed and produced by companies belonging to a sub-industry under the medico industry called the Danish rehabilitation industry. As the same product can fall within both categories depending on the situation and who procures it, the distinction between the two product categories is quite complex and not very clear-cut. In Denmark *assistive products* fall within the budgets of the municipalities, whereas *treatment products* fall within the budgets of the Regions. However, if an *assistive product* is ordained as part of a hospital treatment, it becomes a *treatment product* (Ministeriet for Sundhed og Forebyggelse 2013). According to a circular based on §74 in the Danish health law, *treatment products* in broad terms include *assistive products* and apparatus that are implanted as part of a hospital treatment, ordained as part of a hospital treatment or as a continuation of a hospital treatment as well as assistive products and

apparatus that the hospital finds that the patient needs while he/she is waiting for a hospital treatment (Ministeriet for Sundhed og Forebyggelse 2013). The scope of *treatment products* therefore also includes *assistive products* used at home, as long as the user is advised by a hospital.

### 3.3 The Danish Medico Industry in Numbers

In 2012, 9.1 billion DKK was spent on medical equipment in Denmark equal to 4.6% of the total public healthcare expense (Appendix A.1, Figure A.1). Adding some perspective to these numbers, the size of the Danish market of medical equipment in 2012 amounted to 0.5% of the global market, which therefore was worth a total of around 1.820 billion DKK (Appendix A.1, Figure A.1).

The medico industry contributes positively to the Danish economy in general. In 2012 the Danish BNP decreased by 0.6%, while the medico industry experienced a growth rate of 5.9% (Danmarks Statistik 2013), (Appendix A.1, Figure A.1). Part of the growth rate can be attributed to the industry exports, which accounts for an estimated 95% of the total production (Appendix A.1, Figure A.3). This export in 2012 amounted to 17.1 billion DKK, which was around 3%<sup>2</sup> of the total Danish export of goods that year (Appendix A.1, Figure A.3). The Danish medico industry is known for its large multinational companies producing disposable medical equipment, apparatus, instruments and hearing aids, but in fact small and medium sized enterprises (SMEs) dominate the industry composition (Medicoindustrien 2008). The composition of the European medico industry follows the same pattern and thus SMEs make up 95% of the European medico companies (Eucomed Medical Technology n.d.a). The fact that smaller companies dominate the industry composition makes the medico industry interesting to look at in terms of innovation. SMEs are generally well suited for the way in which innovations of medical technology often emerge from intimate collaborations between healthcare professionals, academia and manufactures (Eucomed Medical Technology n.d.a). That continuous innovation is required for the companies to survive and prosper is evident from looking at the product categories (Eucomed Medical Technology n.d.a). In a high-tech industry like the one of medical equipment, the key driver of innovation is very short lifecycles, and improvements of a breakthrough technology are therefore continuously made (Eucomed Medical Technology n.d.a). To maintain a high level of innovation, it could therefore be relevant for the medico companies to look into PPIs. This makes the industry very interesting to the problem statement of this study.

The numbers presented leave no doubt that the Danish medico industry is an interesting industry with great prospects if the potential is properly exploited. What make the industry particularly interesting in a PPI perspective are the high technology level and the majority of SMEs.

---

<sup>2</sup>  $\frac{17.1}{587.9} \cdot 100\% \approx 3\%$ . The source of the total export is: (Danmarks Statistik 2013).

As the study focuses on the part of the medico industry that operates at a regional level in Denmark, the Danish Regions play an important role as the public partner. Specifically, the focus is placed on companies that produce general medical equipment and products characterised as treatment products. For simplicity the units of analysis will be referred to as companies from the Danish medico industry although some members of the industry are excluded from the study as a result of the delimitation.

## Chapter 4 Literature Review

### 4.1 Methodological Considerations

Before reviewing the literature, some methodological considerations have been made in order to do it in an appropriate way for this particular study to contribute to existing literature.

First, in order to be able to include both empirical and non-empirical literature like theoretical propositions, the method of synthesis is qualitative. Non-empirical literature is considered an important contribution to this review, and therefore the qualitative approach has been deemed most appropriate compared to the quantitative approach, which is solely based on empirical studies (Salkind, SAGE Publications 2010).

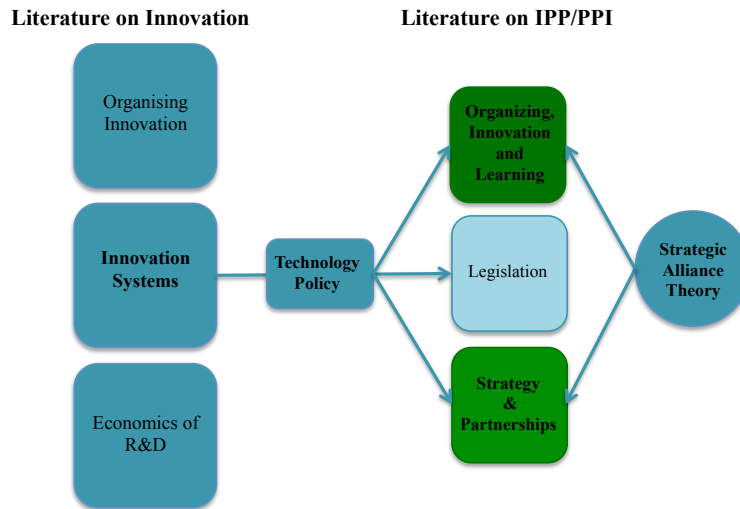
Second, by applying a conceptual organisation to the review, the goal is to identify central issues and draw links across the fields related to the topic (Salkind, SAGE Publications 2010). As shall be evident from the review, the contribution of this study is to be found in the intersection of *Systems of Innovation*, *PPIs* and *Strategic Alliance Theory*.

Third, as a way of eliminating sources of bias in the coverage of the relevant literature, steps have been taken to make the review as representative as possible. The literature search therefore has been conducted across various databases and journals in an attempt to make it as exhaustive as possible (Salkind, SAGE Publications 2010).

Lastly, attention is drawn to the fact that only literature in English and Danish is included. This potentially excludes important research conducted in other languages and possibly yields some limitations to the study (Salkind, SAGE Publications 2010).

Being aware of these methodological priorities strengthens the review and thereby also the contribution of the study.

Figure 4.1 – Structure of Literature Review



Source: Author's creation

## 4.2 Innovation Theory

As far back as 1912, Joseph Schumpeter was one of the first theorists to theorise on economic innovation. Ever since Schumpeter identified the phenomenon of *Creative Destruction*, several theorists have broadened up the scope of innovation as a theoretical field (Fagerberg, Fosaas & Sapprasert 2012). According to a quantitative cluster analysis covering core literature on innovation from 1912 to 2005, Fagerberg, Fosaas & Sapprasert (2012) found that the literature could be divided into three main clusters. These clusters are, *Organising Innovation*, *Economics of R&D* and *Innovation Systems (IS)*. These three directions originate from the same germs of thought and therefore are highly interrelated. However, the literary coverage of the three directions of innovation theory has undergone an evolution, and a shift in focus is spotted in the beginning of the nineties. Before 1990, the literary focus was placed on innovation in firms and industries, whereas the current focus is on *Systems of Innovation* and the effect of innovation on the entire economy (Fagerberg, Fosaas & Sapprasert 2012). Covering all three clusters is beyond the scope of this study and thus focus is being placed on *Innovation Systems*, which is the most relevant when looking at the broader macro perspective and how PPIs can help meet some of the socioeconomic challenges faced by the Danish healthcare sector. Literature on IS notes that firms do not normally innovate in isolation, but in collaboration and in interdependence with other organisations (Edquist 2006). Exactly that philosophy is what the PPI approach builds on to create more innovation and therefore the area of *Innovation Systems* is where this study is situated in a literary perspective.

Exploring the literature, the review by Fagerberg, Fosaas & Sapprasert (2012) finds that the most prominent authors contributing to the core literature on *Systems of Innovation* are Nelson, Lundvall and Freeman. The primary focus of the work by these authors is *National Systems of Innovation*, which, according to Nelson (1993), can be defined in the following way,

“The national system of innovation is constituted by the institutions and economic structures affecting the rate and the direction of technological change in society” (Nelson 1993, p.267).

In his study of differences in national systems of innovation and how they can be used to explain variations in national economical performance, Nelson (1993) defines a *system* as a set of institutions, whose interactions determine the innovative performance of an economy. Examples of such institutions and economic structures are laws, rules, norms and routines that constitute incentives and obstacles for innovation (Edquist 2006).

To understand how Public-Private Innovation is related to *Innovation Systems*, the socio-institutional setup is introduced. The socio-institutional setup is part of the National Innovation Systems and consists of social and political development blocks as well as systems of R&D and technology policy. Nelson notes how,

“Technology policy includes public intervention in the process of technological change as a whole” (Nelson 1993, p.279).

Nelson (1993) further notes that technology policy includes both technological development as well as encouragement of the application of new technology. Examples of such encouragements are,

- State Support to R&D
- National Technology Programs
- Support of Technology Diffusion
- Public Technology Procurement (Nelson 1993).

In relation to the latter, Lundvall (1992) recognises how public sectors in many countries try to play the role of a pacer via technology programmes and public procurement policies. Lundvall further acknowledges that the way in which the public sector is creating, maintaining and developing systems of innovation is many-sided. However, he also recognises that not all sides can be covered in one work and Lundvall therefore has chosen to focus on the public sector as a *user* and a *regulator*.

Having detected the core literature, the overall picture drawn from the review of the literature on *Systems of Innovation* depicts how focus has been on exploring the public partner as a regulator and explaining how procurement can be used as a policy-pacing tool for creating

innovation. In other words, focus has been placed on specifying the circumstances under which the public sector participates in the innovation processes as a competent pacer that stimulates long-term positive learning effects both internal and external to the public sector (Lundvall 1992). The core literature explains how public technology procurement can be used as a pacing tool for creating innovation, but not how the private companies perceive this tool. As the aim of this study is to explore the private companies' perception of the closely related concept of Public-Private Innovation and thereby explain their propensity to engage, the private side of this macro approach to innovation is where this study aims at contributing to the existing literature.

Before moving into an assessment of the literature covering PPIs, an attempt will be made to make sure that the private company perspective of innovative procurement as a policy tool is not covered in the literature traditionally dealing with systems of innovation at a firm level, namely *Organising Innovation*. According to the literature review by Fagerberg, Fosaas & Sapprasert (2012), the core literature of this theoretical cluster is written by Rogers, Cohen & Levinthal and Nelson & Winter and covers the topics of absorptive capacity, diffusion of innovation as well as theory on economic change. As none of these topics cover the private company perspective in a macro context, a gap is left open for this study to contribute to the literature.

### 4.3 Context Specific Literature

Referring to figure 4.1, the next phase of the literature review serves the purpose of exploring the literature on *Public Technology Procurement*, which has just been identified as a policy-pacing tool under *Technology Policy* in the review of *Systems of Innovation*. Public Technology Procurement is another name for IPP, which was gone through in chapter 1. In the same chapter it was explained how IPP and PPI are closely related concepts apart from the presence of a purchase contract, and this link becomes relevant in the subsequent literature review. Given the inadequate amount of literature and theoretical work on PPI, a review of Public Procurement and Innovative Public Procurement has been conducted in order to gain some valuable insights on the concept.

As part of their study comparing public procurement and private purchasing, Arlbjørn & Freytag (2012) have reviewed literature on public procurement, which provides an insightful overview of literature dealing with both regular procurement as well as innovative procurement. In the review the authors divide the literature into three clusters, *Strategy & Partnership*, *Legislation* and *Organization, Innovation & Learning* (Arlbjørn, Freytag 2012). The cluster covering literature on *Legislation* includes several studies dealing with public procurement directives and policies. Specifically, these studies are concerned with the regulating role of the public entity and therefore have strong ties to the theoretical sub-group under national systems of innovation dealing with the encouragement tools under technology policy. Within the legislative cluster of IPP/PPI literature, theorists and researchers have been concerned with how public technology procurement can generate innovation and whether or

not it has proven effective, whereas a presumption of this report is that PPI does generate innovation opening up to the question of how it can be made attractive for the private entities to engage in. To answer this question a contribution must be made to a combination of the last two clusters identified by Arlbjørn & Freytag (2012), *Strategy & Partnership* and *Organization, Innovation & Learning*, which currently do not include any study dealing with the private companies perception of engaging in PPIs, which will influence their strategic decisions.

Having reviewed both innovation theories in general and coupled them with context specific literature on PPIs, it is evident how there is a gap in the literature, which this study aims to close. For the purpose of closing part of that gap, theory of strategic alliances is introduced.

#### 4.4 Literature for Conceptual Framework

The last part of the literature review serves as an argument of why *Strategic Alliance Theory (SAT)* can be used to help close part of the literary gap identified in the previous paragraphs. Having chosen *SAT* for the conceptual framework, still a lot of choices and delimitations remain to be made. Throughout the evolution of the concept, *SAT* has been approached from a lot of theoretical and empirical perspectives. Among these perspectives are the overall perspectives including theories like *Resource-Based Theory*, *Transaction Cost Theory*, *Contingency Theory*, *Game Theory*, *Social Exchange Theory* and *Personal Relationship Theory* (Sambasivan et al. 2013). In the setup of the conceptual model the specific combination of theories utilised will be discussed. First, reasoning is provided that PPIs can be considered strategic alliances. According to the definition of strategic alliances provided by Kale & Singh,

“A strategic alliance is a purposive relationship between two or more independent firms that involves the exchange, sharing, or co-development of resources or capabilities to achieve mutually relevant benefits” (Kale, Singh 2009, p. 46).

Except the fact that the definition refers to a strategic alliance as an inter-firm alliance, the co-development of resources or capabilities is in accordance with PPIs. However, for the purpose of looking at strategic alliances between public and private entities, the definition is further unfolded. Thirteen types of strategic alliances constitute the classic forms of inter-organizational relations appearing in traditional theory and research literature (Todela, Knoke 2005). Of those thirteen relationship forms, attention is drawn to *R&D Consortia* and *Strategic Cooperative Agreements*, as they are particularly relevant for the discussion of PPIs as strategic alliances. As the name suggests, the first relationship form refers to an agreement for R&D collaboration, whereas the latter refers to a contractual business network based on joint multiparty strategic control, in which partners collaborate on key strategic decisions and share the responsibilities and performance outcomes (Todela, Knoke 2005). Both of these relationship forms come close to the idea of PPIs. The general definition of strategic alliances and the definition of specific relationship forms share the inter-firm aspect, and the definitions

are therefore not directly applicable to PPIs. However, Kale & Singh (2009) introduce a new combination of alliance partners, namely commercial or for-profit organisations entering strategic alliances with non-profit entities, NGOs or formal collaborations with individuals. Moving away from merely inter-firm alliances, Kale & Singh (2009) consider the partnership between for-profit and non-profit entities to be a strategic alliance because the entities involved bring to the partnership distinct and valuable resources to meet mutually beneficial objectives.

With this review of definitions it can be concluded that Danish medico companies entering pre-commercial innovation projects with the Danish Regions fall under the revised definition of strategic alliances. Extant literature has been concerned with pure commercial alliances, neglecting the area of private-sector partnerships with government agencies (Todela, Knoke 2005). Applying the existing theories and empirical findings to strategic alliances between public and private entities therefore should be done with caution. Any matter caused by the shift from inter-firm alliances to alliances with public partners, is discussed during the model setup in chapter 7.

With regards to the theory used for setting up the SEM, one merit of applying the framework by Sambasivan et al. (2013) is that it draws upon Kale & Singh's notion of all the stages of a strategic alliance lifecycle. This holistic approach is important in explaining private companies' incentive and willingness to engage in PPIs. Numerous authors have been concerned with organisations' absorptive capacities and how they constrain their effective information processing, acquisition of partner expertise and adoption of innovation (Todela, Knoke 2005), but according to Kale & Singh (2009) the explanatory power is increased when all stages of the cycle are considered.

By reviewing relevant literature from particular literary clusters within innovation theory, PPI literature and strategic alliance theory, it is possible to situate the analysis of this report into an existing gap in the literature. Setting up a strategic alliance SEM based on Sambasivan et al.'s framework and exploring additional aspects in qualitative interviews will help to answer the research questions of this study and add to the existing literary gap on the private and strategic perspective of PPIs. Theory on strategic alliances best capture the dynamics of the evaluation/consideration phase that private firms are undergoing before choosing to engage in the pre-commercial innovation phase of a PPI.

## **Chapter 5 Methodology**

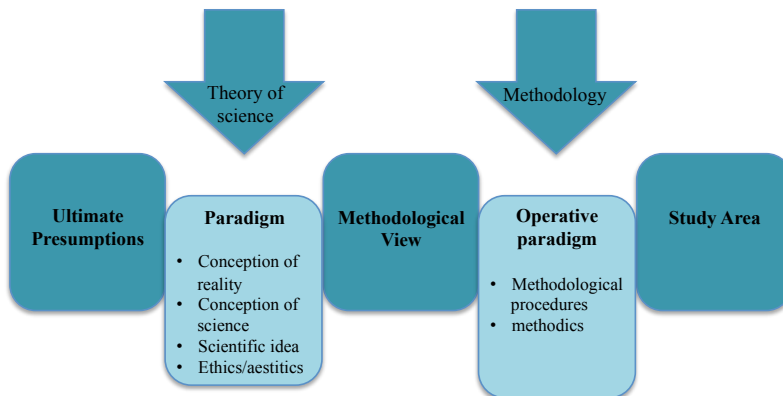
In the methodological field, extensive work has been done on paradigms to discover the field of creating knowledge in social science, and the result has been various ways of presenting the methodological views. In order to ensure consistency of the methodological decisions and their basis, a single framework has been chosen for this dissertation. The frame of reference



for the methodological part of the dissertation is Arbnor & Bjerke's (2009) way of presenting theory of science. Referring to the illustration below, the framework will guide the structure of the methodology paragraphs. The structure therefore is as follows.

The next paragraph cursorily discusses ultimate presumptions and the paradigms, which leads to the introduction of the methodological view applied to the dissertation. Having discussed the methodological view, the section moves on to describe methodical procedures. The methodological procedures undertaken constitute the first part of the operative paradigm. The second part of the operative paradigm, methodics, will be discussed in chapter 8. Covering the different parts of figure 5.1, below, is important as the methodological view encompasses some ultimate presumptions as well as provides some prerequisites for the design of practical instruments used to develop the operative paradigm that will be used throughout the analysis (Arbnor, Bjerke 2009).

**Figure 5.1 – Paradigm and Operative Paradigm**



Source: Author's creation with inspiration from (Arbnor, Bjerke 2009)

## 5.1 Ultimate Presumptions

Ultimate presumptions make up a set of “philosophical” hypotheses about reality (Arbnor, Bjerke 2009). Ultimate presumptions indirectly influence the process of knowledge creation, and therefore it is highly important that the researcher is aware of these. Thus, the guiding principles for the creation of knowledge must be in line with both ultimate presumptions held by the researcher and the problems, which are subject to the research conducted (Arbnor, Bjerke 2009). I always have the personal ambition of explaining things as I am convinced that reality is fact based. My ultimate presumptions about reality therefore are consistent with those of the positivism and more specifically with those of the *analytical philosophy*, which is highly focused on problems and problem clarifications (Arbnor, Bjerke 2009). The guiding principles, which will be gone through in the methodology sections not only fit these ultimate presumptions of mine, but also the problem outlined in the problem statement.

## 5.2 Paradigm

As mentioned in the introduction of methodology, various proposals for classifying paradigms exist, e.g. Burrell & Morgan's distinction between *the functionalist*, *the interpretive*, *the radical humanist* and *the radical structuralist paradigm* (as in Arbnor, Bjerke 2009) or Guba's *post-positivism*, *critical science* and *constructivism* (as in Arbnor, Bjerke 2009). Common to all of them are the underlying paradigmatic considerations regarding *conceptions of reality*, *conception of science*, *scientific ideal and ethical and aesthetical aspects* (Arbnor, Bjerke 2009). The paradigmatic starting point of this dissertation is that reality is ordered, filled with facts and logical in causes and effects. In addition, reality is thought to be independent of individual perceivers, which means that I, as a researcher, am guided by the idea that science is objective and therefore should not be influenced by partial interests (Arbnor, Bjerke 2009). Applying these paradigmatic considerations to the dissertation means that the cause-effect relationships tested in the structural equation model will constitute the ordered reality of PPIs.

## 5.3 Methodological View

Referring to the figure 5.1, above, the less abstract classifications of paradigms are called methodological views and constitute the link between theory of science and methodology. Like Guba and Burrell & Morgan, Arbnor & Bjerke (2009) also have classified paradigms into methodological views. The authors distinguish between the *analytical view*, the *system's view* and the *actor's view*. Given the paradigmatic considerations of this dissertation as well as the research questions, the appropriate methodological view to apply is the *analytical view*.

In addition to the scientific ideal of impartiality, discussed above, an ethical aspect of the analytical view becomes relevant to discuss. Although researchers can give advice to different decision makers, they should clearly distinguish between the roles of decision-making and creating-knowledge (Arbnor, Bjerke 2009). In the introduction to this dissertation it was described how the perspective is shifted away from the extensively covered policy perspective of PPPs, and therefore this distinction is of great importance. Specifically, the aim of this dissertation is to focus on the knowledge-creation part by gaining some knowledge about PPI collaborations from a private perspective and then let the findings serve as inspiration for the decision markers.

The last important consideration affecting the research design of this dissertation is the way the analytical view conceives reality to be summative (Arbnor, Bjerke 2009). The summative characteristic means that new scientific findings add to the old ones and make the picture of the phenomenon more and more complete (Arbnor, Bjerke 2009). This is an important implication to the research conducted in this dissertation, because a limited set of findings make up the completeness of the phenomenon so far. Conducting an explanatory study on PPI, based on the existing insufficient knowledge covering the study area, therefore entails the almost inevitable risk of committing specification error. Specification error decreases the

overall predictive power of a SEM and therefore the research is designed in a way that will limit the risk of committing this type of error. Moving on with the estimation, it turns out that this is not an important concern, as the PLS estimation method is reasonably robust to this inadequacy (Haenlein, Kaplan 2006, Vinzi et al. 2010).

### 5.3.1 Explanatory Research

Within the analytical view, four different types of research can be conducted, depending of the level of ambition of the research. Moving from the lowest level of ambition and up, they are, *descriptive research*, *explanatory research*, *forecasting research* and *guiding research* (Arbnor, Bjerke 2009). Despite the fact that the ambition of each research type varies, they all share the same basic levels of ambition, *to discover* and *to explain* (Arbnor, Bjerke 2009, p. 97). This implies that although explanatory research is carried out for the purpose of answering the problem statement of this dissertation, elements of exploration and description are still embedded as preliminary exercises. According to Arbnor & Bjerke (2009), discovery refers to the process of developing problems, or, if problems already exist, to show the characteristics and behaviour of objects and subjects in reality. From the problem formulation it is evident that a problem of engaging private companies in PPIs already exists, causing the objective of the discovery part to become exploration and description of the characteristics and behaviour of the private firms. To gain insights for this purpose, interviews with medico companies and public representatives are conducted previously to sending out the questionnaire. The representatives from the public entity are not directly interviewed about the engagement of private firms, but more generally about the process of PPIs (Appendix C.1). Gaining some knowledge on how PPIs are proposed from the public side will help shed some light on private engagement.

### 5.3.2 Complementarity

Carrying out the preliminary interviews will create an explorative basis for a description of what is at stake in PPIs. Furthermore the ambition of these interviews is to reach an understanding of the immediate perceptions and thereby increase the level of the total contribution of the research. To reach this understanding, rather than just mere description of the perceptions, elements of the actor's qualitative approach, like personal interviews, are included in the interviews. Some scholars of methodology oppose that methodological views can be combined and argue that they are too conflicting in their ultimate presumptions. On the other hand, scholars, including Arbnor & Bjerke (2009), recognise that what they call *complementarity* has some merits to it. Arbnor & Bjerke's position is adopted, but relevant issues will still be discussed in order to make deliberate use of methodology.

The scientific ambition varies among the methodological views. Thus, the ambition of the actor's view is not to generalise findings, but to get a genuine understanding of the cases selected (Arbnor, Bjerke 2009). However, referring to the use of structural equation modelling in this dissertation, the ambition of the research is to come up with some

generalisable knowledge about the pre-commercial phase of PPIs, which is different from the ambition of the actor's view. Partly for the reason of difference in scientific ambitions, Arbnor & Bjerke (2009) argue that mixing methods right away will cause a lack of consistency, stringency and credibility in the creation of knowledge. However, as long as the method mixing is done creatively and consciously, Arbnor & Bjerke (2009) argue that there is no problem in doing so. This methodological justification for mixing methodological approaches is called *complementarity*. According to Arbnor & Bjerke (2009), complementarity is the procedure of considering circumstances based on the point of departure of a methodological approach, against another approach's set of ultimate presumptions. This can take place in different parts of the research, either in the description of the problem, the data collection or in the analysis of the data (Arbnor, Bjerke 2009). In other words, one methodology is used as the base approach, while another approach is used as a transformative approach, from which different techniques and methods can be picked (Arbnor, Bjerke 2009). Referring to the aim of this dissertation, a combination of explanatory research with qualitative data collection will allow for a better understanding of how Sambasivan et al.'s framework should be modified to better model PPIs as opposed to the inter-firm relations that it was originally intended for.

## 5.4 Operative Paradigm

### 5.4.1 Methodical Procedures

Methodological procedures represent the procedures undertaken by the researchers to

“... arrange, develop, and/or modify any technique, theory, or previous result in a methodological approach, or alternatively, develop a new technique” (Arbnor, Bjerke 2009, p. 176).

Within the analytical view, the following groups of techniques are considered, *selection techniques*, *sampling techniques*, *traditional data collection techniques*, *measurement and reliability techniques* and *validation techniques* (Arbnor, Bjerke 2009).

#### 5.4.1.1 Selection Technique

Selection technique is about selecting units to be studied when creating knowledge. The selection technique has to be consistent with the methodological view (Arbnor, Bjerke 2009). The ambition of the analytical approach is to make statistical inferences about the population. In order to do so, the selected units of analysis must be representative so that when the description and explanation of the selected units are present, so are the description and explanation of the area of interest as a whole (Arbnor, Bjerke 2009).

#### **5.4.1.2 Traditional Data Collection Technique**

Within traditional data collection techniques a distinction is made between primary information/data and secondary information/data. In the introductory paragraph it was pointed out how the quantitative structural equation modelling analysis rests on primary data, and that the research is supported by secondary data in the creation of the research design e.g..

When discussing the interplay between the methodological view and the methodological procedures for this research, the primary data collection becomes particularly interesting. As Arbnor & Bjerke (2009) put it, some areas are underdeveloped in the research, and therefore explorative studies must be undertaken before hypotheses can be formulated in areas where such significant hypotheses are missing. Furthermore they stress that such explorative work is an inevitable part of any effort intended to develop better knowledge about companies and related social phenomena (Arbnor, Bjerke 2009). The explorative interviews, included as a part of the data collection technique in this research, are believed to counter some undiscovered issues and therefore contribute to the development of the conceptual model.

#### **5.4.1.3 Sampling Techniques**

The details of the sampling method used to collect quantitative, primary data will be discussed under *methodics*, but relevant considerations are made in regards to methodical procedures. In order to be able to make statistical inferences about a population, the sample drawn must be representative. Within the resource limitations of this dissertation, steps are therefore taken to draw a representative sample.

#### **5.4.1.4 Measurement Techniques**

Of utmost importance to the analytical view with regards to measurement techniques are reliability and validity (Arbnor, Bjerke 2009).

Under *methodics* it is described how *internal validity* of the measurement is adopted by using the questionnaire developed by Sambasivan et al., whereas *external validity* is assessed during the analysis.

Compared to the systems approach and the actor's approach to creating knowledge, it is important under the analytical approach that the measurements are reliable. As it has been introduced under *data*, the reliability was therefore checked as a preliminary step to data collection.

## Chapter 6 Qualitative Data Collection

### 6.1 Preliminary Interviews

The introductory paragraph introduced how the main purpose of carrying out the qualitative interviews has been to explore additional dimensions related to pre-commercial PPIs with the Danish Regions, which might have an influence on the medico companies' propensity of engaging in such PPIs. The purpose of this paragraph therefore is to answer the research questions concerning perceptions, additional dimensions and issues of pre-commercial PPIs from the medico companies' perspective.

To gain a broader understanding of the medico companies, three representative informants have been interviewed. To represent small start-ups, the general manager of Unisensor, Jens Haugaard was interviewed and to represent multinational companies, Elisabeth Reimer Rasmussen from Medtronic was interviewed. In addition to representing Medtronic, Elisabeth Reimer Rasmussen is the chairman of the expert group for health economics under Medicoindustrien and therefore holds a broad knowledge on what is at stake in the industry. The last informant interviewed is Erik Kromann<sup>3</sup>, who by virtue of his numerous board positions and many years of experience working in the industry, can be perceived to be an expert. Given his status, Erik also has a very strong general feeling of what is going on in the industry.

The first impression gained from the interviews is that managers generally lack sufficient knowledge about the opportunities of participating in PPIs in the Danish healthcare sector. Lacking sufficient knowledge about this collaboration form causes the managers difficulties in identifying relevant opportunities for their companies. According to the informants, lack of sufficient knowledge and information therefore is a source of demotivation of engaging in PPIs. On the other hand, when asked about what the managers actually perceive to be the motivation for engaging in PPIs, Jens Haugaard, representing the smaller companies, explains how the motivation would be to gain access to resources and knowledge, while Elisabeth Reimer Rasmussen explains how larger companies usually are driven by the opportunity of getting to try some of their own technologies in new settings and new contexts. This is in line with the findings of the Capacent report (2009) prepared on behalf of the Danish Business Authority. In this report it is described how large international companies typically engage in PPIs to test new technologies in new contexts and to gain some general PPI experience that can be utilised in other contexts, while smaller companies enter PPIs to develop specific products or services for the purpose of supplying them to the public sector afterwards.

When presented to the two-stage model, the informants expressed some concern regarding the qualification issue. SMEs, typically start-ups, are forced by their investors to generate sales as a proof of financial viability. The commercial focus of PPIs therefore becomes very important

---

<sup>3</sup> Information on Erik Kromann can be found on <http://hlipr.com/business-development-board-members/122-strategic-business-advisor-erik-kromann>

and qualifying for the commercial tender is seen more as a requirement than as an extra incentive. In connection hereto, Jens Haugaard stresses how important it is for the companies to be able to spot a business opportunity and prospects of gaining both national and international competitiveness, when presented by a PPI project. If they do not see the opportunity for a viable business model, the project is not attractive to them.

Another challenge regarding the pre-commercial phase of the model is that smaller companies need fairly clear specifications in the alliance formation phase. They need to know whether the final product will be close enough to their core competencies for them to be competitive producing it. Larger companies also prefer to get a little more specifications from the start in order to know if they will be able to come up with specifications for the final product and be able to produce it.

Having gone through the key takeaways from the interviews, it is evident how the managers' immediate perception of the two-stage model for PPIs is that it does not constitute an attractive alternative for the companies as it is now. The informants point towards issues of lacking knowledge and information, qualification issues and insufficient specifications at the pre-commercial tender. These issues leave the impression that the managers lack motivation for working towards acquiring the knowledge required for them to introduce PPIs as a strategic alternative to their companies. Despite the fairly negative perception of engaging in pre-commercial PPI, the three managers agree that participation could be an important parameter of competitiveness in the future, both nationally and internationally. During the set up of the conceptual mode, manager motivation therefore should be considered an additional dimension to the framework by Sambasivan et al. (2013).

## **Chapter 7 Theory of Conceptual Model**

In the literature review, strategic alliance theory was identified as a useful line of theory for answering the problem statement of this dissertation and for closing part of an existing gap in the literature. In the following, the conceptual model will be set up based on the theoretical framework on strategic alliances developed by Sambasivan et al. (2013) as well as on the additional dimension of manager motivation identified during the preliminary interviews. By tailoring Sambasivan et al.'s structural equation model and adding a PPI specific construct, it is possible to gain a deeper understanding and explain what dimensions influence private companies' propensity to engage in the pre-commercial innovation phase of PPIs.

The main difference between Sambasivan et al.'s conceptual model and the model proposed in this dissertation is the units of analysis. For this study, the units of this analysis are private companies and therefore implications of shifting from inter-firm alliances towards public-private alliances are discussed as they arise, and necessary modifications are done.

## 7.1 Model Assumptions

As a prerequisite for developing the conceptual model, it is relevant to discuss any assumptions made about the evaluation criteria applied by private medico companies when considering different investment alternatives, as they are assumed to influence their propensity to engage in PPIs. Private companies sometimes combine commercial and social objectives, especially in the healthcare industry, but as private medico companies are all for-profit organisations, it is reasonable to assume that their propensity to engage in pre-commercial PPIs is driven by incentives other than the social benefits of improving healthcare solutions. A pre-commercial innovation process is assumed to be too resource heavy for these kind of companies to engage in it if it was not for their own financial benefit. Thus, despite the fact that evaluation criteria often consist of differently weighted parameters, the overriding evaluation criterion is assumed to be financial.

Departing from the construct of primary interest, *Propensity of Private Companies Engaging in Pre-commercial PPIs*, the hypotheses proposed for the structural model are presented in a descending order, moving from perceived outcome towards dimensions of the business environment and initial motivation for engaging in strategic alliances. All of the hypotheses proposed in subsequent paragraphs appear from Figure 7.9, below.

## 7.2 Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions

*Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions* is the dependent construct for which the structural equation model is set up to explain the variance. Thus, compared to the framework by Sambasivan et al. (2013), the objective has been changed from explaining *Strategic Alliance Outcome* to explaining the propensity that private medico companies want to engage in pre-commercial PPIs with the Danish Regions.

**Table 7.1 – Propensity of Private Companies Engaging in Pre-commercial PPIs**

Latent Construct	Indicators
Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions	Goal Achievement
	Value Creation
	Re-evaluation

Source: Author's creation

### 7.2.1 Operationalisation

As the name of the construct implies, the latent construct represents the extent to which the private companies perceive an alliance in the pre-commercial innovation phase to enable them to create value and achieve their goals and therefore *Goal Achievement* and *Value Creation* remain important dimensions of the construct. It is reasonable to assume that private companies will be willing to engage in pre-commercial PPI if they perceive it to create value and contribute to the achievement of their goals. Using the same indicators is the same as



assuming that *Strategic Alliance Outcome* and *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions* are strongly correlated, which seem reasonable.

As the majority of the companies in the medico industry are assumed not to have engaged in PPIs yet, the *Re-evaluation* indicator has been eliminated from the model. In order to make sure that no important aspects have been omitted with the exclusion of *Re-evaluation*, the operationalising questions of *Goal Achievement* and *Value Creation* have been re-examined from a PPI perspective. The questions for *Goal Achievement* cover goal achievement of the alliance and the alliance's contribution to realisation of general business objectives, which are deemed sufficient (Appendix G.1, s\_21\_1 – s\_21\_3). With regards to *Value Creation*, the questions listed by Sambasivan et al. (2013) have been compared to a list of motives for private companies to engage in PPIs, listed in a report by the Danish Business Authority (Capacent 2009). The rationale for comparing the existing questions about *Value Creation* to the list of PPI motivations is that it is reasonable to assume that motivation drives the propensity to engage. The motives are:

- Product Development
- Basic Innovation (experience and knowledge without genuine product development)
- Access to Users
- Access to Knowledge and Market
- Network Creation with Other Private Companies
- Network Creation with the Public Sector
- Access to Test Competencies if Research Institutes are Participating in the Process (Capacent 2009).

The comparison has led to a decomposition of a network question to capture the difference between network effects with other companies and network effects with the public sector (Appendix G.1, s\_22\_4, s\_22\_5). In addition, a question about basic innovation was added to capture the difference in motives about the nature of the innovation created (Appendix G.1, s\_22\_2).

### 7.3 Manager Motivation

Drawing on the key findings from the preliminary interviews, *Manager Motivation* is included to capture the deficient motivation expressed by the managers. The following hypothesis is proposed to add a PPI specific dimension to the model by Sambasivan et al. (2013).

*H<sub>11</sub>: The stronger the Manager Motivation for engaging, the higher the Propensity of Private Medico Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

Including  $H_{11}$  introduces a personal perspective to a model primarily focused on constructs influencing the company's decisions on a broad organisational level. By combining the organisational aspect with a personal aspect, the explanatory power of the model is believed to be stronger. The explanation of the positive relationship between *Manager Motivation* and *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions* is straightforward. If managers feel motivated they are more willing to work towards having their company engaging in pre-commercial PPIs and thus the propensity of this actually happening increases.

Utilising *Theory of Planned Behaviour* provides the theoretical basis for the relationship proposed in  $H_{11}$ . *Theory of Planned Behaviour* stems from the field of consumer behaviour, but applies to more than just purchase situations. The theory assumes that,

“... consumers consciously consider the consequences of the alternative behaviours under consideration and choose the one that leads to the most desirable consequences and that seems realistic to carry out” (Peter, Olson & Grunert 1999, p. 130).

The theory is therefore well suited for explaining managers' intention to engage in PPIs.

Formally, *Theory of Planned Behaviour* can be expressed as follows:

$$B \approx BI = A_{act}(w_1) + SN(w_2) + PC(w_3),$$

where

B= Specific behaviour

BI = Managers' intention to engage in that behaviour

$A_{act}$  = Managers' attitude towards engaging in that behaviour

SN = Subjective norm regarding whether other people want the consumer to engage in that behaviour

PC = Perceived control over the behaviour.  $w$ 's reflect the relative influence of the components on BI.

The first part of the equation states that *Behavioural Intention*, which is explained by *Attitude*, *Subjective Norm* and *Perceived Control*, is the single best predictor of *Specific/Actual Behaviour* (Peter, Olson & Grunert 1999). This additional construct of *Manager Motivation* therefore sets out to measure *Behavioural Intention* rather than *Specific Behaviour*. When applied to a PPI specific context, this *Behavioural Intentions* represents the manager's motivation for working towards getting his/her company to engage in pre-commercial PPIs.

Table 7.2– Manager Motivation

Latent Construct	Indicators
Manager Motivation	Attitude
	Subjective Norm
	Perceived Control & Information
	Involvement

Source: Author's creation

Besides the three elements of *Theory of Planned Behaviour*, also *Involvement* is added as an indicator of *Manager Motivation*. The managers interviewed pointed towards lack of information as an issue regarding pre-commercial PPIs and therefore it is relevant to assess their level of willingness to acquire the information necessary. This is an indication of their involvement. The theoretical basis for introducing *Involvement* to the model stems from consumer behaviour. A key concept under consumer behaviour theory is *Consumer Involvement*, where *Involvement* is defined as,

“Consumers’ perception of importance or personal relevance for an object, event or activity” (Peter, Olson & Grunert 1999, p. 77).

Although introduced under consumer behaviour, *Involvement* can be understood in a more universal sense, and therefore it also finds application in a PPI context.

### 7.3.1 Operationalisation

In this paragraph, a detailed reasoning is provided of how all of the indicators of *Manager Motivation* have been operationalised into statements.

An *Attitude* reflects a manager’s overall evaluation of performing the behaviour (Peter, Olson & Grunert 1999). The operationalizing question of *Attitude* therefore becomes:

- “My overall evaluation of engaging in pre-commercial PPIs is positive”.

A *Subjective Norm* consists of two components, *Normative Beliefs* and *The Motivation to comply with these Beliefs*. *Normative Beliefs* represent “doing what other people want me to do”, whereas the latter represents the motivation to comply with the expectations of these other people (Peter, Olson & Grunert 1999). Applied to a PPI specific context, the issue becomes whether the manager should start working towards making his/her company engage in pre-commercial PPIs. The operationalisation statement therefore becomes:

- “Engaging in Public-Private Innovation could be an important source of competitiveness in the future and therefore I think that it would improve my carrier opportunities if I worked towards getting our company to engage in it”.

The last component included from the *Theory of Planned Behaviour* is *Perceived Control*, which reflects the extent to which the manager believes that he/she is able to actually perform the behaviour. Besides generally feeling in control, the qualitative interviews revealed two important findings that should be considered here. First, the lack of information expressed by the interviewed managers could turn out to be an obstacle, and second, the managers asked are not necessarily the only person in the organisation making decisions like these. Therefore, the operationalising statements of *Perceived Control & Information* become as follows:

- “I am sufficiently informed about this collaboration model to be able to decide whether or not it makes up an attractive opportunity for our company”.
- “I feel capable of proceeding with this alliance form”.
- “As a representative of the Danish market, I am not dependent on other persons in our organisation, when it comes to making decisions about entering alliances like these”.

Stating the following is used to assess the level of *Involvement*:

- “I am willing to actively seek more information about this type of partnership”.

During the development of the statements used to measure *Manager Motivation*, steps have been taken to ensure a certain level of validity and reliability. Providing sufficient theoretical basis for the indicators have ensured internal validity, whereas making sure to formulate the statements precisely and clearly to avoid ambiguity has ensured reliability. Furthermore it has been checked that the statements do not contain two statements in one and that the statements do not lead the respondents to particular answers (Lavrakas, SAGE Publications 2008a).

## 7.4 Relational Capital

Table 7.3 - Relational Capital

Latent Construct	Indicators
Relational Capital	Commitment
	Trust
	Communication

Source: Author's creation

Relational Capital is derived from *Personal Relationship Theory* (PRT) and *Social Exchange Theory* (SET). In this study the construct is defined by the three indicators, *Commitment*, *Trust* and *Communication*, which are generally believed to be the most prevailing aspects of the construct (Sambasivan et al. 2013). The three indicators serve as an informal control mechanism necessary to achieve joint action and goal fulfilment in the post formation alliance management phase (Sambasivan et al. 2013). *Commitment*, *Trust* and *Communication* are therefore perceived to be highly critical in order to ensure the success of a strategic alliance and therefore also important for the understanding of the propensity of private medico companies engaging in such strategic alliances. Along those lines Sambasivan et al.(2013) go

as far as to claim that strategic alliances are doomed to fail in the absence of *Relational Capital*, because it can be perceived to be a quality indicator of the relationships between strategic alliance partners.

For a more precise definition of the construct, *Trust* is what enables effective joint decision-making and problem solving, whereas *Commitment* represents the willingness of strategic alliance partners to invest resources in contributing toward positive outcomes (Nyaga et al., 2010, as in Sambasivan et al. 2013). Lastly, *Communication* is an indicator of quality of information, information participation and information sharing.

When the level of the three indicators, *Trust*, *Commitment* and *Communication* is high, the chances of the partners achieving their goals are believed to be higher (Nyaga et al., 2010, as in Sambasivan et al. 2013). Everything else held constant, the prospects of goal achievement increase the private medico companies' propensity of engaging in pre-commercial PPIs with the Danish Regions and therefore the following hypothesis is put forward,

*H<sub>10</sub>: The stronger the Relational Capital between the strategic alliance partners the higher the Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

### 7.5 Interdependence Level

Like *Relational Capital*, *Interdependence* is derived from *Personal Relationship Theory* and *Social Exchange Theory*. Extending the definition of goal interdependence given by Das & Teng,

"... the degree to which partner firms need each other in an alliance for the achievement of their goals" (as in Sambasivan et al. 2013, p. 343),

to include task interdependence and reward interdependence, the joint definition of *Interdependence* becomes the degree to which public and private partners need each other in an alliance for the achievement of their tasks, goals and reward. To measure the interdependence level, statements about *Goal*, *Task* and *Reward Interdependence* are put as indicators. Interdependence is present whenever one of the parties does not entirely control all of the conditions necessary for the achievement of a desired outcome (Sambasivan et al. 2013). This is one of the reasons why *Interdependence* is a highly interesting construct to look at in a PPI context. The partners in a Danish healthcare PPI naturally will be highly dependent on each other and therefore the Danish Regions' lead demand for medical equipment will encourage private medico companies to generate innovation, which the public partner would not be able to generate itself.

Table 7.4 - Interdependence Level

Latent Construct			Indicators
Interdependence Alliance Partners	between	Strategic	Task Interdependence
			Goal Interdependence
			Reward Interdependence

Source: Author's creation

It is generally believed that interdependency within a strategic alliance promotes deeper integration because partners with high task interdependence are willing to contribute more to reach shared goals and achieve win-win results (Sambasivan et al. 2013). One way to integrate is to communicate and thereby break down barriers hindering any achievement of shared goals. As already suggested, *Communication* is considered an indicator of the level of *Relational Capital* between strategic alliance partners and therefore the following hypothesis about the relationship between *Interdependence* and *Relational Capital* is proposed (Sambasivan et al. 2013),

*H<sub>9</sub>: The higher the level of Interdependence, the higher the level of Relational Capital between strategic alliance partners.*

## 7.6 Perception of Opportunistic Behaviour

*Perception of Opportunistic Behaviour* simply is the perception that a private company will be exploited by its partner (Sambasivan et al. 2013). Together with bounded rationality, the assumption of opportunistic behaviour represents the central assumption in transaction cost economics, that individuals always will aim at maximising utility (Nikolova 2008). Thus, opportunism can be defined as self-interest seeking with guile (Nikolova 2008). Nikolova (2008) further clarifies how opportunistic behaviour can range from blatant forms like lying, stealing and cheating, to more subtle forms of deceit including incomplete and distorted disclosure of information.

Table 7.5 - Perception of Opportunistic Behaviour

Latent Construct	Indicators
Perception of Opportunistic Behaviour	Perception of Opportunistic Behaviour 1
	Perception of Opportunistic Behaviour 2
	Perception of Opportunistic Behaviour 3

Source: Author's creation

In an article on trust, control and risk in strategic alliances, Das & Teng (2001) argue how moving from a single-firm strategy to an inter-firm strategic alliance inevitably will introduce the risk of opportunistic behaviour performed by the other firm (Das, Teng 2001). But what about the risk of opportunistic behaviour in a strategic alliance between public and private

partners? Strategic alliance partners often fear becoming a victim of opportunistic behaviour for example by being locked in or not getting a fair share of intellectual property resulting from the alliance (Todela, Knoke 2005). Included in the aspect of opportunistic behaviour is also the difficulty of writing complete contracts on contingent claims guarding the parties against the risk stemming from imperfect and asymmetric information (Parker, Hartley 2003). Referring to the description of the PPI process, the public entity holds more information regarding the innovation process and what companies will qualify for the different steps of the process. Private companies therefore could wonder if the public entity acts transparently and publish the complete knowledge withheld and thereby try to decrease potential information asymmetry. *Perception of Opportunistic Behaviour* therefore is an interesting latent construct to assess and thus two hypotheses including the construct are proposed.

Hypothesis 8 represents the postulate that companies who perceive their partners likely to exploit them will be less likely to build close relationships with them. This perception will reduce the interdependence in terms of joint decision-making in task coordination, goal achievement and reward distribution (Sambasivan et al. 2013). Hypothesis 8 therefore is therefore formulated as follows.

*H<sub>8</sub>: The stronger the Perception of Opportunistic Behaviour, the lower the level of Interdependence between strategic alliance partners<sup>4</sup>.*

The reasoning behind hypothesis 7 follows the same logic. Partners, who perceive their counterparts to behave opportunistically, will tend to communicate less and as a result show less trust and commitment to the partner (Sambasivan et al. 2013).

*H<sub>7</sub>: The stronger the Perception of Opportunistic Behaviour by the partners the lower the level of Relational Capital between them<sup>5</sup>.*

## 7.7 Asset Specificity

Williamson (1985) defines *Asset Specificity* as,

“... durable investments that are undertaken in support of particular transactions, the opportunity cost of which investments is much lower in best alternative uses or by alternative users should the original transaction be prematurely terminated” (as in Lui, Wong & Liu 2009, p. 1214).

In other words, *specificity* refers to the fact that the assets cannot be redeployed in other settings. Considering the large number of SMEs in the medico industry, *Asset Specificity* is an

---

<sup>4</sup> The statements have been changed to positive wording, and therefore the effect coefficient will be positive although hypothesised as an inverted relationship

<sup>5</sup> See foot note 4

interesting construct to evaluate, as the allocation of resources to specific partnerships will constitute a greater risk to these companies.

For the purpose of clarifying concepts, *Asset Specificity* and *Relationship Specific Assets* are used interchangeably throughout the dissertation. Several authors have followed this example (Lui, Wong & Liu 2009).

According to table 7.6, below, the medico companies' intended willingness to dedicate tangible and intangible assets to a pre-commercial PPI with the Danish Regions is used to measure the level of *Asset Specificity*.

**Table 7.6 - Asset Specificity**

Latent Construct	Indicators
Asset Specificity	Intangible Assets
	Tangible Assets

**Source:** Author's creation

Investments in relationship specific assets can both restrict and enable specific goals and tasks performed by the strategic alliance partners and even determine the reward of the partners (Sambasivan et al. 2013). Put very simply, the more the partners have invested in the relationship, the more interdependent they are. Therefore the hypothesised relationship becomes as follows,

*H<sub>6</sub>: Asset Specificity is positively related to Interdependence between strategic alliance partners.*

In order to explain the effects of investing in relationship specific assets, Sambasivan et al. (2013) have applied *Transaction Cost Theory*. *Transaction Cost Theory* explains the level of asset specificity as a function of the perceived threat of opportunistic behaviour. If the company perceives the likelihood of opportunistic behaviour to be high, it is hesitant to invest in relationship specific assets (Sambasivan et al. 2013). If one of the partners in a strategic alliance devotes specific assets to the relationship and the other partner is able to withdraw itself from the relationship without incurring any costs, there is a strong temptation for this partner to pursue its own interests at the expense of the partner who invested assets in the relationship (Sambasivan et al. 2013). Dedicating assets specifically to an alliance therefore is a positive gesture. Accordingly, Parkhe (1993) has suggested that a partner's aversion towards investing in partnership specific assets indicates that the company will perceive itself to be vulnerable as they see their partner as being more likely to behave opportunistically (as in Sambasivan et al. 2013). For this reason, the hypothesised relationship between *Asset Specificity* and *Perception of Opportunistic Behaviour* is as follows.



*H<sub>5</sub>: Asset Specificity is negatively related to the Perception of Opportunistic Behaviour by the strategic alliance partners<sup>6</sup>.*

The relationship between *Asset Specificity* and *Relational Capital* is the last one going out from *Asset Specificity*. A study by Kwon & Suh has confirmed the direct positive effects of *Asset Specificity* on *Trust*, which is an indicator of *Relational Capital* (as in Sambasivan et al. 2013). Furthermore commitment to a relationship like a strategic alliance is often reflected in a resource commitment, which is essentially the same as *Asset Specificity* (Sambasivan et al. 2013). A transaction costs perspective suggests that committing resources specifically to a relationship will increase the costs of switching to a new relationship and thereby increase the partners' willingness to make the existing relationship work. Based on this, the proposed relationship between *Asset Specificity* and *Relational Capital* is as follows.

*H<sub>4</sub>: The higher the level of Asset Specificity, the higher the level of Relational Capital between the strategic alliance partners.*

## 7.8 Strategic Alliance Motive

As the name of the construct suggests, *Strategic Alliance Motive* covers the motives for companies to engage in strategic alliances. In broad terms these motives can be divided into two indicator categories, *Property-based Motives* and *Knowledge-based Motives*. Both categories contain motives about compensating the company for lacking resources and skills necessary to maintain and enhance substantial competitive advantage over its competitors (Sambasivan et al. 2013). Motives can be considered one of the initial drivers of engagement and thus is highly important to look at in a PPI context.

**Table 7.7 - Strategic Alliance Motive**

Latent Construct	Indicators
Strategic Alliance Motives	Property-based
	Knowledge-based

**Source: Author's creation**

The *Strategic Alliance Motive* construct is derived from *Resource-Based Theory* (RBT), where it is believed that the most common motives for companies to enter strategic alliances are resource extension and skills acquisition (Varadarajan & Cunningham, 1995, as in Sambasivan et al. 2013). Other companies are motivated to enter strategic alliances as a means of reducing financial risk as well as a way of sharing the cost of research and development (Bos 2006).

<sup>6</sup> The statements have been changed to positive wording, and therefore the effect coefficient will be positive although hypothesised as an inverted relationship

### 7.8.1 Operationalisation

Looking at the questionnaire, it is evident how the operationalisation of the construct includes questions about financial, technological and managerial motives. In the process of modifying the model and the questionnaire to better fit PPIs, it was considered whether questions about technological infrastructure, technological competences and managerial skills should be included. Referring to the list of private companies' motives for engaging in PPI, set forth by the Danish Business Authority, the technological and managerial motives are not explicitly listed. In order to figure out whether these were relevant in a PPI setting, they were included in the preliminary interviews as a point of discussion. It turned out that both technological and managerial motives can be present, and therefore they are included in the questionnaire.

The examples listed of tangible and intangible asset motives have been changed to make the questionnaire more PPI specific. For instance innovation facilitation is listed as an aspect of goodwill because this facilitation of the innovation process is a valuable asset possessed by mediator organisations like VIF (Capacent 2009).

The variation of motives between SMEs and larger companies detected in the qualitative interviews is already built into the questionnaire because motives for private companies to enter an alliance with a public entity are the same as if they were entering an inter-firm alliance.

The perceived importance of an alliance, and thereby also the motive of entering it, affects the behaviour of the companies (Sambasivan et al. 2013). Different behaviour will yield different levels of *Trust*, *Commitment* and *Communication* and hypothesis 2 therefore posits the following,

*H<sub>2</sub>: The stronger the Strategic Alliance Motives between partners, the higher the level of Relational Capital between them.*

*Strategic Alliance Motives* represent the shared objectives of the alliance and therefore is associated with both *Goal* and *Task Interdependence*. The reasoning underlying this is straightforward. A company looking to enter a strategic alliance will choose a partner, whom they believe will enable them to reach their goals by helping them to complete the necessary tasks for doing so. Based on this reasoning, the following hypothesis is put forward,

*H<sub>1</sub>: The stronger the Strategic Alliance Motives between partners, the higher the level of Interdependence between them.*

## 7.9 Environment

*Environment* is derived from *Contingency Theory* (CT) and the construct affects a company's strategic and operational plans significantly (Sambasivan et al. 2013). The intuitive definition of *Environment* therefore covers every internal and external factor affecting a company and its strategic and operational plans. Examples of such factors influencing a company's environment are *turbulent competition*, *rapid regulatory changes*, *technological developments*, *public policy shifts*, *social changes* and *unstable economic conditions* (Sambasivan et al. 2013). Given these factors, the incentive for companies to form strategic alliances is to overcome the impact of environmental uncertainty and create barriers to entry (Sambasivan et al. 2013). Companies who lack the resources and skills to overcome e.g. technological pressure from the business environment can look externally for these. Doing so will enable them to effectively compete in a changing marketplace (Sambasivan et al. 2013).

At a high level of abstraction, the three indicators *Complexity*, *Dynamism* and *Munificent* measure the internal and external factors influencing the business *Environment*. The three constructs cover the spectrum from the competitive situation over changeability of the environment to availability of resources (Appendix G.1, s\_1\_1 – s\_3\_3\_r).

**Table 7.8 – Environment**

Latent Construct	Indicators
Environment	Complexity
	Dynamism
	Munificent

Source: Author's creation

Having discussed both *Environment* and *Strategic Alliance Motives*, the following hypothesis is proposed.

*H<sub>3</sub>: Environment has a positive impact on the Strategic Alliance Motives: the more uncertain the Environment, the stronger will be the Strategic Alliance Motives.*

## 7.10 The Mediating Effect of Relational Capital

Besides the ten hypotheses, Sambasivan et al. (2013) have proposed another four hypotheses on the mediation effect of *Relational Capital*. More specifically the mediation hypotheses are as follows,

*H<sub>16a</sub>: Relational Capital mediates the relationship between Strategic Alliance Motive and Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

*H<sub>16b</sub>: Relational Capital mediates the relationship between Asset Specificity and Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

*H<sub>16c</sub>: Relational Capital mediates the relationship between Perception of Opportunistic Behaviour and Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

*H<sub>16d</sub>: Relational Capital mediates the relationship between Interdependence between partners and Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

The theoretical reasoning for testing *Relational Capital* as a mediation effect is based on the argumentation that the construct encapsulates the intensity of the interaction among the strategic alliance partners as well as the reasoning behind hypothesis 2, 4, 7 and 9 (Sambasivan et al. 2013).

### 7.11 Direct Effects

Although setting up the mediating effects, Sambasivan et al. (2013) did not explicitly set up the direct effects between *Strategic Alliance Motive*, *Asset Specificity*, *Perception of Opportunistic Behaviour* and *Interdependence* and *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions*. Methodologically, the authors argued that the direct effects are integrated in the hypotheses on the mediating effects because a direct effect needs to be present in order to test if it is mediated by another latent construct. However, as the structural model could turn out to include significant relationships for direct effects and insignificant relationships for mediation effects, four separate hypotheses are set up and tested explicitly for the direct effects. Methodologically it is very important to be clear about every step of the research design in order for fellow researchers to be able to build on the findings of the research. Therefore discussing this step is considered an important part of critically applying prior findings.

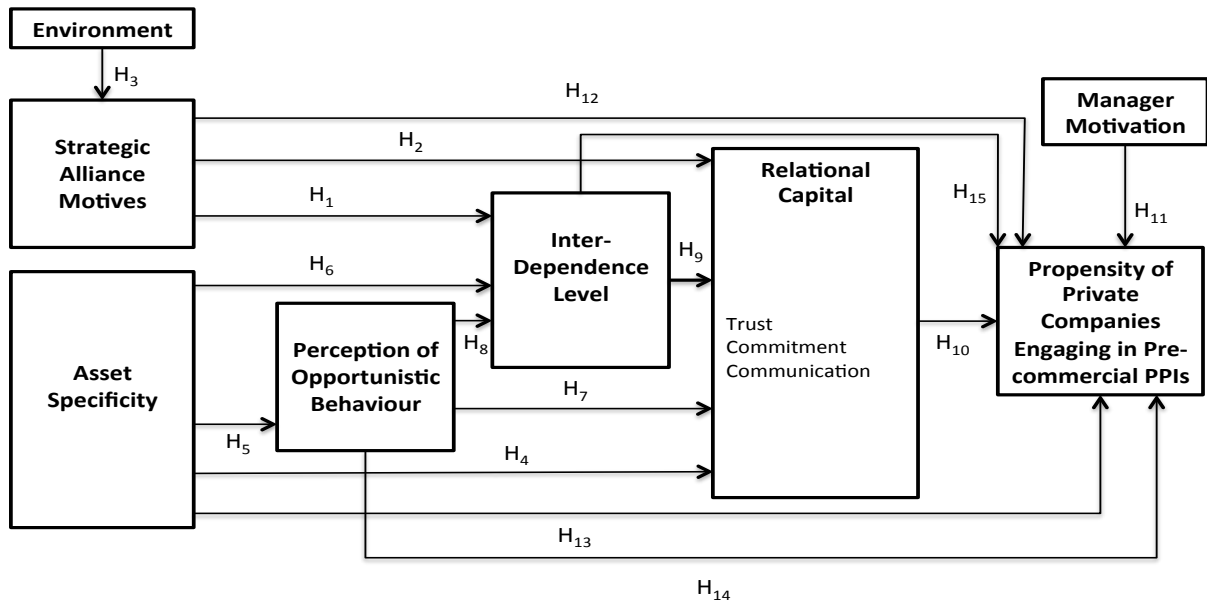
*H<sub>12</sub>: The stronger the Strategic Alliance Motive, the higher Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

*H<sub>13</sub>: Asset specificity is positively related to Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

*H<sub>14</sub>: The stronger the Perception of Opportunistic Behaviour, the lower the Propensity of Private Companies Engaging in Pre-commercial PPIs with a public partner.*

*H<sub>15</sub>: The higher the level of Interdependence between the strategic alliance partners, the higher Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions.*

Figure 7.9 – Conceptual Model



Source: Author's creation with inspiration from (Sambasivan et al. 2013)

## Chapter 8 Quantitative Data Collection

### 8.1 Methodics

The second part of the operative paradigm, *methodics*, represents the way in which the researcher arranges the techniques-become-methods in study plans and how the study is actually carried out (Arbnor, Bjerke 2009). As *methodics* rests on methodical procedures the reasoning behind these is a natural extension of the reasoning behind the methodical procedures.

#### 8.1.1 Software Tool

The online survey tool, Survey-Xact has been used for the data collection (Rambøll Management Consulting A/S n.d.). Like most online tools, Survey-Xact can be used for both setting up the questionnaire and distributing it in a convenient way (Fritz, Morgan & SAGE Publications 2010). A link to the online survey, a hard copy version of the questionnaire, the cover letter and a reminder are all included in appendix D.1 – F.3.

#### 8.1.2 Internet-based Survey

Conducting internet-based surveys entails both advantages and limitations compared to other data collection methods.

Among the advantages is the elimination of the risk of human errors committed during the process of data capturing and the elimination or reduction of interviewer effects (Lavrakas,

SAGE Publications 2008b). In terms of interviewer effects there can still be some left in the formulation of the questions and therefore precautions have been taken against leading the respondents to answer in a particular direction. Interviewer effect therefore should not be a concern when analysing the results.

Applying an internet-based approach for data collection also shifts some of the control from the interviewer to the respondent. Self-administration enables the respondent to answer in his/her own pace, but it also introduces the risk that representatives of the companies other than the ones that the survey was intended for answer the questionnaire (Lavrakas, SAGE Publications 2008b). This limitation is almost impossible to control, but a preliminary effort was made in order to minimise its scope. This effort is described under the sampling paragraph.

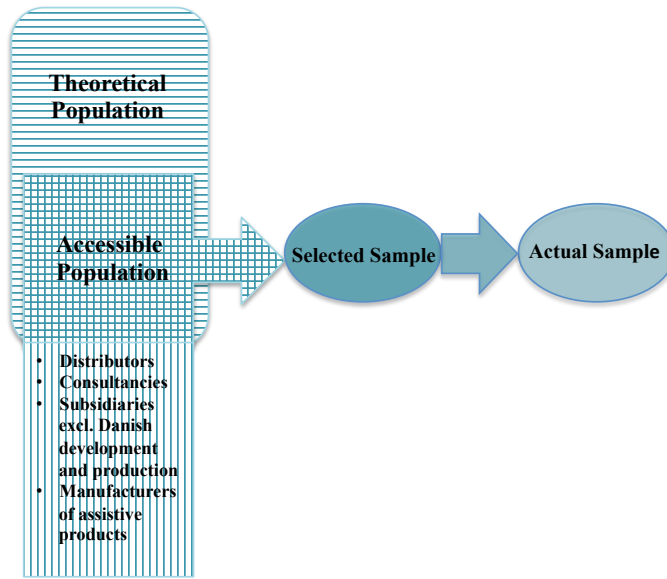
As the study concerns businesses and not individuals like consumers, it has been challenging to get a sufficient number of responses to the questionnaire. Several steps have therefore been taken to eliminate the limitations that an insufficient sample would have caused to the results. One of these steps has been to use the validation function of Survey-Xact. Including a validation of each question forces the respondent to answer all of the questions on a page before proceeding to the next page. In this way, no respondents have been lost due to missing answers.

Another relevant limitation that internet-based studies often encounter is sampling issues. Issues of invalid results arise when the sample method has not been designed scientifically (Lavrakas, SAGE Publications 2008b). Sampling issues like this renders the possibility to make valid inferences about the subjects studied and therefore it has been of great importance during the methodological process to design the sampling procedures in an correct way. Rigorous definitions and considerations of the survey population of this study therefore will be gone through in the subsequent paragraph on sampling.

### **8.1.3 Sampling Method**

The sampling design of the quantitative data collection follows the process depicted in figure 8.1, below.

Figure 8.1 - Sampling Process Diagram



Source: (Fritz, Morgan & SAGE Publications 2010)

#### 8.1.3.1 Theoretical Population

The theoretical population for which the analysis intends to be valid consists of companies in the Danish medico industry, according to the delimitation made in the industry introduction. The considerable part of companies who primarily export their products therefore are included in the population as long as they sell just a small fraction of their products to the Danish Regions.

As mentioned in the industry introduction, the companies relevant to the survey are diverse and therefore do not share a common industry code. Not knowing all the relevant industry codes, a complete list of the theoretical population cannot be obtained. Furthermore, even if all relevant industry codes were known, the aggregated number would include companies not producing products for the healthcare sector, e.g. regular dental instruments produced under the industry code, 3250000: *Production of medical and dental instruments as well as accessories hereto* (Erhvervssyrelsen n.d.). Not being able to identify and estimate the total population, it has not been possible to perform random, probabilistic sampling. Instead, convenience sampling has been applied. The potential consequences of non-probabilistic sampling are discussed in the analysis.

#### 8.1.3.2 Accessible Population

To identify the accessible population, lists over members of Medicoindustrien and Danish Rehabilitation Group, two of the industry organisations within the Danish medico industry, has been obtained. However, the only shared characteristic by the companies listed for the theoretical population is the fact that they are all within the business of medical equipment or

assistive/treatment products. Therefore not all of the companies identified as accessible are relevant to the theoretical population. Steps have therefore been taken to exclude companies belonging to the accessible population, but not the theoretical population. These are the companies with the characteristics listed in the part of the accessible population not overlapping with the theoretical population in figure 8.1, above. These steps make up the purposive convenience sampling described in the paragraph.

#### ***8.1.3.3 Selected Sample***

Purposive sampling is a special case of convenience sampling under the non-probabilistic sampling methods (Fritz, Morgan & SAGE Publications 2010). *Purposive* means that samples are selected based on predetermined criteria related to the research. Referring to the definition of the theoretical sample for this study, one such criterion is that the participating companies must be developing and producing companies. In order to meet this criterion, the companies were sorted by classifications. In this way, only manufactures, start-ups and the subsidiaries, for which the decision to engage in PPIs are relevant, were invited to participate. Lacking the decision power regarding PPI initiatives, distributors, consultancies and some subsidiaries have been disregarded.

Having selected a sample, the first step towards distributing the online questionnaire was to look up e-mail addresses on the company websites. To those companies where only info e-mail addresses or contact formulas were available, an e-mail was sent to request the contact information for the right person in the company. As the companies vary in size and organisational structure, the e-mail sent out contained a suggestion of what positions that the relevant person in the company could hold. In the instances where the name of the relevant person was available on the website, the contact information for that person was requested specifically.

In some cases the contact information for the persons, who seemed relevant, was available on the websites, and therefore the second step of the process was to send e-mails directly to those persons. Some of these respondents replied, confirming that they were the person to talk to and in other cases the request was forwarded to a colleague in the organisation. As it turned out to be challenging to get enough respondents for the questionnaire, companies that had not responded to the request were contacted telephonically. Doing so yielded a few more respondents.

These steps have all been taken to ensure that the right person was targeted, as this will improve the validity of the answers.

#### ***8.1.3.4 Actual Sample***

The actual sample is composed of the company representatives who agreed to participate and actually completed the online survey. In order to increase the response rate, reminders were sent out on the day of the deadline and the survey was prolonged for one week.



## 8.2 Operationalisation of Constructs

The questionnaire is a modification of the original questionnaire prepared by Sambasivan et al. (2013). By utilising an existing operationalisation of the constructs, the theoretical foundation of the indicators used to measure the latent constructs is ensured. As for the latent construct, *Manager Motivation*, it has already been described how the theoretical foundation for the operationalisation is to be found in the preliminary qualitative interviews as well as in the theory of planned behaviour.

In addition to the modifications already presented under the conceptual framework, a few more modifications have been done as a result of a change in research context. Every statement has been reworded to allow the respondents to express their perceptions of an alliance with a public partner and therefore “*will*” is replaced by “*would*”. Also, to avoid redundancy, a few statements have been disregarded due to overlap. Changes like these will not challenge the theoretical basis.

### 8.2.1 Measurement Scale

The online survey consists of a standardised questionnaire with statements to which the respondents indicate their level of agreement. The response alternatives follow a 5-point Likert scale ranging from “*Strongly Agree*” to “*Strongly Disagree*”. Likert scales are often used when asking about perceptions as they are easy to construct and easy for the respondents to understand and use (Jepsen 2008). As opposed to a semantic differential scale, which presents two divergent alternatives, the Likert scale is unipolar, meaning that the respondents are presented to an attitude or behaviour and then asked to indicate how close to or far from they are (Jepsen 2008).

Regarding the type of data collected using Likert scales as the measurement scale, PLS estimation is possible to use with both nominal, ordinal and interval scaled data and therefore the on-going discussion about data classification of data collected on Likert scales becomes irrelevant for this study (Vinzi et al. 2010).

As Pre-commercial Public-Private Innovation is assumed to be a relatively unknown concept to most of the respondents prior to taking the online survey, a 5-point scale has been used. In this way the respondents do not have to make decisions about small nuances in the response alternatives that they might not be able to make. Furthermore, as a Likert scale is a symmetrically balanced continuum, using an odd number of response alternatives results in a neutral alternative, which is desirable to have when studying perceptions of a fairly new concept, which the respondents have no experience with.

Lastly, referring to appendix F.1 and F.2, no “Don’t know” option has been included. An effort was made to sufficiently inform the respondents about the different aspects of Pre-

Commercial Public-Private Innovation in the cover letter of the study and therefore everybody is expected to have a perception, whether it is positive, negative or neutral.

### 8.2.2 Pilot Test

Generally, the study rests on Sambasivan et al.'s (2013) methodological work regarding reliability and validity of the indicators, but reliability and content validity were re-evaluated separately before sending out the questionnaire. For the additional construct, *Manager Motivation*, which does not rest on previous work, considerations about validity and reliability were part of the operationalisation.

Also Medico expert, Erik Kromann reviewed the questionnaire to check content validity and make sure that the multi-item scales covered the constructs in an adequate way. At the same time it was checked if the modifications done to the original questionnaire had the desired effect of being better tailored the PPI context and that no obvious bias effects were present.

To assess the reliability of the statements and make sure that the representatives of the target population understood the statements in the same way, some of the critical statements were presented during the preliminary interviews. This procedure gave a good idea about the level of clarity and familiarity. Furthermore, reliability was checked one last time by having a couple of persons with a general economical understanding testing the questionnaire to see if the statements were clearly and unambiguously formulated.

## Chapter 9 Data Analysis

To facilitate the understanding of the data analysis, the structure of chapter 9 is broadly outlined. Starting out, a preliminary data analysis is conducted to assess the quality of the data material collected, after which a brief description follows of how the modelling was done.

Having described the modelling, an analysis of the outer model (*measurement model*) will be provided leading to an evaluation of the outer model. Next, the inner model (*structural model*) is ready to be tested. Like the outer model, the results of the inner model test are evaluated. A discussion of the findings in relation to the theoretical foundation concludes the chapter.

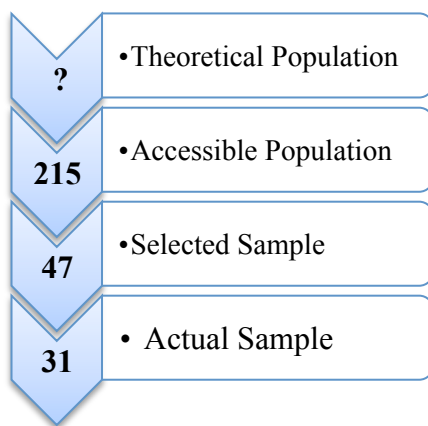
### 9.1 Preliminary Data Processing

#### 9.1.1 Data Cleansing

Following up on the data sampling process, the actual numbers are listed in the subsequent sampling funnel, figure 9.1. The total number of companies on the two member lists obtained is 215. After a purposive convenience sampling, 47 companies remained in the sample and received an invitation to participate in the online survey. Out of the selected sample of 47, a total of 37 respondents entered the online survey. Of these 37 respondents, four withdrew

before completing the questionnaire and therefore have been excluded from the data file. One drawback of excluding data listwise is that it reduces the sample size, which has a considerable impact when the sample is already small. However, in terms of introducing bias into the estimated model, the listwise exclusion method performs adequately to other methods if the missing data is not too great (Hair et al. 1998). Down to 33, another two respondents have been excluded as they have classified themselves as distributors and therefore no longer qualify. By including a control question asking the respondents to indicate their company type, it was double-checked that only companies for which the study is relevant are included in the data file. By doing so the validity of the answers is improved. 31 responses therefore make up the actual sample used for estimating the SEM. This equals a response rate of 66%, which is satisfactory considering the steps taken to reach as high a response rate as possible.

**Figure 9.1 – Sampling Funnel**



Source: Author's creation

### 9.1.2 Distribution of Data

As a prerequisite of doing any statistical analysis, the distribution of the dataset is examined. This is done by looking histograms for all the indicators. To assist the interpretation of the histograms and their conformity with the normal distribution, measurements of skewness and kurtosis are examined. Referring to appendix H.2, the values deviate from the desired level of 0 for skewness and 0 for excess kurtosis, which is the one reported by SPSS. Based on this, it can be concluded that the data is not normally distributed. However, as already mentioned SEM estimation is robust to non-normal data and therefore using *bootstrapping* as a resampling method allows estimation of the sampling distribution of almost any statistic. The statistical tests necessary for structural equation modelling therefore can be undertaken without any problems (Hair et al. 2012).

### 9.1.3 Representativeness

Not being able to determine the theoretical population makes it impossible to determine whether the actual sample selected is representative or not. Testing the latter using statistical Chi Square test is not possible because the assumption of normality is violated (Jensen,

Knudsen 2006). A way to go about this is to discuss if anything indicates that the sample composition should be different from the one of the theoretical population. Doing so will give an indication of the sample's representativeness and the external validity of the study. For this study, there are no indications that the companies chosen from the member lists acquired should be different from the companies who are not a member of either the Medico industry or Danish Rehabilitation Group. This assertion is based on the fact that the member companies are highly diverse in terms of company size, organisational structure, technology level etc. (Danish Rehabilitation Industry n.d, Medicoindustrien n.d).

Summing up, it cannot be determined whether the non-probabilistic sample is representative or not, but there are no obvious indications that it should not be. In fact, the diversity of the sample supports representativeness of the sample. However, when interpreting the results, it is important to keep in mind that the sample may not be representative.

## 9.2 Structural Equation Modelling and Estimation

Setting up the conceptual model in SmartPLS was done in two steps. First, the structural model was built by setting up all of the constructs and combining them according to the hypothesised relationships. Second, the measurement model was constructed by attaching all of the indicators to their respective construct. The estimation of the SEM was initially done at two levels of abstraction. These two levels will be described in next paragraph before moving into a more detailed assessment from paragraph 9.3 and onwards.

### 9.2.2 Two Levels of Abstraction

Referring to the questionnaire, the questions asked for each latent construct are divided into subgroups like *complexity*, *dynamic* and *munificence* belonging to *Environment*. For the purpose of exploring the data material, the model was therefore set up in two different ways. Level two, which is the highest level of abstraction, was set up with the eight latent constructs. These eight latent constructs were replaced by 20 sub-constructs in the level one model to see whether the indicators would load more strongly on the sub-factors than on the large factors and therefore better explain *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions*. Conducting a factor analysis for both levels resulted in four more indicators loading significantly for the final level one model, but it turned out that the level one model suffers from several barriers and limitations (Appendix L.1). A couple of the sub-factors are single-indicator constructs and the increased number of parameters to be estimated increases the complexity of the model to an extent that makes an estimation based on a sample size of 31 respondents difficult to justify. Furthermore, looking at appendix L.2 to L.3, it is interesting to see how the model splits when the last insignificant relationship between *POB* and *Target Interdependence* is removed. The model becomes invalid and thus cannot be estimated. The steps of the analysis therefore will be conducted on the level two model exclusively.

### 9.3 Measurement Model

#### 9.3.1 Reflective Modelling

In a paper by Hair et al. (2012), the authors assess the use of PLS-SEM in marketing research. Although the present study is not concerned with marketing, it is interesting to learn that almost 12% of the papers reviewed fail to describe the constructs' measurement model. In order not to commit the same methodological mistake, it is explicitly stated how the measurement model of this study is *reflective*. Whether a measurement model is reflective or formative depends on the direction of the effect between the latent variables and its indicators. The direction of the effect is theoretically driven and therefore should be considered before estimating a SEM. For the reflective model the indicators are functions of the latent variables and therefore changes in the latent variable are reflected as changes in the indicators (Vinzi et al. 2010). For the SEM of this study this is the way the effect is pointing. Take *relational capital* as an example. An increase in the perceived *relational capital* will manifest itself as an increase in *trust*, *commitment* and in the quality of *communication*. A confirmatory factor analysis is therefore done next.

In a reflective model, each group of indicators is related to a latent construct and assumed to measure a unique underlying concept (Vinzi et al. 2010). In order to make sure that the hypothesised groups of indicators explain the changes in the latent constructs, a *confirmatory* factor analysis therefore is conducted. A *confirmatory* factor analysis has its starting point in theory or hypotheses about the grouping of the underlying dimensions and therefore is preferred over an *explorative* factor model for which the objective is to explore the number and composition of the underlying latent dimensions determined by the dataset (Jensen, Knudsen 2006). By conducting a *confirmative* factor analysis it is possible to create a set of compounded scales to use when the structural model is tested.

#### 9.3.2 Qualification for Confirmatory Factor Analysis

Before the factor analysis is conducted, the data material's qualification for factor analysis is assessed. The basis for this assessment is the correlation matrix appearing in appendix I.1. In order to make the matrix easier to grasp, correlations above 0.6 are highlighted in green, whereas correlations under 0.6 are highlighted in red. From the matrix it is clear that it qualifies for factor analysis because it contains both weak and strong correlations and because the green cells are fairly centred on the diagonal indicating that the correlation is stronger between questions asked about the same latent construct. To support the conclusion of qualification for factor analysis, Kaiser-Meyer-Olkin (KMO) and Barlett's test statistics are evaluated (Appendix I.2). For all of the factors, the null hypothesis that the variables are uncorrelated is rejected and except for *Asset Specificity* all KMO values are above the recommended level of 0.5 (Jensen, Knudsen 2006). The value of 0.488 for *Asset Specificity* is not low enough to give rise to any concerns about carrying out the factor analysis to assess the indicator reliability.

## 9.4 Evaluation of Measurement Model

As a reliable and valid measurement model creates a better basis for testing the structural model, measures of reliability and validity will be evaluated in the following paragraphs.

### 9.4.1 Indicator Reliability

The confirmatory factor analysis is conducted in SmartPLS by looking at the factor scores of the indicators and excluding the ones with a loading below 0.7 to ensure indicator reliability (Hulland 1999). The 0.7 limit ensures that there is more shared variance between the construct and its measures than error variance (Vinzi et al. 2010). Indicators with loadings below 0.7 can be included if the researcher finds it relevant, but generally strong theoretical rationale must exist for including indicators with a factor loading below 0.4 and even in that case, the indicator will add very little explanatory power to the model (Hulland 1999). Using 0.7 as the limit, a total of 35 indicators have been excluded from the measurement model and 34 remain to measure the eight latent constructs (Appendix J.1 and J.2).

Since the model is reflective, the indicators are interchangeable and therefore exclusion of single indicators should not give rise to any concerns with regards to the meaning of the latent construct and generalizability of the study (Hair et al. 1998).

### 9.4.2 Internal Consistency Reliability

In order to check whether each group of indicator variables meets the requirement of being homogeneous and uni-dimensional, the internal consistency is evaluated (Vinzi et al. 2010). Two measures of internal consistency exist, *Cronbach's Alpha* and *Composite Reliability*. According to Chin (1998) the *Composite Reliability* measure provides a better indicator of internal consistency reliability than *Cronbach's Alpha*, because the latter assumes each indicator variable to be equally important in defining the latent construct (as in Vinzi et al. 2010). Both measures are easily available from the report provided by SmartPLS, which has been reproduced in appendix J.3.

To ensure internal consistency reliability the rule of thumb is that both measures should be above 0.7. This value is reached in every case except from *Cronbach's Alpha* for *Asset Specificity*. However, the responding *Composite Reliability* compensates for this minor deviation and internal consistency reliability therefore is present in the measurement model (Vinzi et al. 2010).

### 9.4.3 Convergent Validity

To measure convergent validity, average variance extracted (AVE) is evaluated. The AVE measure quantifies the proportion of variance that the latent construct captures from its indicator variables relative to the amount caused by measurement error. Thus, the value of AVE should be above 0.5, which means that the greater part of the indicator variance is accounted for by the latent construct (Vinzi et al. 2010). Referring to appendix J.4, the AVE for all of the latent variables are above 0.5 and therefore the requirement of convergent validity is met for the measurement model.

#### 9.4.4 Discriminant Validity

Having established that the latent constructs capture a significant amount of their indicators' variance, it is important to find out if the latent constructs differ from each other. This is done by comparing the square root of AVE to the correlation between the particular construct and other constructs in the model (Vinzi et al. 2010). As it is apparent from the matrix in appendix J.5, the constructs do not correlate enough to raise any concern about discriminant invalidity.

#### 9.4.5 Cross Loadings

The last check of the measurement model is the cross loadings. This check is done to make sure that the indicator variables' strongest loading is on the factor to which they belong given the hypothesised grouping of the underlying dimensions. Referring to appendix J.6, the strong cross loadings fall in vertical clusters, meaning that they load strongly on the factors that they were intended to.

By performing these various tests, it has been established that the necessary foundation for testing the structural model is present.

### 9.5 Structural Model

#### 9.5.1 Test of Relationships Between the Latent Constructs

The structural model is tested using t-tests based on pooled standard errors obtained via a bootstrapping resampling procedure (Vinzi et al. 2010). Each t-statistic is held against the limit value of 1.967, which is the limit for a two-tailed t-test with a confidence level of 90% (Appendix K.1). The insignificant relationships are excluded one by one starting with the least significant. Choosing a minimum confidence level of 90% results in a final model with eight latent constructs and 15 different indicator dimensions. Between the eight latent constructs, 9 out of 19 hypothesised structural paths turned out to be significant. Of the nine relationships, two are significant at a 90% confidence level, three are significant at a 95% confidence level and four are significant at a 99% level (Appendix K.2). The level of confidence is represented by the p-value, whereas the reported r-values indicate correlations, (Appendix K.6).

##### 9.5.1.1 Results

For reference, the final result of the simultaneous hypotheses testing is reported in appendix K.3 and in figure 9.2, below.

Hypothesis 1, which tests the relationship between *Strategic Alliance Motive* and *Interdependence* between strategic alliance partners, is supported ( $r=0.58$ ,  $p < 0.05$ ). This indicates that the stronger the perceived strategic alliance motives, the stronger the perceived interdependence between the strategic alliance partners.

Hypothesis 2, which posits the relationship between *Strategic Alliance Motive* and *Relational Capital*, is supported at a very high level of confidence ( $r=0.67$ ,  $p < 0.01$ ). This implies that the stronger the perceived strategic alliance motives, the stronger the perceived relational capital between the partners.

Hypothesis 3, which states that there is a positive relationship between *Environment* and *Strategic Alliance Motives*, is supported ( $r=0.42$ ,  $p < 0.05$ ). This shows that Danish medico companies, who perceive themselves to be challenged by a highly dynamic business environment, have stronger perceived motives to engage in PPIs with the Danish Regions to overcome these challenges and strengthen their level of innovation. The representatives of the Danish medico industry stressed a concern for rapid regulatory changes and public policy shifts when asked about their business environment during the interviews. Drawing upon this finding, this concern strengthens their motives of engaging in pre-commercial PPI with the Danish Regions.

Hypothesis 4 explains the relationship between *Asset Specificity* and *Relational Capital*. This hypothesis is not supported by the empirical data. It is therefore not possible to conclude that the more the medico companies perceive themselves willing to invest in relationship specific assets the more positive effect it will have on the intensity of their relationship to the Regions.

Hypothesis 5 is supported implying a relationship between *Asset Specificity* and *Perception of Opportunistic Behaviour* ( $r=0.59$   $p < 0.01$ ). This means that private companies making specific investments for the success of the alliance is negatively related to the perception of opportunistic behaviour. In other words, if the companies choose to disregard the concerns of information asymmetry and disqualification for the commercial tender introduced in section 7.6 and invest in relationship specific assets, it is an expression that they do not perceive the chances of opportunistic behaviour to be considerable.

Note that questions about perception of opportunistic behaviour were asked in a positive wording which results in a positive correlation despite an inverted relationship.

Hypothesis 6 specifies the relationship between *Asset Specificity* and *Interdependence* between the strategic alliance partners. This hypothesised relationships is not supported, indicating that the perception of making asset specific investments do not increase the perceived interdependence between the strategic alliance partners significantly.

Hypothesis 7 posits a relationship between *Perception of Opportunistic Behaviour* and *Relational Capital* between the strategic alliance partners. This relationship is not supported. By rejecting hypothesis 7 it cannot be concluded that the private companies perceive the fear of opportunistic behaviour to influence how committed they would be to a public strategic alliance partner and the quality of communication between the strategic alliance partners. Drawing upon the preliminary interviews, a possible explanation could be that although the managers express a concern of uncertainty and lack of involvement by the public partner, they



do not perceive that to be equivalent to opportunistic behaviour. Note again how questions about perception of opportunistic behaviour were asked in a positive wording and therefore result in a positive correlation despite an inverted relationship.

Hypothesis 8 specifies the relationship between *Perception of Opportunistic Behaviour* and *Interdependence* between the strategic alliance partners. The hypothesis is statistically supported ( $r=0.53$ ,  $p < 0.10$ ). This shows that if the private companies perceive the risk of opportunistic behaviour to be high, the perceived interdependence is significantly reduced. Looking at this in a broader perspective this means that even though hypothesis 6 about a direct effect of *Asset Specificity* on *Interdependence* was rejected, *Asset specificity* has an indirect effect on *Interdependence* through *Perception of Opportunistic Behaviour*.

Again, the positive correlation coefficient is caused by the positive wording of the question asking about perception of opportunistic behaviour.

Hypothesis 9 tests the relationship between *Interdependence* and *Relational Capital* between strategic alliance partners. This relationship is supported ( $r=0.66$ ,  $p < 0.05$ ). Supporting this hypothesis implies that a higher degree of perceived interdependence between the strategic alliance partners increases the perceived relational capital between them.

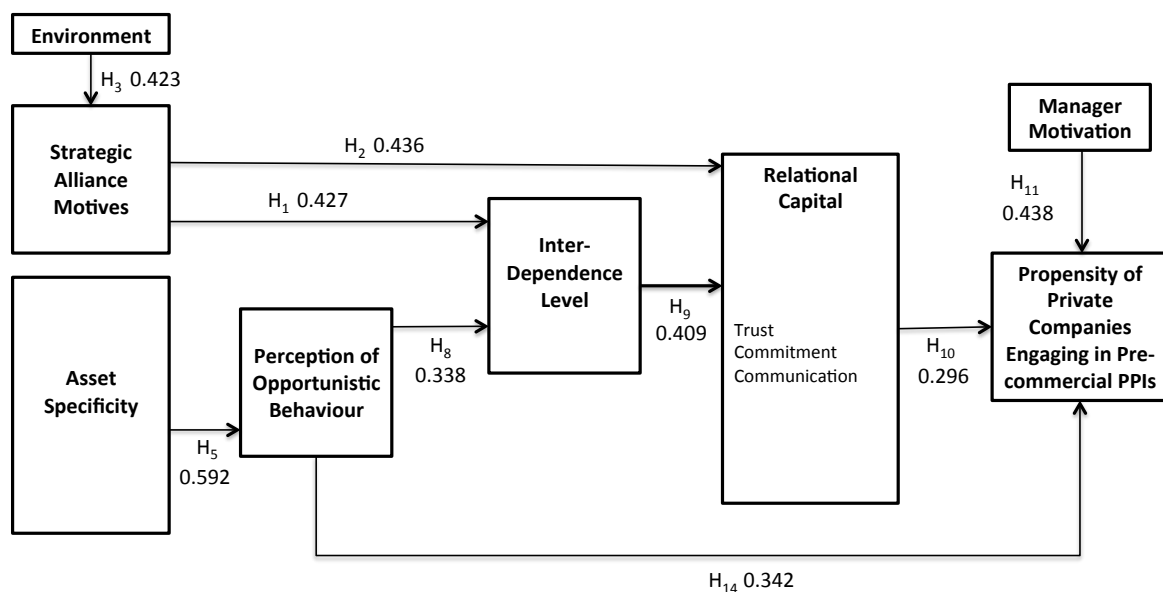
Hypothesis 10 proposes the relationship between *Relational Capital* and *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions*. This relationship is supported ( $r=0.75$ ,  $p < 0.10$ ). The stronger the perceived relational capital between strategic alliance partners, the higher the propensity of private medico companies engaging in pre-commercial PPIs with the Danish Regions.

Hypothesis 11 tests the relationship between *Manager Motivation* and *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions*. This hypothesis was set up on the basis of the preliminary interviews and turns out to be highly significant ( $r=0.76$ ,  $p < 0.01$ ). This indicates that managers' engagement, attitude, perceived control and perceived information level as well as the subjective norm affect private companies' propensity to engage in pre-commercial PPIs with the Danish Regions.

Broadening the picture to include the full strategic alliance lifecycle adopted from Kale & Singh (2009), it is interesting to find that hypotheses about the perceptions of the last stage of the lifecycle (*Post-formation Alliance Management*) are supported, whereas the hypotheses rejected concern the first and second stage (*Alliance Formation & Partner selection* and *Alliance Governance & Design* (*Alliance Formation & Partner selection* and)). In an attempt to explain why this might be the case, a closer look is taken at *Asset Specificity*. Referring to the histograms in appendix H.1, most companies would not dedicate neither tangible nor intangible assets to a strategic alliance with a public partner. A possible explanation of this is that the responding companies are too small to hold the necessary resources to make such relationship specific investments and as a result also lack the experience necessary to be able

to form perceptions about allocating resources. This possibly explains why perceptions of neither *Relational Capital* ( $H_4$ ) nor *Interdependence* ( $H_6$ ) are affected significantly by perceptions of *Asset Specificity*. Adding to this,  $H_7$  has been rejected, leading to the conclusion that *Perception of Opportunistic Behaviour* does not affect *Relational Capital* significantly either. Summing up, the rejection of both  $H_4$  and  $H_7$  therefore leaves the impression that Danish medico companies perceive themselves forced to take on some calculated risk if choosing to engage in pre-commercial PPIs. The reason for this is twofold. First, investing in relationship specific assets does not increase the level of trust, commitment and communication and second, an increased level of perceived opportunistic behaviour will not decrease the level of trust, commitment and communication significantly.

Figure 9.2 Final Structural Equation Model



Source: Author's Creation

### 9.5.2 Test of Direct Effects on Relational Capital

Of the four hypotheses of direct effects added to the framework proposed by Sambasivan et al. (2013), hypothesis 12, 13, 14 and 15, only hypothesis 14 is supported ( $r=0.66$ ,  $p < 0.01$ ). This suggests that the smaller the private companies perceive the chances of opportunistic behaviour, the higher the propensity that they would engage in PPIs with the Danish Regions. Of the four hypotheses added to the conceptual model, it is not surprising that it is the effect of *Perception of Opportunistic Behaviour* on *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions* that turns out to be significant. The reason why this finding is not surprising is that *Perception of Opportunistic Behaviour* is related to the highly significant *Manager Motivation* that also has a direct effect on *Private Companies' Propensity of Engaging in PPIs with the Danish Regions*. The idea of a relationship between *Perception of Opportunistic Behaviour* and *Manager Motivation* is not directly supported by theory, but stems from the preliminary interviews conducted. For the same reason the relationship is not tested as part of the conceptual model, but added to the model, which was

then tested again. It turned out that the relationship is supported at a confidence level of 95% and a correlation between the constructs of 0.38. Exploring the data material in this way helps to back the argument that *Perception of Opportunistic Behaviour* and *Manager Motivation* together with *Relational Capital* describe the essence of the *problem of attraction*.

### 9.5.3 Test of the Mediation Role of Relational Capital

The last four hypotheses tested concern the mediation effect of *Relational Capital*. Mediation effects are normally tested via Sobel's test, which compares the direct effects of a construct with and without a mediation construct in the structural model. However, two circumstances make it unnecessary to perform Sobel's test. First, the rejection of hypotheses 12, 13 and 15 of the direct effects makes it redundant to test any mediation effects. Second, concerning hypothesis 16c, which suggests a mediation of the direct effect of *Perception of Opportunistic Behaviour* on *Private Companies Engaging in Pre-commercial PPIs with the Danish Regions*, there is no need to test this as hypothesis 7 is rejected and therefore no mediation effect exists.

## 9.6 Evaluation of Structural Model

### 9.6.1 Coefficient of Determination

The coefficient of determination, ( $R^2$ ), represents the amount of explained variance of each endogenous latent construct and serves as the primary criterion for structural model assessment (Hair et al. 2012). No normalised statement can be made for acceptable threshold values of  $R^2$  as it depends on the study (Vinzi et al. 2010). Referring to table 9.3, the determination coefficient for *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions*, which is the latent construct that this study sets out to explain, is 0.782. This means that by applying the framework proposed by Sambasivan et al. about strategic alliances in supply chains and adding a latent construct of manager motivation, it is possible to explain 78.2% of the variance in private medico companies' propensity to engage in PPIs with the Danish Regions. Being able to identify the main parameters to adjust is of great value to the Danish Regions as it can be used to help them solve the *problem of attraction*. 0.782 is satisfactory for a study of a new phenomenon like this one.

With regards to the remaining endogenous constructs, every coefficient of determination look satisfactory, except strategic alliance motive. Only 17.9% of the variance of this construct is explained. Obtaining a coefficient of determination of this size naturally introduces considerations about possibly unobserved heterogeneity. As strategic alliance motive affects both interdependence between strategic alliance partners and relational capital, a suggestion for further research would be to lay bare this construct and related constructs that might correlate with it.

Table 9.3 – Coefficient of Determination

Endogenous Construct	Coefficient of Determination $R^2$
Strategic Alliance Motive	0.179
Interdependence	0.423
POB	0.351
Relational Capital	0.562
Propensity to Engage in PPIs	0.782

### 9.6.2 Goodness of Fit

Goodness of fit (GoF) is used to measure the overall prediction performance of the model. In describing how well the model fits the set of observations, the GoF measure takes into account both the measurement model, (*communalities*), and the structural model, ( $R^2$ ). For this model, the GoF is 0.66 (for calculations, refer to appendix K.4). No inference-based threshold exists to judge the statistical significance of a GoF value and therefore the researcher must evaluate and conclude what he/she finds satisfactory for the study. Given the short history of the PPI concept, a goodness of fit value of 0.66 is highly satisfactory.

### 9.6.3 Path Coefficient Estimates

Path coefficients indicate the influence of one construct on another construct. As can be seen from table 9.4, the signs of the path coefficients all tally with the prosed effects. Strongest is the effect of *Asset Specificity* on *Perception of Opportunistic Behaviour* and *Manager Motivation* on *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions*. For instance if the perceived manager motivation increases by one unit, the companies' propensity to engage in pre-commercial PPIs increases by 0.438. In fact, manager motivation appears to have the largest effect on the propensity to engage in pre-commercial PPIs among the identified factors.

It should be noted that moderator effects have been considered in order to be able to draw inference about groups of subsamples. However, the data material does not support adding a moderating variable since a cross table between *company type* and *company size* shows no considerable difference in size among company types.

Table 9.4 – Path Coefficients and Effect Sizes

Path	Proposed Effect	Path Coefficient	$f^2$	Effect Size
Environment → Strategic Alliance Motive (H <sub>3</sub> )	+	0.423**	0.218	Moderate
Strategic Alliance Motive → Interdependence (H <sub>1</sub> )	+	0.427**	0.244	Moderate
Asset Specificity → POB (H <sub>5</sub> )	-	0.592***	0.541	Strong
Interdependence → Relational Capital (H <sub>9</sub> )	+	0.409**	0.269	Moderate
Strategic Alliance Motive → Relational Capital (H <sub>2</sub> )	+	0.436***	0.272	Moderate
POB → Propensity to Engage in PPIs (H <sub>14</sub> )	-	0.342***	0.284	Moderate
Relational Capital → Propensity to Engage in PPIs (H <sub>10</sub> )	+	0.296*	0.202	Moderate
Manager Motivation → Propensity to Engage in PPIs (H <sub>11</sub> )	+	0.438***	0.491	Strong
POB → Interdependence (H <sub>8</sub> )	<sup>-7</sup>	0.338*	0.168	Moderate

\*Significant at a 90% confidence level, \*\* Significant at a 95% confidence level, \*\*\* Significant at a 99% confidence level

#### 9.6.4 Effect Size

Effect size ( $f^2$ ) is used to assess whether a predictor variable has a substantial influence of the dependent variable (Vinzi et al. 2010). The effect size is computed by comparing  $R^2$  for the dependent variable when the predictor variable is included, to when it is not (Appendix K.5). Based on threshold values of 0.02, 0.15 and 0.35 effect sizes are classified as weak, moderate and strong. According to table 9.4, above, there are no weak effects included in the model and the effects of *Asset Specificity* on *Perception of Opportunistic Behaviour* and *Manager Motivation* on *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Regions* are strong. Leaving out any of the predictor variables therefore would have had considerable consequences.

<sup>7</sup> Questions about perception of opportunistic behaviour have been changed from negative to positive wording. Therefore the path coefficient is positive although the relationship is inverted

Having tested the structural equation model set up to explain the *Propensity of Private Companies Engaging in Pre-commercial PPIs with the Danish Region* it turns out that 78.2% of the variance of the propensity can be explained by considering the following seven latent constructs,

- Environment
- Strategic Alliance Motive
- Asset Specificity
- Perception of Opportunistic Behaviour
- Interdependence
- Relational Capital
- Manager Motivation.

Out of 19 relationships between the eight latent constructs, 9 turned out to be significant. Considering these 9 relationships can help the Danish Regions to attract private medico companies to engage in the pre-commercial stage of the two-stage model. Particularly interesting is it to find that the additional construct, *Manager Motivation*, derived from the preliminary interviews is significant. This supports the methodological decision to apply complementarity as a way to increase the contribution of the study.

Regarding the robustness of the structural equation model, the level of both reliability and validity for the reflective measurement model and the structural model is satisfactory. Using these findings for further research, one should keep in mind that the sample might not be representative.

## Chapter 10 Conclusion

This thesis has investigated the recent concept of Public-Private Innovation (PPI). By taking a private perspective to PPIs, the study contributes to the gap in the cross-section of literature on Systems of Innovation, PPIs, and Strategic Alliance Theory.

Initiated by the societal challenges within the Danish healthcare sector, the purpose of the study has been to identify the factors influencing the *Propensity of Private Medico Companies Engaging in Pre-commercial PPIs with the Danish Regions*. The motivation for identifying these factors has been to gain some insights on what factors to address in order to diminish the identified attraction problem of the two-stage model proposed by the Danish Regions. The problem of attraction broadly represents companies' concern about the return on their resource investment, which is influenced by aspects like their chance of qualifying for a commercial tender.

Drawing upon a conceptual framework proposed by Sambasivan et al. (2013), a structural equation model was set up to explain the *Propensity of Private Medico Companies Engaging in Pre-commercial PPIs with the Danish Regions*. Based on a number of preliminary interviews, it was possible to modify the framework to better fit a PPI context. In fact, the empirically tested model is able to explain 78.2% of the variance of *private medico*

*companies' propensity of engaging in pre-commercial PPIs*. Statistically testing the model revealed that the following factors have a significant effect on the propensity to engage:

- *Environment*
- *Strategic Alliance Motive*
- *Asset Specificity*
- *Perception of Opportunistic Behaviour*
- *Interdependence*
- *Relational Capital*
- *Manager Motivation*.

Among these factors, Manager Motivation turned out to have the largest effect on the propensity to engage.

Furthermore, a simultaneous test of the structural paths among the factors showed that *Propensity of Private Medico Companies Engaging in Pre-commercial PPIs with the Danish Regions* is directly affected by *Perception of Opportunistic Behaviour*, *Manager Motivation* and *Relational Capital* and indirectly affected by *Interdependence*, *Asset Specificity*, *Strategic Alliance Motive* and *Environment*. Thus, it is paramount for the two-stage model to be effective in handling the societal challenges of the Danish healthcare system and that the Danish Regions address these identified factors in their strategies.

Finally, due to the non-probabilistic sampling approach, it should be noted that the results might not be fully representative for the population of Danish private medico companies.

## **Chapter 11 Implications in an International Perspective**

As the proposed structural model explains 78.2% of the variance in private medico companies' propensity of engaging in pre-commercial PPIs with the Danish Regions, the Regions are provided with valuable insights about influential factors and their mutual relationships. These insights are believed to make the Regions capable of preparing initiatives to better attract the companies to engage in a two-stage PPI alliance as part of their strategic planning of innovation objectives. Knowing what factors to address during the strategic process of developing better PPI models is considered first order implications of the findings of this study, whereas the positive effects of taking initiatives to address the important factors are considered second order implications of the findings. The second order implications will introduce an international perspective of the findings.

### **11.1 First Order Implications**

As already implied, the first order implications of the findings are the implications of having the Danish Regions incorporating the identified factors in their process of creating more and better innovation in the healthcare sector. Referring to the delimitation of the study, the implications are discussed at a strategic level, considering long-term actions and therefore no

operational recommendations are given as to how day-to-day decisions can be taken to improve the PPI environment.

Looking at the seven factors that are important for explaining private medico companies' propensity of engaging in pre-commercial PPIs with the Danish Regions, four of them are believed to be susceptible to influence by the Regions in a longer time horizon.

#### **11.1.1 Strategic Alliance Motives**

Knowing how *Strategic Alliance Motive* influence both *Interdependence* and *Relational Capital* and thus indirectly the private companies' propensity of engaging, work should be done to better comply with these motives. Generally, the Regions are advised to communicate more clearly the prospects of a commercial tender and specifically in dealing with SMEs, there should be a stronger focus on the basis for a viable business model.

#### **11.1.2 Perception of Opportunistic Behaviour**

As Denmark is the least corrupt country in the world, it is a bit surprising to find that *Perception of Opportunistic Behaviour* represents some important considerations for private companies to enter strategic alliances with the Danish Regions (Transparency International 2012). Acknowledging that *Perception of Opportunistic Behaviour* affects the private companies' propensity of engaging both directly and indirectly through *Interdependence* and *Relational Capital*, steps should be taken to try to diminish, for instance, the level of information asymmetry and thereby earn legitimacy. One way of doing this could be to report some examples of best practice.

#### **11.1.3 Relational Capital**

In continuation of the advice to take steps to earn legitimacy, the resulting image improvements of the Regions is believed to signal better conditions for building trust and commitment and thereby add to the perception of the willingness to build stronger *Relational Capital*. Thus, the Regions cannot do anything to directly influence *Relational Capital* as it is build during the lifecycle of an alliance, however initiatives can be taken to provide more clarity about the process of partner elimination and thereby add positively to the perception of communication.

#### **11.1.4 Manager Motivation**

If improved, communication and information sharing also add positively to the motivation of the managers, which turned out to be a very influential factor in explaining private companies' propensity of engaging in PPIs. Specifically, part of the initiatives taken to improve the level of communication and information sharing could be to reach out to the managers in the companies and thereby raise the level of personal engagement.



The next paragraph presents a discussion of the international implications that it would have if the Regions succeed in attracting more companies to engage in pre-commercial PPIs.

## **11.2 Second Order Implications**

The notion that a Danish study like this will have implications reaching beyond a national level is backed by the belief that the Danish medico industry is one of the most important clusters in the global market for medical equipment (Riis 2005).

### **11.2.1 Improved International Competitiveness**

Assuming that the Danish Regions consider the insights provided and take the steps necessary to attract more companies to engage in PPIs, the level of innovation in the industry presumably will increase. Referring to the introduction of the medico industry innovation is key in maintaining and improving the competitiveness of the companies in an industry with a high technology level and very short product lifecycles. For that reason it is reasonable to assume that an increased level of innovation will manifest itself in an increased level of competitiveness, given the assumption that the demand for medical equipment is fairly homogeneous. According to the definition of medical equipment and the export figures in chapter 3, this seems to be the case. Under the same assumption of homogeneous demand, improved competitiveness will increase exports, everything else held constant.

### **11.2.2 Export Fostering**

To strengthen the international competitiveness of the Danish companies is highly prioritised in the current discussion on the socioeconomic challenges of Denmark. According to the Ministry of Research, Innovation and Higher Education, the global demand for new solutions is increasing and therefore the societal challenges constitute an export potential for those countries and companies that are capable of creating durable solutions to these (Ministeriet for Forskning, Innovation og Videregående Uddannelser 2013b). Adding to this, the former Danish Minister for Trade and Investment, Pia Olsen Dyhr, stresses in an article published by Medwatch how there is an unexploited export potential in the Danish medico industry (Munksgaard 2012). According to the minister, the export of medical equipment is simply too small given its potential. Historically, the Danish medico companies have been known for their high quality products and as the demand for such products is increasing, Pia Olsen Dyhr suggests that initiatives are to be taken by the Danish government to foster exports of medical equipment.

In a report prepared by Dansk Industri it is stressed how providing favourable home market conditions when trying to foster exports (2012). If the Danish companies get the chance to gain some experiences of providing solutions to welfare challenges of the public sector it can provide the basis for the global companies of tomorrow (Dansk Industri, 2012). Therefore, having introduced and concluded this study on PPI by accentuating how innovation in the

## **PRE-COMMERCIAL PUBLIC-PRIVATE INNOVATION IN HEALTHCARE**

### **Chapter 11 Implications in an International Perspective**

#### **11.2 Second Order Implications**

healthcare sector is a hot topic in the debate of the societal challenges currently faced, it is highly advisable that the Danish Regions consider the insights provided under *first order implications*. Doing so will improve both the solutions provided in the Danish Healthcare sector as well as the international competitiveness of the medico companies.

## Literature List

Arbnor, I. & Bjerke, B. 2009, *Methodology for Creating Business Knowledge*, 3rd edn, SAGE Publications Inc, Los Angeles, London, New Dehli, Singapore, Washington DC.

Arlbjørn, J.S. & Freytag, P.V. 2012, "Public procurement vs private purchasing: Is there any foundation for comparing and learning across the sectors?", *International Journal of Public Sector Management*, vol. 25, no. 3, pp. 203-220.

Bos, L. 2006, *Pre-commercial Procurement of Innovation- A missing link in the European Innovation Cycle*, European Commission, Brussels.

Capacent 2009, *Analyse af Offentlig-Privat Samarbejde om Innovation*, Erhvervs- og Byggestyrelsen, Copenhagen.

Chin, W.W. 2002, *Partial Least Squares for researchers: An overview and presentation of recent advances using the PLS approach*, Slide show edn, s.n., Houston.

Damvad, 2011, *Innovative Public Procurement and Health Care*, Nordic Council of Ministers, Copenhagen.

Danish Rehabilitation Industry n.d, *Medlemmer i DRG* [Homepage of Danish Rehabilitation Industry], [Online]. Available: <http://www.rehabgroup.dk/00016/> [2013, 10/04].

Danmarks Statistik 2013, *Nationalregnskab 4. kvat. 2012*, Danmarks Statistik, København.

Dansk Industri 2012, *Offentlig-Privat Samarbejde - Redegørelse 2012*, Dansk Industri, Copenhagen.

Danske Regioner 2013, 03/19-last update, *Sundhed - Regionerne arbejder for et sundhedsvæsen i verdensklasse* [Homepage of Danske Regioner], [Online]. Available: <http://www.regioner.dk/Sundhed.aspx> [2013, 04/01].

Das, T.K. & Teng, B. 2001, "Trust, Control, and Risk in Strategic Alliances: An Integrated Framework", *Organization Studies*, vol. 22, pp. 251-283.

Diamond, P. 2012, *The Grey Tsunami - How to Reap a Healthy Longevity Dividend*, 1st edn, New Statesmen, <http://www.newstatesman.com/blogs/economics/2012/04/grey-tsunami>.

Edquist, C. 2006, 7. *Systems of Innovation: Perspectives and Challenges*, Oxford, England ; Oxford University Press, Oxford.

Edquist, C. & Zabala-Iturriagoitia, J.M. 2012, "Public Procurement for Innovation as mission-oriented innovation policy", *Research Policy*, vol. 41, no. 10, pp. 1757-1769.

Erhvervsstyrelsen n.d., *Det centrale virksomhedsregister* [Homepage of Erhvervsstyrelsen], [Online]. Available: <http://www.cvr.dk/Site/Forms/CMS/DisplayPage.aspx?pageid=0> [2013, 07/15].

## PRE-COMMERCIAL PUBLIC-PRIVATE INNOVATION IN HEALTHCARE

### Literature List

#### 11.2 Second Order Implications

- Eucomed Medical Technology n.d.a, *Innovation, Research & SMEs* [Homepage of Eucomed Medical Technology], [Online]. Available: <http://www.eucomed.be/key-themes/innovation-research-smes> [2013, 08/28].
- Eucomed Medical Technology n.d.b, n.d, *What Medical Technology Excatly is* [Homepage of Eucomed], [Online]. Available: <http://www.eucomed.be/medical-technology> [2013, 08/27].
- Fagerberg, J., Fosaas, M. & Sapprasert, K. 2012, "Innovation: Exploring the knowledge base", *Research Policy; Exploring the Emerging Knowledge Base of 'The Knowledge Society'*, vol. 41, no. 7, pp. 1132-1153.
- Fritz, A.E., Morgan, G.A. & SAGE Publications, I. 2010, *Sampling. Encyclopedia of Research Design. SAGE Publications, Inc.* [Homepage of SAGE Publications], [Online]. Available: <http://knowledge.sagepub.com.esc-web.lib.cbs.dk/view/researchdesign/n398.xml> [2013, 06/29].
- Haenlein, M. & Kaplan, A.M. 2006, "A Beginner's Guide to Partial Least Squares Analysis", *Understanding Statistics*, vol. 3, no. 4, pp. 283-297.
- Hair, J.F., Sarstedt, M., Ringle, C.M. & Mena, J.A. 2012, "An assessment of the use of partial least squares structural equation modeling in marketing research", *Journal of the Academic Marketing Science*, vol. 40, pp. 414-433.
- Hair, J.F., Anderson, R.E., Tatham, R.L. & Black, W.C. (eds) 1998, *Multivariate Data Analysis*, 5th edn, Prentice Hall, New Jersey.
- Hulland, J. 1999, "Use of partial least squares (PLS) in strategic management research: a review of four recent studies", *Strategic Management Journal*, vol. 20, pp. 195-204.
- Jensen, J.M. & Knudsen, T. 2006, *Analyse af spørgeskemadata med SPSS*, 1st edn, Syddansk Universitetsforlag, Odense.
- Jepsen, A.L. 2008, "Anvendelse af skalaer til måling af sociale fænomener" in *Valg der skaber viden - om samfundsvidenskabelge metoder*, ed. S. Voxted, pp. 129-139.
- Kale, P. & Singh, H. 2009, "Managing Strategic Alliances: What Do We Know Now, and Where Do We Go From Here?", *Academy of Management Perspectives*, vol. 23, no. 3, pp. 45-62.
- Lavrakas, P.J. & SAGE Publications, Inc 2008a, *Questionnaire. Encyclopedia of Survey Research Methods. SAGE Publications, Inc* [Homepage of SAGE Publications], [Online]. Available: <http://knowledge.sagepub.com.esc-web.lib.cbs.dk/view/survey/n424.xml?rskey=Zr1pOI&row=5> [2013, 08/03].
- Lavrakas, P.J. & SAGE Publications, I. 2008b, - *Internet Surveys. Encyclopedia of Survey Research Methods. SAGE Publications, Inc.*, SAGE Publications, s.i.

Lui, S.S., Wong, Y. & Liu, W. 2009, "- Asset specificity roles in interfirm cooperation: Reducing opportunistic behavior or increasing cooperative behavior?", *Journal of Business Research*, vol. 62, no. - 11, pp. - 1214-1219.

Lundvall, B. 1992, *National Systems of Innovation. Toward a Theory of Innovation and Interactive Learning*, Pinter, London.

Medicoindustrien n.d., *Fakta om Branchen* [Homepage of MedicoIndustrien], [Online]. Available: <http://www.medicoindustrien.dk/Default.aspx?ID=3714> [2013, 08/27].

Medicoindustrien n.d, *Medlemmer* [Homepage of MedicoIndustrien], [Online]. Available: <http://www.medicoindustrien.dk/Default.aspx?ID=11281> [2013, 10/04].

Medicoindustrien 2008, *Medicoindustrien i tal - Brabchestatisik 2007*, Medicoindustrien, s.i.

MedTech Europe 2013, *Graphics* [Homepage of MedTech Europe], [Online]. Available: <http://www.medtecheurope.org/key-themes/legislation/mdd-revision/visuals> [2013, 08/28].

Ministeriet for Forskning, Innovation og Videregående Uddannelser 2013a, 03/25-last update, *Innovationsstrategi* [Homepage of Ministeriet for Forskning, Innovation og Videregående Uddannelser], [Online]. Available: <http://fivu.dk/aktuelt/temaer/innovationsstrategi> [2013, 08/13].

Ministeriet for Forskning, Innovation og Videregående Uddannelser 2013b, 06/04-last update, *Samfundsudfordringer skal drive innovation* [Homepage of Ministeriet for Forskning, Innovation og Videregående Uddannelser], [Online]. Available: <http://fivu.dk/aktuelt/temaer/innovationsstrategi/samfundsudfordringer-skal-drive-innovation> [2013, 08/12].

Ministeriet for Forskning, Innovation og Videregående Uddannelser 2012, 12/14-last update, *Samfundsudfordringer skal drive innovationen* [Homepage of Ministeriet for Forskning, Innovation og Videregående Uddannelser], [Online]. Available: <http://fivu.dk/aktuelt/pressemeddelelser/2012/samfundsudfordringer-skal-drive-innovationen> [2013, 08/13].

Ministeriet for Sundhed og Forebyggelse 2013, *Cirkulære om afgrænsning af behandlingsredskaber, hvortil udgiften afholdes af sygehusvæsenet*, Circular edn, CIR no. 9079, Copenhagen.

Munksgaard, K.M. 2012, 11/15-last update, *Minister opfordrer medico-firmaer til øget samarbejde* [Homepage of MedWatch], [Online]. Available: [http://medwatch.dk/secure/Medico\\_Rehab/article4908723.ece](http://medwatch.dk/secure/Medico_Rehab/article4908723.ece) [2013, 06/21].

Nelson, R.R. 1993, *National innovation systems, a comparative analysis*, Oxford University Press Inc., New York.

## PRE-COMMERCIAL PUBLIC-PRIVATE INNOVATION IN HEALTHCARE

### Literature List

#### 11.2 Second Order Implications

Nikolova, N. 2008, *Opportunistic Behavior*. *International Encyclopedia of Organization Studies*. SAGE Publications, Inc [Homepage of Sage Publications], [Online]. Available: <http://knowledge.sagepub.com/view/organization/n345.xml> [2013, 04.24].

OPI-Lab, Living Lab Denmark, Rønne & Lundgren Advokatfirma, Poul Schmidt/Kammeradvokaten & OPI-Labs juridiske arbejdsgruppe 2012, *OPI-Aftale 1A*, OPI-Lab, s.i.

Parker, D. & Hartley, K. 2003, "Transaction costs, relational contracting and public private partnerships: a case study of UK defence", *Journal of Purchasing and Supply Management*, vol. 9, no. 3, pp. 97-108.

Peter, J.P., Olson, J.C. & Grunert, K.G. (eds) 1999, *Consumer Behaviour and Marketing Strategy*, McGraw Hill, s.i.

Rambøll Management Consulting A/S n.d, *Survey Xact* [Homepage of Rambøll Management Consulting A/S], [Online]. Available: <http://www.surveyxact.com/> [2013, 06.08].

Region Hovedstaden 2013a, 07/12-last update, *Innovation* [Homepage of Region Hovedstaden], [Online]. Available: <http://www.regionh.dk/topmenu/omRegionH/denAdministrativeRegion/Videncenter+for+Innovation+og+Forskning/Innovation.htm> [2013, 08/15].

Region Hovedstaden 2013b, 07/12-last update, *Videncenter for Innovation og Forskning* [Homepage of Region Hovedstaden], [Online]. Available: <http://www.regionh.dk/topmenu/omRegionH/denAdministrativeRegion/Videncenter+for+Innovation+og+Forskning/> [2013, 08/15].

Region Hovedstaden 2012, *Region Hovedstandens model til Offentlig-Privat Innovation i Sundhedsvæsenet*, Region H, Copenhagen.

Riis, A.M. 2005, *Brugerdreven innovation i medicobranschen*, Økonomi- og Erhvervsministeriets enhed for økonomiske forskning og analyse, FORA, Copenhagen.

Ruff, S.A. & Jacobsen, E. 2012, *Healthcare Innovation Lab - Brugerdreven sundhedsinnovation via simulation inden for byggeri, produktudvikling og services*, Center for Sundhedsinnovation, Region Hovedstaden, Herlev.

Salkind, N.J. & SAGE Publications, Inc 2010, *Literature Review. Encyclopedia of Research Design*. SAGE Publications, Inc [Homepage of SAGE Publications], [Online]. Available: <http://knowledge.sagepub.com.esc-web.lib.cbs.dk/view/researchdesign/n222.xml?rskey=aJhdCS&row=1> [2013, 09/09].

Sambasivan, M., Siew-Phaik, L., Abidin Mohamed, Z. & Choy Leong, Y. 2013, "Factors influencing strategic alliance outcomes in a manufacturing supply chain: Role of alliance motives, interdependence, asset specificity and relational capital", *International Journal of Production Economics*, vol. 141, no. 1, pp. 339-351.

## PRE-COMMERCIAL PUBLIC-PRIVATE INNOVATION IN HEALTHCARE

### Literature List

#### 11.2 Second Order Implications

Sullivan, L.E. & SAGE Publications, Inc 2009, 12/16-last update, *Taxonomies. The SAGE Glossary of the Social and Behavioral Sciences. SAGE Publications, Inc* [Homepage of SAGE Publications Inc.], [Online]. Available: <http://knowledge.sagepub.com.esc-web.lib.cbs.dk/view/behavioralsciences/n2521.xml> [2013, 09/21].

Todella, E. & Knoke, D. 2005, "Strategic Alliances and models of collaboration", *Management decision*, vol. 43, no. 1, pp. 123-148.

Transparency International 2012, *Corruption Perception Index 2012* [Homepage of Transparency International], [Online]. Available: <http://www.transparency.org/cpi2012/results> [2013, 04/30].

Vinzi, V.E., Chin, W.W., Henseler, J. & Wang, H. 2010, *Handbook of Partial Least Squares - Concept, Methods and Applications*, Springer, Berlin.

Witters, L., Marom, R. & Steinert, K. 2012, "The Role of Public-Private Partnerships in Driving Innovation" in *The Global Innovation Index 2012*, ed. S. Dutta, 5th edn, INSEAD, WIPO, France, pp. 81-88.