Paper to be presented at the DRUID 2012

on

June 19 to June 21

at

CBS, Copenhagen, Denmark,

How Valuable Is Your Partnership? A Framework for Valuing Public-Private Research Partnerships in Biomedical Sciences

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Abstract

An increasingly occurring approach is partnering by setting up so-called Public Private Research Partnerships (PPRPs) for pre-competitive research. Value measurement of these PPRPs in biomedical sciences is an unexplored topic in literature, although value measurement is critical to justify the huge public investments and also asses the value of the role of PPRPs to overcome the existing R&D bottlenecks. This research is set up to find answer on the research question: ?How can a Public Private Research Partnership in the field of biomedical sciences be valued??. Based on expert-interviews and a workshop with stakeholders a list of 14 indicators is proposed, in which a division is made between Input, Process, and Performance indicators (which are divided into Output and Outcome), thereby covering the whole system. Although the proposed framework of indicators to measure value heavily depends on the availability of relevant information, it may serve as a standard approach to demonstrate the value of collaborative research undertaken by PPRPs.

Jelcodes:O32,L14

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Key words: Public-Private Partnerships, Research Partnerships, Open Innovation

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Introduction

Increasing R&D costs and a decreasing number of New Chemical Entities (NCEs) launched by pharmaceutical companies have been a major concern for the (bio)pharmaceutical sector in recent years. This implicates that societal needs are decreasingly being met and innovative activity, which enhances the economy, is declining; an incentive for governments to also seek for solutions for the decreasing output of pharmaceutical companies. These issues create an environment where these actors seek the right approach to fill the pipeline and maintain their competitive advantage. An increasingly occurring approach is partnering by setting up so-called Public Private Research Partnerships (PPRPs) for pre- competitive research. Initiatives like the European Innovative Medicines Initiative (IMI) and the Dutch Top Institute Pharma (TI Pharma) are two prime examples, and are subject of the research described in this thesis.

To asses whether PPRPs succeed in their approach of collaboration and achieving their targets, management and measurement of these processes is essential in value creation by PPRPs. Value measurement of PPRPs in biomedical sciences is an unexplored topic in literature, although value measurement is critical to justify the huge public investments and also asses the value of the role of PPRPs to overcome the existing R&D bottlenecks. Moreover, value measurement of PPRPs helps to identify best practices. Therefore, this research is set up to find answer on the research question: “How can a Public Private Research Partnership in the field of biomedical sciences be valued?”

Although the drivers to participate may differ for each of the stakeholders, the main reason to participate in a PPRP is to have an advantage over non-collaborative business or research. These advantages lie in risk sharing, access to knowledge, human and financial resources and the effective use of the network function the PPP provides.

Nonetheless, for a PPP to create value, one should overcome challenges that characterize collaboration. These challenges include the management of different organizational cultures, dissimilar time horizons, issues related to IP sharing, the transparency of research findings and adapting strategies. Furthermore, PPPs operate in a challenging environment due to long timelines of R&D processes, high costs, a global playing field and the multitude of required background knowledge.

Public Private Partnerships

A Public Private Partnership in its broadest definition is any form of intended collaboration between public and private parties, as described by Bennett and Iossa (2006) and McQuaid and Scherrer (2010). However, the definition of a PPP which is used in this thesis and which best touches upon underlying theory is: "*a strategic relationship of durable character between public and private actors in which resources, risks and rewards are shared aimed to create synergy"* (Wolthuis, 2009).

Organizations involved in a PPP conduct and/or sponsor research and development (Link, 2002). Therefore, a PPP could be illustrated by the Triple Helix Model of University – Industry – Government Relations, in which a PPP can be considered as a hybrid organizations active in the interface between all stakeholders (Etzkowitz 2000).

The roles of the three main stakeholders included in the Triple Helix Model differ from the traditional, more individualistic ones and the stakeholders. Universities encompass a proactive position in converting knowledge to commercial use and also in extending the conversion of input into academic knowledge. Companies become more academic by increasing their technological level, and participating more in training providence and sharing of knowledge. Governments increasingly take on the role of entrepreneur and venture capitalist and still set the rules of the game. Hence, PPPs comprise a reciprocal relation between research, economic, and social activities (Etzkowitz, 2003).

Drivers for Participation and Challenges in Public Private Research Partnerships

The main reason to participate in a PPRP is to have a cost advantage and/or significant other advantages over continuing business or research without collaborating (Hagedoorn, 2000). Consequently, the drivers found to be essential in the knowledge-based and resource-based theories are similar to the drivers found in academic literature on PPPs. Four domains can be identified from the list of drivers to participate in collaborative research and could cover the framework of indicators. These domains include knowledge, financials, human capital, and networks. The projected result of partnering is to decrease the time to launch a product and moreover to reduce the time to break-even. Hence, there are clear potential benefits to establish a partnership; however there are also challenges for parties involved in PPPs to overcome. Challenges include the management of different organizational cultures, different time horizons, issues related to IP division, the transparency of research findings and adapting strategies (Bammer, 2008; Dooley, 2007; Hagedoorn, 2000; Mazouz, 2008; Nwanka, 2003; Tijssen, 2004). The difference in culture between parties can cause barriers and delays in the collaboration process. Possibly impeding elements of culture include the objectives of the project, timescale and incentive system. Furthermore, academic researchers aim to publish

their work, while industry researchers try to keep findings confidential to protect intellectual property rights and possibly retain competitive advantage. Trust and also detailed contracts can help overcome these issues (Dooley, 2007).

The possible advantages and challenges related to a PPRP as previously described are derived from literature and mainly describe researches undertaken outside the field of biomedical sciences. Although the impact of the advantages and challenges regarding a PPRP can differ per industry, they are also largely applicable in the field of biomedical sciences. The interviews with experts in the field of Biomedical sciences held for this research confirm this statement.

Factors Influencing Successfulness of Public Private Research Partnerships

Trust and Commitment

Trust is one of the most frequently mentioned factors linked to inter-firm cooperative relations (Grandori, 1995). Here, trust is defined as the willingness to accept vulnerability based upon having positive expectations about other people's intentions and behaviours in situations which are interdependent and/or risky (Rousseau, 1998). Further, commitment is defined as "the desire to continue the relationship and ensure its continuance" (Wilson, 1995). Plewa and Quester (2007; 2008) show that trust and commitment have a positive influence on satisfaction of employees in industry-university collaborations. Furthermore, the studies show that personal experience can positively result in engagement, which can have a positive influence on commitment (Plewa, 2007; 2008). Personal engagement is defined here as the enthusiasm and intrinsic motivation of a person. Commitment of employees and employees' satisfaction are claimed to be factors which have a significant impact on the successfulness of industry-university collaborations to create value (Plewa, 2008). Social capital plays a vital

role in creating value in partnerships, also according to Hitt et al. (2003) and Yli-Renko et al. (2001). Social capital is defined in these studies as: "advantage gained through access to social networks and corresponding relationships". One of the challenges found to influence the successfulness of a PPP is the considerable difference in organizational culture between public and private organizations. However, Davenport et al. (1999) found that trust can decrease the impact of these differences. This is partly due to trust reducing perceived risk associated with participation in research partnerships (Ven, 2006).

Knowledge Exchange

Knowledge is found to be an essential element of economic growth besides physical capital and labour. By transforming knowledge into products and processes it can be considered as commercially exploitable (Mueller, 2006). Furthermore, knowledge enables the use of new knowledge, potentially resulting in new opportunities (Powell, 1996). Collaboration in research potentially results in access to supplementary knowledge (Powell, 1996). Additionally, the firm's ability to integrate external knowledge effectively (Spender, 1996) and more specifically the capability to integrate and organize this knowledge in support of innovation projects and processes are factors that can influence the firm's performance significantly (Su, 2007). According to Chesbrough (2006), managers of pharmaceutical companies need to develop a capability to identify, incorporate and utilize the public science knowledge base often freely available in order to increase innovative performance. Experience in prior research partnerships can positively influence knowledge exchange by generating knowledge and capabilities on how to communicate and collaborate following learning processes (Cyert, 1997). Furthermore, increased proximity of all parties involved in a public private partnership facilitates knowledge transfer (Feldman, 2006).

The stickiness of knowledge is related to ease in which it can be transferred (Hippel, 1994). A significant share of knowledge in the biomedical sciences is instinctive or tacit, rendering the mission to collaborate and learn collectively particularly complicated (Pisano, 2006).

Communication includes information sharing both internally and across an organization's boundaries regarding the formal and informal activities of an organization. An UNESCO-sponsored international study of innovation in teams showed that the level of communication both within and between research teams had a significantly positive effect on the number of publications, R&D effectiveness, scientific recognition of their teams and applied value of their work (West, 2002). Several scholars have noted that the degree of exchange of both tangible and intangible including tacit knowledge is of significant influence on the successfulness of research partnerships (Bjerregaard, 2009; Davenport, 1999; Philbin, 2008). Frequent interaction and mutual trust built by social capital are factors that impact this degree of knowledge exchange extensively (Bjerregaard, 2009; Davenport, 1999; Philbin, 2008). Santoro et al. (2006) show a similar relation between the various stakeholders in university-industry research partnerships outside the Biomedical industry.

Intellectual Property

Patents have dissimilar meanings in different industries. The biomedical industry is a field in which patents play a critical role to protect innovations (Arora, 2008; Lehman, 2003). Intellectual property protection mechanisms are especially important to research partnerships since knowledge exchange is crucial for its successfulness (Hertzfeld, 2006). Patents are often shared among competitors in for instance the electronic industry through cross licensing. This sharing is required since a particular product contains various patented technologies. Nonetheless, in the biomedical industry the patent generally equals the product, and thus protects the huge amounts of investments in research and development required to discover

and ultimately launch a drug (Lehman, 2003). Hence, the technology transfer-intellectual property policies and capabilities of the parties involved in a PPRP can be of a more considerable impact on strategy in the biomedical industry than in other industries. This generally results in the term ‘open innovation’ as being reflected less ‘open’ in biomedical sciences than in other industries, meaning that exchange of knowledge is related to financial potential, particularly in later phases of development. Hence, a pharmaceutical company strives to form detailed IP contracts (tipharma).

Champions

Furthermore, various scholars have highlighted the pivotal role that champions can play in the successful implementation of an idea (Howell, 2004). The definition of Plewa and Quester (2008) is used here; a champion is “a staff member or group pushing a project forward as well as overtaking the role of informing and communicating with both relationship sides. He/she has the ability to promote and to influence an idea, project or relationship, and possesses the enthusiasm and intrinsic motivation to succeed”. The study conducted by Plewa and Quester (2008) showed a minimal effect of champions on trust and commitment. Hence, the considerable role of champions should be explained by other mechanisms which is an interesting topic to be researched in future. Contextual knowledge is expected to be one of the factors that plays a role in this (Howell, 2004). Personnel exchange between various stakeholders can enhance the contextual knowledge of the involved employees. Champions cannot be assigned and it is hard to identify them, but the likelihood that champions develop can be stimulated (Howell, 2004). Therefore, it is decided not to process champions in the framework of indicators presented later in this thesis, but only the factors that enhance the development of champions.

The quality of the partnerships significantly influences the performance of these alliances. Given the complex organizational and operational issues that arise in the course of developing and managing these partnerships, partners need to be aware of the merits and limitations of these partnerships. Success in these linkages requires the partners to develop specific managerial and administrative competencies, which is a time-consuming process. Companies that do not have these skills may not fully gain the benefits associated with these linkages (George, 2002). Therefore mediating bodies in public private partnerships can play a crucial role.

The theory regarding factors that influence the successfulness of a PPRP are derived from literature mainly describing researches undertaken outside the field of biomedical sciences. Although the impact of factors on successfulness of a PPRP can differ per industry, they are also largely applicable in the field of biomedical sciences. The interviews with experts in the field of Biomedical sciences also confirm this statement.

Value Measurement of Public Private Research Partnerships in Biomedical Sciences

The value of a Public Private Research Partnership can be assessed by measuring the alteration in performance of the various stakeholders when participating. This performance increase or decrease can be measured using various indicators of which the importance can differ per stakeholder.

Sinclair and Zairi (2000) point out the importance of balancing the set of performance measures used, including both financial and non-financial measures. Focus on a single performance measure can result in unintended outcomes, as performance could then be maximized against that particular measure, and can damage overall performance. In addition

to that, Osborne (2000, ch.17) states that it is very difficult to set unambiguous outcome measures to evaluate PPRPs that are accurately linked to the objectives set in advance. Moreover, Osborne (2000, ch.17) writes that focus on i.e. output measures which evaluate quantity can deteriorate quality. Therefore, this author states that evaluation systems of PPRPs should include both process measures and outcome measures.

Process indicators can be used to evaluate crucial tasks and present timely feedback. Performance indicators can be used to evaluate the achievements concerning the objectives set. Key performance indicators at the organizational level should be based on Critical Success Factors. Critical Success Factors can be defined as "the few key areas where 'things must go right' for the organization to flourish" (Sinclair, 2000).

Dixon et al. (1990) describe five features of a successful performance measurement system. According to these scholars, measurement systems should:

1. be mutually accommodating and consistent with an organization's operating objectives, targets, programs and critical success factors;
2. communicate information through as little and as simple a set of indicators as possible;
3. disclose how effectively expectations are fulfilled;
4. include a range of measurements for every organizational section that facilitate all members of the organization to comprehend how their decisions and activities influence the entire organization;
5. support managerial learning and incessant improvement.

Experience in Collaboration

An UNESCO-sponsored international study of innovation in teams showed that diversity in projects, interdisciplinary orientations, specialties, funding resources, R&D activities, and professional functions, which shows major similarities to the project teams managed by TI Pharma, resulted in a 10 percent increase in scientific recognition, R&D effectiveness, and number of publications (West, 2002).

Grimsey and Lewis (2005) show that PPPs in the engineering industry resulted in a three time increase of large projects delivering on time and to budget. Furthermore, Beyer and Browning (1999) describe SEMATECH, which is a pre-competitive research partnership in the semiconductor industry. SEMATECH was established in the US to facilitate US semiconductor companies to gain market share since Japanese competitors were taking over their market share. The outcome of the partnership was obvious: the market share of US semiconductor companies increased from 37% to 48% in 5 years.

Although the engineering and semiconductor industries are incomparable with the biomedical industry, which means that these results are thus not representative for the biomedical industry, it shows the potential synergies that can occur by partnering in a high-tech industry.

Although only little research is undertaken in the field of value measurement of collaboration in the biomedical industry, some research findings are provided here that can facilitate benchmarking and also target setting. A study undertaken by UNU-MERIT on behalf of the Association of European Science and Technology Transfer Professionals (ASTP) showed that on average, in many different types of industry, €1 million in research generates the output listed in Table 2.

--- Insert Table 2 about here ---

The results of the study provide an indication of the level of investment in public research that is required to produce outcomes such as a spin off or a patent with commercial potential.

Although the data of ASTP include many different industries and are therefore not directly representative for the biomedical sciences, data from the Netherlands Genomics Initiative (NGI) showed that a biomedical research institute generates a number of patent applications equalling the international survey for public research. NGI is a Dutch organisation that covers research regarding the complete chain from basic science to applied research and development in the field of healthcare, agriculture, sustainability and safety (NGI, 2007). These findings showed that NGI created 0.19 patent applications, 0.07 licenses, and 0.02 spin-offs per €1 million invested in research. Important to know is that NGI was founded in 2002 and these numbers are only from the first period of operation. NGI is expected to grow in the upcoming years regarding efficiency and effectiveness in research.

Quantification of performance indicators in this document are based on previous experiences with partnerships in other high-tech environments and preliminary results of partnerships in the biomedical sector. These numbers provide an indication of what could be expected of the performance of public-private partnerships, but what is desirable should ultimately be decided by all stakeholders.

Methodology

Research Strategy

The framework will be mainly built upon existing theory and will be extended and refined by knowledge gained through interviewing managers and researchers closely involved to the research partnerships TI Pharma and IMI. A survey will be sent to the participants before a workshop is organized so that the survey results can also be discussed at the workshop. Then, a workshop will be organized where experts will discuss the initial framework, the survey results and give input. Finally, the list of indicators will be further validated using the management information regarding the current evaluation system at TI Pharma.

Unit of analysis

The case unit analysis will concern the PPRP TI Pharma. Top Institute Pharma (TI Pharma) is a research consortium that employs over 500 PhD students and post-docs. TI Pharma's strategic R&D program capitalizes on the public and private Dutch knowledge infrastructure and is aimed at shortening the drug development trajectory and reducing the risk of clinical failure of potential new medicines. At the moment of writing, approximately 50 running projects are supported and organized by TI Pharma. At least 3 different parties are cooperating in a project, of which at least one university. Between the different projects no knowledge is exchanged without a contract being prepared, this is to prevent confidential information being transferred to another party without return (Tipharma).

TI Pharma's current partners are major academic research and medical centres in Amsterdam, Rotterdam, Utrecht, Leiden, Nijmegen, Groningen and Maastricht, leading research institutes in The Netherlands, including the Dutch Cancer Institute (NKI, Amsterdam), Hubrecht Laboratory (Utrecht), Netherlands Vaccine Institute (NVI, Bilthoven), and TNO (Applied

Scientific Research), also Small and medium-sized biopharmaceutical companies such as IQ Corporation, OctoPlus, Pepscan Systems and Pharming, and moreover, global pharmaceutical companies such as AstraZeneca, GlaxoSmithKline, Merck, Novartis, Numico, Organon, Pfizer and Solvay (Tipharma).

Expert Interviews

First, qualitative expert interviews are used to improve the theoretical framework. The experts interviewed include:

- 2 lower managers TI Pharma
- 1 middle manager TI Pharma
- 1 top manager TI Pharma
- 1 middle manager Life Sciences Health (LSH)
- 1 middle manager from the Ministry of Economic Affairs of The Netherlands; Manager Life Sciences, Food, Health and Water of the NL Agency
- 1 top manager of GlaxoSmithKline (GSK) Pharmaceuticals; Vice President External Scientific Collaborations Europe
- 1 top manager of the University of Leuven; the Rector Magnificus

The interviews were set up in a way that the interviewee read the list of indicators beforehand. Subsequently, the background was presented regarding the creation of this list of indicators. Then, we discussed which indicators are most important for the interviewee and the party he was working for and what elements the interviewee missed. After the interviewee recommended to add an indicator, extra literature was searched regarding that specific indicator. This literature is also presented in the chapter describing the results from the interviews.

Workshop

The framework formed using theory and information derived from interviews with experts was the main input of discussion at the organized workshop. Workshop participants were mostly high managers from existing stakeholders involved with TI Pharma and/or IMI. In total, 18 people were invited, but 15 people managed to participate. A limitation is that no person of the government participated. The participants include:

- 2 lower managers TI Pharma
- 1 middle manager TI Pharma
- 1 top manager TI Pharma
- 1 middle manager European Committee Directorate General Research (EC DG Research)
- 1 top manager European Medicines Agency (EMA)
- 1 top manager Yellow Research
- 2 middle managers IMI
- 1 IP Consultant and Research Assistant
- 1 top manager AstraZeneca
- 1 top manager Center for Translational Molecular Medicine (CTMM)
- 1 top manager Top Institute Food and Nutrition (TIFN)
- 1 top manager GSK
- 1 top manager Monitor group

The workshop started with a short introduction by the scientific manager of TI Pharma, which included the objective of the day: identify the performance indicators and methods for measurement of a PPRP in biomedical sciences. Subsequently, three presentations were held by various stakeholders. First, the discussion document including the list of indicators was

presented. The second presentation was on the interaction between Public Private Partnerships and the regulatory bodies. Third, the influence of the behaviour of scientists on the quality of the partnership was presented and discussed. Then, the group was split in two groups to discuss the framework of indicators in somewhat smaller groups. Following this, the results of these discussions were presented to the complete group and a group discussion was organized to finalize the workshop and create specific take-aways.

Case Unit Analysis

Ultimately the current evaluation methods of running projects within TI Pharma will be analyzed to test whether the indicators are useful in practice and to examine the feasibility of the framework. TI Pharma is analyzed by using several important indicators form the framework. These projects are evaluated using several indicators from the theoretical framework. A restriction of this evaluation is that only some indicators are used since most projects have only been running since two or three years. Results of this case unit analysis will then be used to further refine the framework.

Indicators

A division between the various indicators is made following the various levels of practical applicability. This practical applicability follows the levels a PPP consists of and the sector it adheres to. The PPP encompasses all activities undertaken by the complete organization, which includes research, but also activities of the mediating body. The consortium level is the level of a project. Thus, in case of TI Pharma 50 consortia have to be evaluated. Furthermore, per consortium at least 3 different partners collaborate in research, which is illustrated as partner level. Although various partners collaborate in one consortium, the partners can have different aims. Therefore, partner level is the final level of the model and encompasses the

largest quantity. The division in levels illustrates another element of complexity in the measurement of the value of PPPs.

A balanced set of performance indicators, including both financial and non-financial measurements, is important (Sinclair, 2000). Focus on i.e. output measurements which evaluate quantity can deteriorate quality. Therefore, evaluation systems of PPRPs should include both process indicators and performance indicators (Sinclair, 2000). Process indicators can be used to evaluate crucial tasks and present timely feedback. Performance indicators can be used to evaluate the achievements concerning the objectives set.

In the proposed list of indicators, a division is made between Input, Process, and Performance indicators (which are divided into Output and Outcome), thereby covering the whole system:

- An *input* is defined as "the human, financial, and physical resources received to support programs, activities, and services" (Burke, 2007).
- A *process* is defined as "the means or method used to deliver programs, activities, and services" (Burke, 2007).
- An *output* involves "the quantity of products or services actually produced". Output indicators express the development of projects in the short term and are often related to efficiency (Burke, 2007).
- An *outcome* is defined as "the quality of the benefit for or impact on stakeholders of programs, activities, and services" (Burke, 2007). Outcome indicators communicate eventual business, social and economic impact of the partnership.

Four domains are identified from the theory regarding drivers to participate in collaborative research and are relevant to each part of the indicator system. These domains cover

knowledge, financials, human capital, and networks. Table 3 breaks the PPRP down into all domains throughout the different stages (input, process, output, and outcome).

--- Insert Table 3 about here ---

Main findings

The results from this study regarding the measurability of the indicators resulted in the creation of the following matrix (see Table 4). The matrix demonstrates the measurability of an indicator and the importance of an indicator. An indicator is considered important when it scored ≥3 in the survey, or was discussed in the workshop where the participants decided in consensus that the indicator was of high importance. Hence, as aforementioned the indicator '*targets achieved'* is added and considered to be important, and also, the indicators '*number of partners per stakeholder*', '*exchange of personnel*', and '*number of joint scientific publications*' (instead of indicator 'quantity and quality of publications') were discussed and regarded as important to measure the value of a PPRP. The measurability is based on the complexity to measure the indicator, but also the complexity to link the indicator to the work of the PPRP.

--- Insert Table 4 about here ---

Obviously, the indicators considered as important and measurable by experts from various stakeholders involved with the PPRPs TI Pharma and IMI will receive the main focus and be used in practice to measure the value of a PPRP. Moreover, the indicators 'exchange of information between partners' and 'level of trust' are of a very high level of importance in value creation by PPRPs. Hence, the bold and italic indicators in the framework show the difference between collaborative research and academic or industrial research.

At the time of this research only 7 of the 14 most important and measurable indicators can be measured within TI Pharma due to time constraints and the relatively short timeline that TI Pharma projects have been running. The 7 indicators which are measured are 'amount of funding', 'in cash and in kind contributions', 'number of patents', 'number of partners per type of stakeholder', 'number of joint scientific publications', 'new ventures started' and 'number of continued projects' (see table 5).

--- Insert Table 5 about here ---

Project Portfolio

TI Pharma projects are undertaken in 6 different research areas: (Auto-) immune diseases, cardiovascular diseases, oncology, infectious diseases, Central Nervous System (CNS) diseases, and the overall research platform. The overall research platform focuses on the efficiency analysis of the drug discovery, development and utilization process. The TI Pharma portfolio is not solely built upon therapeutic projects, but 30% is about enabling technology projects. The projects concerning enabling technologies are also divided in 6 varying research areas: Target finding, Validation and Animal models, Lead Selection and in silico Modelling, Predictive Drug Disposition and Toxicology, Biomarkers and Biosensoring, Drug Formulation, Delivery and Targeting, and Pharmaceutical Production Technologies.

In just more than 3 years of projects running, TI Pharma already showed to deliver results. These results include more than 130 joint scientific publications, 11 patents or patent applications and also collaboration between parties that never collaborated before. Furthermore, 72 different organizations are partnering, of which 46 private, and 26 public ones. Further, 18 of the 46 private partners are non-SMEs, and thus 28 partners are SMEs.

Finally, no spin-offs are currently set up yet. However, this indicator is more important in another 5 years of operation since 3 years of running is very short for projects in biomedical science. As Table 5 shows, the indicators 'number of patents', 'number of partners per type of stakeholder' 'number of joint scientific publications', and 'new ventures started' are considered to be of high importance to measure the value of a PPRP.

At the moment this research was undertaken, 50 TI Pharma projects were running. 1 small project was finished after 3 years of running, and 2 projects were fused into 1. Hence, no projects were terminated as consequence of insufficient quality. Therefore, the 'number of continued projects' within TI Pharma indicates high value for the PPRP. Nonetheless, the Midterm review showed that the quality of 2 TI Pharma projects running in 2009 scored insufficient. TI Pharma managers indicated that these 2 projects were not terminated since the TI Pharma project structure did not allow them to. The reason for this is that PhD students cannot be transferred to another project very easily. Not terminating insufficient scoring projects would not be the line of thought and action in pharmaceutical companies and this indicator can therefore not be compared with data regarding project continuation in joint ventures. Nonetheless, there are data available regarding research projects undertaken by joint ventures in the pharmaceutical industry which are already in the clinical phase. Hoang and Rothaermel (2005) show that 63 of 158 (40%) research projects undertaken by joint ventures in the pharmaceutical industry were completed successfully; the rest was discontinued before completion, mainly due to insufficient quality. Furthermore, Gassmann and Reepmeyer (2005) found that on average a compound in the preclinical phase has a probability of success of approximately 10% to indicate the regularly low rate of success of projects in the precompetitive phase.

Funding

The funding of TI Pharma comes from different parties. 50% is subsidized by the Ministry of Health, Welfare and Sport, approximately 25% is paid by industry via in cash contributions and the last 25% is financed by universities via in kind contributions. For the period of 2005-2009 €130 million was funded by the Ministry of Health, Welfare and Sport. Hence, a total of €260 million was invested in TI Pharma in that period. This amount of funding is high compared to the funding CTMM received from it stakeholders for the period 2005-2009; approximately €30 million. The amount of funding is equal to the amount of funding NGI received to undertake research in biomedical sciences in their first 5 years of operation (2002-2007); €280 million. However, NGI already received additional funding (€280 million from government) for their next 5 years of operation, and TI Pharma is still waiting for their second round of funding from government. Although an amount of €6 million is already received to bridge the coming period, it causes a high level of uncertainty at TI Pharma and its stakeholders. The delayed decision can be the consequence of various factors. Timing can be one reason, since the Cabinet have resigned and the new-to-come government is planning to cut costs at all departments. In addition to that, the focus on innovation and the fields of interest can change per government. Nonetheless, if there would be no doubts at the Dutch government about TI Pharma, the decision to fund the organization for an additional 5 years, would already have been taken.

Evaluation Structure

This paragraph describes the evaluation structure that has been used until this research was undertaken in measuring the value of TI Pharma. Also, the most important results of this evaluation are presented. It shows that measurement of the various indicators using an IT system is more complicated in practice than in theory. TI Pharma managers state that this is mainly due to a lack of compliance to the guidelines set. Another practical limitation is that data regarding IP and research results is not digitalized. Hence, researchers have to fill in paperwork for evaluation, which is related to reluctance.

In the fall of 2009, InnoTact Consulting B.V. conducted a survey amongst all TI Pharma researchers (n=466) to determine how TI Pharma and its work is experienced. TI Pharma managers perceived this survey as "very useful". The response rate was 54% (n=252), which indicates that a large part of the researchers is willing to participate in a survey. The conducted survey consisted of a project related part and a personal part. The total number of statements was 32. Moreover, there was room for comments related to the statements. Qualitative indicators from the created framework which were measured by the survey are:

- the exchange of methods and protocols;
- the exchange of results;
- exchange of staff;
- career prospects.

70% of the researchers that filled out the survey agreed on the statement "there is an adequate exchange of research methods, protocols, and generated results between the partners of my consortium". Only 11% of the contributors disagreed on this statement. Furthermore, 40% of the contributors agreed on the statement "there is sufficient exchange of staff between the

partners of my consortium to support the research work", while 22% disagreed on this statement. Further, 78% of the contributors agreed on the statement "participation in a TI Pharma project has substantially extended my professional network in The Netherlands", and only 8% disagreed on this statement. However, only 28% of the researchers that filled out the survey agreed on the statement "participation in a TI Pharma project has substantially extended my international professional network", while 44% disagreed on this statement. Nonetheless, 55% of the contributors agreed on the statement "participation in a TI Pharma project will substantially improve my chances on the (inter)national labour market", and only 9% disagreed.

Also, the quantitative indicator 'number and quality of courses provided within partnership' showed to be measurable easily. The first three years 4 different courses were organized by TI Pharma. Since 2009, 3 new courses have been added to the Education and Training portfolio of TI Pharma. These courses are elaborately being evaluated after they took place, i.e. on usefulness for the participant.

Moreover, 72% of the contributors agreed with the statement "the involvement of both academic and industrial parties in my consortium benefits the quality and/or quantity of the results of my project", and only 10% disagreed with this statement. What is more, 90% of the researchers that filled out the survey agreed on the statement "TI Pharma plays a positive role in further developing pharmaceutical research in The Netherlands", while none disagreed. This shows a very positive view of TI Pharma researchers regarding the TI Pharma organization. However, these researchers are somewhat coloured.

The survey results were used for the Midterm review executed to show the value of TI Pharma and assure refunding from the government. In its review, the Midterm review

committee recommended TI Pharma to come up with a balanced set of indicators to show its value to stakeholders. This recommendation was one of the incentives to conduct the research described in this report.

Discussion and Conclusions

Based on both the qualitative and quantitative elements of this study, 12 indicators are identified as being most important as well as measurable to value a PPRP in the field of biomedical sciences. 2 process indicators, which score lower on measurability, are added because of their high level of importance in value creation of a PPRP. As a consequence, the following 14 indicators are presented as the list of indicators to value the work of a PPRP in the biomedical sector:

--- Insert Table 6 about here ---

Per type of indicator one is made bold, which indicates the most important ones for value measurement of a PPRP. These 14 aforementioned indicators focus on the unique features of a PPRP; the collaborative research. An additional conclusion from the workshop is the finding that the framework of indicators can be considered a cyclical process; good processes, outputs, and outcomes lead to increased inputs.

The main contribution of this research is that it fills a gap in literature regarding the topic ‘value measurement of collaborative research undertaken by PPRPs in the biomedical industry’. Moreover, the findings and the created framework could possibly also be useful for PPPs outside the biomedical sector. The combination of qualitative and quantitative analyses supports existing literature, but also provides a contribution to theory, namely the primary

focus on processes of a relatively large number of indicators in a value measurement framework for PPRPs. Novel aspects of high importance for value measurement of PPRPs are found by this research, which contributes to existing literature. Finally, the essence of measurability of indicators for value measurement is an interesting contribution to theory.

This research provided a useful list of indicators to measure the value of PPRPs, which at the same time the most significant managerial implication of this study. Further, a division between the various indicators on measurability and importance is made as result of the research undertaken. Moreover, the research results indicate that the main focus of value creation, and therefore value measurement of PPRPs lies in processes.

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Appendix: Tables in order of appearance

Table 1: Various drivers for different parties to participate in Public Private Partnerships

Universities and academic medical centres
• Access to proprietary technologies
• Improved possibilities to commercialize high potential research findings
• Access to research funding
• Access to knowledge concerning the commercial potential
Private companies
• Leveraging R&D budget
• Access to academic research knowledge
• Access to high class academics and their networks
• Access to better leads which enhances the product development process
• Improved reputation/image
Government
• Attracting high class researchers to a country
• Increasing economic performance of country's or continent's biomedical sector
• Increasing employment
• Addressing societal needs
• Increasing the value gained from publicly funded research

Source: Baum, 2010; Beers, 2008; Dooley, 2007; Hagedoorn, 2000; Kaplan, 2004; Nwaka, 2003; Tralau-Stewart, 2009; TIPharma (interview data)

Table 2: Output of universities and other research institutes

	Per 1,000 research staff		Per million $ research expenditures[1]	
	Universities	Other research institutes	Universities	Other research institutes
Invention disclosures	18.3	13.0	0,27	0,24
Patent applications	7.0	5.8	0,09	0,09
Patent grants	4.0	5.7	0,05	0,06
USPTO patent grants	1.6	2.1	0,02	0,02
License agreements	5.2	8.1	0,08	0,13
Spin-offs established	1.5	0.3	0,02	0,01
Research agreements	100.3	56.0	1,25	1,11

Source: Adapted from ASTP survey 2009

[1] Financial data are given in US dollar purchasing power parities (PPP$), using OECD data on PPP$ in each European country for 2008. This permits comparisons between European countries that use different currencies and between the ASTP results for Europe and the AUTM results for the United States.

Table 3: Framework of indicators divided per stage and domain to measure the value of PPRP

	Input	**Process**	**Output**	**Outcome**
Knowledge	*- Background IP*	*- Exchange of information between partners (results & methods)* *- Exchange of resources between partners (technologies and compounds)* *- Number of joint scientific publications* *- Absorptive capacity* *- Problem solving capacity*	*- Number of databases* *- Number of target leads* *- Quantity and quality of scientific publications*	*- Product portfolio development* *- Development speed*
Financials	*- Core funding* *- In cash contributions* *- In kind contributions*	*- Costs per FTE* *- Costs per patent*	*- Number of patents* *- Number of products into clinic* *- New ventures started*	*- License revenues* *- New product effectiveness* *- Development effectiveness* *- Financial performance* *- Economic value* *- Competitiveness*
Human capital	*- Number of FTE* *- Number of high profile scientists*	*- Amount and quality of courses provided within partnership* *- Exchange of personnel*	*- Research grants* *- Quantity of PhDs*	*- Career prospects* *- Fit to societal needs* *- Added medical value* *- Employment rate* *- Continuation partnerships*
Networks	*- Number of partners per type of stakeholder*	*- Usage and quality of IT platform* *- Level of trust between partners*	*- Number of continued projects* *- Number of returning partners*	*- Reputation* *- Attractiveness for foreign investors*

Table 4: The division of the indicators based on importance and measurability

Measurability \ Importance for value PPRP	Low	High
High	• Costs per FTE • Costs per patent • Number and quality of courses provided within partnership • Number of databases • Number of target leads • Quantity and quality of scientific publications • Research grants • Number of PhDs • License revenues	• ***Funding*** • ***In kind and in cash contributions*** • ***Number of partners per type of stakeholder*** • ***Number of joint scientific publications*** • ***Exchange of personnel*** • ***Usage and quality of IT platform*** • ***Number of patents*** • ***New ventures started*** • ***Number of continued projects*** • ***Number of returning partners*** • ***Targets achieved*** • ***Partnership continuation after project ends in PPRP***
Low	• Exchange of resources between partners (technologies and compounds) • Absorptive capacity • Number of products in clinic • Product portfolio development • New product effectiveness • Financial performance • Economic strength • Related to societal needs • Added medical value	• Background IP • Number of High profile scientists • ***Exchange of information between partners (results and methods)***[2] • Problem solving capacity • ***Trust between partners***[3] • Problem solving capacity • Development speed • Development effectiveness • Competitiveness • Employment rate • Career prospects • Attractiveness for foreign investors • Reputation

[2] This indicator is considered not as measurable as the other indicators in the final list. However, quantitative and qualitative analysis showed that this indicator is of a very high level of importance in the value measurement of PPRPs. Therefore this indicator is added to the final list of indicators.

[3] This indicator is also considered not as measurable as the other indicators in the final list. However, quantitative and qualitative analysis showed that this indicator is of a very high level of importance in the value measurement of PPRPs. Therefore this indicator is added to the final list of indicators.

Table 5: Indicators measured at TI Pharma

Indicator	**TI Pharma results**
Amount of funding	€130 million
In cash and in kind contributions	€130 million
Number of patents	11 (including applications)
Number of partners per type of stakeholder	26 public, 46 private: 28 SMEs and 18 non-SMEs
Number of joint scientific publications	>130
New ventures started	0
Number of continued projects	50 (=100%)

Table 6: A Framework for Valuing Public-Private Research Partnerships in Biomedical Sciences

Input • **Funding** • In kind and in cash contributions • Number of partners per type of stakeholder
Process • Number of joint scientific publications • Number of patents • Exchange of personnel • Usage and quality of IT platform • **Exchange of information (results and methods)** • Level of trust
Output • New ventures started • **Number of continued projects** • Number of returning partners • Targets achieved
Outcome **Partnership continuation after project ends in PPRP**