

**MASTER**

**Chemistry at Chemelot**

**evaluating the innovative performance and value of an industrial park**

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Eindhoven, November 2011

# **Chemistry at Chemelot**

## **Evaluating the Innovative Performance and Value of an Industrial Park**

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in partial fulfillment of the requirements for the degree of

**Master of Science  
in Innovation Management**

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## ABSTRACT

The aim of this Master Thesis is to create understanding of the development of a Science-Based Industrial Park, and in specific of the development of the Chemelot Campus. In order to create better understanding a method to monitor park development has been developed; this 'performance evaluation tool' is useful for park managers to improve governance policies. The basis of the tool comes from previous studies performed at the High Tech Campus Eindhoven (HTCE), literature on a variety of topics related to industrial and Science Parks (such as Open Innovation, Network Externalities and Innovation Diffusion) and a number of interviews with share- and stakeholders of the Chemelot Campus. The proposed tool will be further developed and used to initiate a long-term development-monitoring project at the Chemelot Campus.

# MANAGEMENT SUMMARY

## AIM OF THIS STUDY

The aim of this research is to create a performance evaluation tool that will assist managers in organizing and managing industrial parks for optimal performance. The following research problem & project definition leads this research:

*Park managers indicate they are unable to monitor the perceived benefits or the performed activities and processes in an efficient and effective way. This means it is unclear to what extent goals are being achieved, and which activities or processes hamper performance, are beneficial for performance or are out of the focus of in-cluster residing firms. Furthermore, literature does not provide the tools to achieve or circumvent this problem. The creation of a performance evaluation tool is necessary to enable park managers to form governance policies, as well as to support the development of a widely accepted park governance theory.*

A performance measurement tool will assist park managers in the development of the Chemelot Campus by providing the information needed to form effective park governance policies.

## INNOVATION THEORY

Literature does not yet provide tools towards governance of the Open Innovation (OI) concept beyond the alignment of business models, and an overview of the difficulties firms face when pursuing OI that park managers can help to remove. An important topic that remains unresolved considers the organization of firms that pursue OI (e.g. what are the boundaries of the firm?). Furthermore, literature regarding the organization of parks for the OI concept is limited, and thus theory provides only little practical information for park managers beyond a focus on the barriers to OI (table: s1). Furthermore, theory on Network Externalities and Innovation Diffusion (table: s2) seem useful in order to optimize management strategies and can assist to increase park value.

Barriers to Open Innovation (Enkel, Gassmann, & Chesbrough, 2009)
Loss of knowledge
Higher coordination cost
Loss of control
Higher complexity
Difficulties finding the right partner
Imbalance between OI and daily activities,
Insufficient time and financial resources

**TABLE S1: MANAGING THE BARRIERS (CHAPTER 3 INCLUDES A MORE EXTENSIVE MODEL)**


The Innovation	The Communication Channels	The Time Frame	The Social System
Relative Advantage - what is the advantage over CI?  Compatibility - how does it fit the BM?  Complexity - how can firms perform OI?  Trial-ability - OI is full commitment! What are some low-key practices to start with?  Observability - who performs OI? Is it successful?	The Information - what do we need to communicate? (The Innovation)  The Sender - who/what is Chemelot? what is it they do? (name@dsm.com??)  The Receiver - who are they? (residents?, future residents?) what information needs to reach who?  The Communication Channel - what information richness allowed by medium? website? magazines? e-mail? symposia?	Where is OI in the time frame? And how does this influence the way we communicate this concept?   (Rogers, 2003)  - is everyone aware of the OI concept, and its potential?  - who is ready for more than some low-key practices?	Is everyone 'open' to accept OI?  - I am minding my own business and I am doing fine!  - My firm does not really fit the OI concept!  - OI is like having a lot of friends on facebook!  - Chemelot is not a dating bureau firms choose their own partners!

TABLE S2: DIFFUSION OF THE OI CONCEPT (CHAPTER 3)

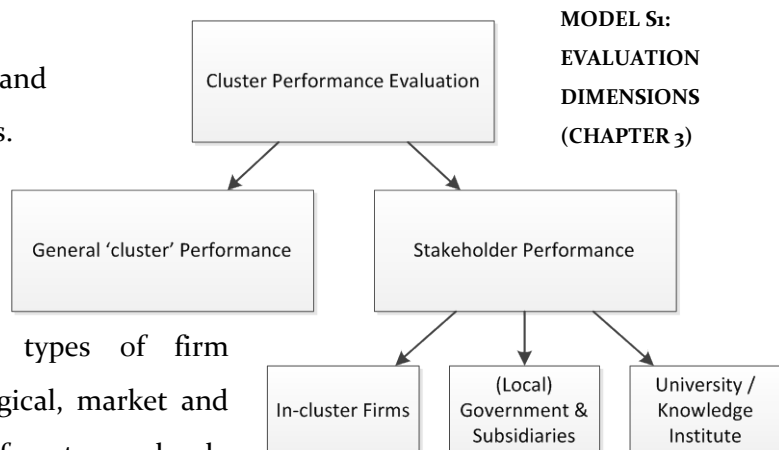
Industrial Parks like Chemelot exist in various formats; a single clear definition does not exist. Closely related to the Chemelot concept are Science Parks (SPs), these parks originate from or have close relation with a knowledge institute like a university. In general, SPs aim to increase knowledge and business development through a high flow of knowledge and technologies within the SP. The actual performance of the SP concept remains unclear due to the mixed results that current literature on the topic displays. Furthermore, the high amount of stakeholders hamper the development of general theory on park performance because of the individual interests of each stakeholder. In this respect, park performance has two dimensions (see the model: S1): general cluster (or park) performance and performance regarding each of the parks stakeholders. Namely, there is a common benefit and an individual benefit for each of the stakeholders. Complementarities, a value sources proposed by Amit & Zott (2001) includes results and suggestions of a variety of researchers regarding the common benefits of parks like Chemelot. Parks have three main complementarities:

- 1 The clusters image,
- 2 the high-tech environment, and
- 3 the ability to share resources.

The performance of the stakeholders, mostly considers the park residents (the firms).

In literature, there are four types of firm performance: Financial, technological, market and time/timing performance. These four types closely

relate to the other value sources (efficiency, lock-in and novelty) proposed by Amit & Zott (2001). In summary, complementarities are the 'common' benefits a park offers, and efficiency, lock-in and novelty represent these benefits on the level of the stakeholders.



## MEASUREMENT TOOL DESIGN

The design of the measurement tool uses the structure created with literature, complemented with findings from practice. These findings result from a series of interviews with shareholders, residing firms and other stakeholders of the Chemelot Campus. Furthermore, the formation of indicators follows a number of requirements and constraints. In general, these indicators need to be simple and intuitive for both the respondents in order to assemble the information as well as for the organization in order to interpret and present the information. In addition, the measurements should allow for long-term usage and they need to be useful for the development of governance policies.

The model presented on the previous page clearly shows the structure of the measurement tool. The tool itself exists of 41 questions spread over 19 topics or indicators. There are several ways to present the tool, for example, indicators can be grouping by those who need to provide the information in order to answer the questions, or by value sources in order to create a more logical coherent structure. Using the first option, 20 questions regard the Chemelot management, 20 questions regard the in-cluster residing firms, 6 questions regard the knowledge institutes and 4 regard the government; a total of 50 question instead of 41 because 3 questions regard all stakeholders. Using the second option is somewhat more difficult because of interactions between value sources. Nevertheless, 15 questions regard complementarities, 8 regard novelty, 4 regard efficiency and 4 regard lock-in; a total of 31 questions meaning 10 questions are not directly linked to value sources, these questions regard the specific interests of the shareholders. These numbers means that the focus of the tool lies on the activities of the Chemelot management and in-cluster firms, and that the tool is balanced over cluster general performance (complementarities), firm-level performance (novelty, efficiency and lock-in), and shareholder performance.

## RESULTS FROM PRACTICE

The interviews provide a lot of information regarding the three main complementarities. The first complementarity, image, is an important factor for all stakeholders. Namely, the Chemelot brand can become a factor that helps firms to attract personnel. DSM can rely on its own brand value, whereas smaller firms do not have this benefit and thus are threatened by the brand of larger firms such as DSM. The other complementarities are functional value for the cluster brand. The high-tech knowledge dense environment is a specifically interesting item for knowledge institutes. Namely, this allows knowledge institutes to improve their focus regarding their (basic) research projects as well as to complement this with (applied) research

in cooperation with business professionals. The last complementarity is the strongest aspect of the Chemelot Campus. This considers the ability to share resources such as utilities, infrastructure, facilities and services. This has major benefits in that these resources can be employed on a greater scale to reduce costs. Furthermore, individual entities are no longer required to invest in all of these resources in order to make them internally available, since specialists ‘within walking distance’ provide them.

A SWOT-model (model: s2) summarizes the results of the interviews:

	Cluster Positives	Cluster Negatives
Cluster Internal Factors	<ul style="list-style-type: none"> <li>• Geographic Location</li> <li>• Strong support from dynamic and stable economic &amp; politic actors</li> <li>• Availability of Licenses</li> <li>• Availability of hard- and software &amp; ability to expand</li> </ul>	<ul style="list-style-type: none"> <li>• Chemelot as cluster brand</li> <li>• Basic Utilities &amp; Infrastructure (cluster can be designated as an old campus)</li> <li>• Visibility of strategy and focus</li> </ul>
Cluster External Factors	<ul style="list-style-type: none"> <li>• Ability to share facilities and services</li> <li>• Ability to become dominant knowledge hub in new business segments (Life Sciences and Bio-based Material Sciences)</li> <li>• The ability to cluster a strong network of firms in the Chemistry sector</li> </ul>	<ul style="list-style-type: none"> <li>• DSM as dominant cluster resident &amp; Park history may hamper development and establishment of SP culture</li> <li>• Ratio small/medium/large firms</li> <li>• Costs (expensive location to expanding or settle + monopoly for campus associated service providers)</li> </ul>

**MODEL S2: CHEMELOT CAMPUS SWOT (CHAPTER 6)**

The results show strong similarities with previous research performed at the Chemelot Campus and HTCE, but includes more information by differentiating between internal and external factors. The remarkable similarity with HTCE shows that Chemelot is a relatively successful park despite its limitations in infrastructure and its size compared to the Campus in Eindhoven. However, it also shows that room for improvement is possible, especially regarding brand value and the mix of firms regarding firm size.





## PREFACE

This Master of Science (MSc) thesis is the result of my graduation project performed on behalf of the Hogeschool Zuyd and the Chemelot Consortium. This graduation project finalizes my study, the master program 'Innovation Management' at the faculty 'Industrial Engineering and Innovation Sciences', which I have followed at Eindhoven University of Technology.

The thesis is a study towards the development of science-based industrial parks such as the Chemelot Campus located at Sittard-Geleen in the Netherlands. The study aims to uncover the factors that influence the performance of industrial parks; this includes defining performance and linking performance to the factors that enable the stakeholders of an industrial park to perform better than they would be able to outside the area of the industrial park. Even though the holiday season posed a major threat regarding the availability of the various interviewees, this study presents a tool that aids the managers of the Chemelot Campus to monitor the development of industrial parks, and to create governance policies in a more structured way.

At the beginning of this project I was already thoroughly informed that there would not be much literature available on the various topics I was about to dive into. Nonetheless, blinded by the Spanish beaches that were still in my mind from one semester earlier, and strengthened by my preliminary literature review on the innovation process in small- and medium enterprises I commenced with enthusiasm. Several weeks later with little result, the actual start of the project appeared to be a long road. At the day of writing however, I owe my first words a gratitude to my university supervisors. First, my thanks go to Dr. J.A. Keizer who introduced the project to me, because this project presented me with an excellent opportunity to get in touch with a number of business professionals that have a proven record of performance in their relative businesses. Second, I would like to thank Dr. M.M.A.H Cloudt as my second university supervisor for providing me with several suggestions along the way that have proven to be essential for the creation of this thesis. Furthermore, I owe my gratitude to the various interviewees that were happy to provide input for this project. Without their help, this project would not have been able to take shape. Finally, I would like to thank my family and friends. In specific my parents, for their joint effort and my father for his insights from practice; very useful to keep track of reality and simplicity.

Eelco Vliek

Utrecht, November 2011

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## LIST OF ABBREVIATIONS

ATAs	Alternative Technology Applications
BIs	Business Incubators
BM	Business Model
BPS	Business-Problem Solving
CI	Closed Innovation (counterpart of OI)
C(I)MO	Context-(Intervention)-Mechanism-Outcome
DSM	Dienst der StaatsMijnen (Dutch State Mines)
EIPs	Eco-Industrial Parks
fte	fulltime equivalent
HsZuyd	Hogeschool Zuyd (local University to Chemelot Campus)
HTCE	High Tech Campus Eindhoven
IASP	International Association of Science Parks
IP	Intellectual Property
K <sub>2</sub> B	Knowledge to business
KPI	Key Performance Indicator
LS	Life Science
MN (MNEs)	Multi-National (Multi National Enterprises)
MS	Material Science
NTBFs	New Technology Based Firms
OECD	Organisation for Economic Co-operation and Development
OI	Open Innovation (Counterpart of CI)
OS	Operating System
R&D	Research & Development
ROA & ROE	Return On Assets & Return on Equity
SMEs	Small and Medium-sized Enterprises
(U)SPs	(University) Science Parks
TNO	Netherlands Organization for Applied Scientific Research
UKSPA	United Kingdom Science Park Association
UM/MUMC+	University Maastricht/Maastricht University Medical Center
USP	Unique Selling Point
VC (CVC)	Venture Capital (Corporate VC)



## Chapter 1: INTRODUCTION

In modern economies, firms compete over innovations. New ways to achieve a competitive advantage are found in the mutual benefit for firms to co-locate. By working together, these clusters of firms and other institutes can achieve greater results than the individual organizations would be able to. This study will research the development of an industrial park in the Netherlands, the Chemelot Campus. The aim is to create a performance evaluation tool that will assist managers in organizing and managing industrial parks for optimal performance. This chapter starts with some background information on the Chemelot Campus, which is the case studied in this thesis. Additionally provided is some background information considering literature that will lead the development of this thesis. The second part of this chapter presents the research design. This includes the problem definition, the research model and the research question. The last section of this chapter guides the reader through the rest of this thesis.

### 1.1 BACKGROUND & MOTIVATION

Three key topics of this thesis are campus organization, governance and performance. Developing an industrial park for optimal performance means it is organized and governed in a way that allows cluster residents to enhance performance. The relation with the Chemelot Campus is that this campus is a reorganization of the original DSM research campus. The original DSM research campus was governed from a cost-base perspective, which resulted in an outdated campus that did not fit the ‘ready for the future’ appearance DSM desires to display<sup>1</sup>. In 2004, DSM started the creation of a plan to transform the DSM research campus into a new organization with new governance with the aim to create a high-performing environment; this plan is the Chemelot Consortium MasterPlan<sup>2</sup>. Next to DSM, the consortium exists of two other parties, together making the so-called ‘triple helix’:

- 1 The local government (Province of Limburg),
- 2 A knowledge/research institute or public partner (UM/MUMC+<sup>3</sup>), and
- 3 A private partner (DSM Netherlands).

In addition to the three topics named earlier, the central (theoretical) topic the MasterPlan adds to this study is the concept of Open Innovation (OI). Namely the mission of the Chemelot Consortium as defined in the MasterPlan is: “*to stimulate and organize OI through*

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<sup>1</sup> Derived from DSM mission statement: <http://www.dsm.com> (accessed 25/10/2011)

<sup>2</sup> Chemelot Consortium MasterPlan: <http://www.chemelot.nl> (summarized in Appendix A)

<sup>3</sup> University Maastricht / Maastricht University Medical Center (also included in list of abbreviations)



*enhanced cooperation and pooling of competences in knowledge development and –retention in the areas of Material Sciences (MS) & Life Sciences (LS) in order to create value”<sup>2</sup>*. Further developing the campus should lead to a growth of the amount of knowledge workers from 1000 (fte) to 2000 (fte). This growth means that DSM will lose its majority share in the Chemelot Campus, and that development of the campus is necessary in order to achieve growth in the number of residents besides DSM. In addition, each shareholder has its individual goals:

- 1 Strengthening the socio-economic development of the region,
- 2 Strengthening the education- and research programs, and
- 3 Improving profitability (use of assets & strengthening innovation).

To reach these goals, each of the shareholders has committed to carry out certain activities (see Chapter 2: The Chemelot Consortium). However, whether these are the activities that lead to the desired goals is unclear. Namely, the Chemelot Consortium may follow a proven concept<sup>2</sup>, there are no tools (i.e. standard park organization or governance methods) available to secure the successful development of the industrial park.

The number of industrial parks is growing, however there is only little known about their development (i.e. organization, governance and performance) other than that the clustering of industries has been found to be a successful tool for regional economic development (Anderson, 1994) (SurrIDGE, Dewit Martin, & Kilko, 1997). Somewhat more developed research topics (regarding park development) are Science Parks (SPs) and Eco-Industrial Parks (EIPs). SPs are a more developed topic because these parks are the origin of the idea to develop clusters of firms and other institutes in order to stimulate regional development. EIPs are industrial parks in which businesses cooperate to reduce waste, a trending topic in the sustainability discussion. Literature on SPs is found most relevant and will thus form the basis for this study to create a better understanding of industrial parks. An important link between SPs and the Chemelot Campus is that ‘sharing’ is an important topic of the MasterPlan. Namely, both the OI concept that leads the development of the Chemelot Campus (Chesbrough, Vanhaverbeke, & West, 2006) and SPs have a focus on an increased flow of knowledge and technology (according to definition by the IASP<sup>4</sup> given in section 3.3.1). Unfortunately, the limited amount of literature does not include a set of clear guidelines towards introducing the OI concept in SPs. In addition, no widely accepted method to govern (Van der Borgh, 2007) or even measure performance of SPs exists. Literature that has appeared is mostly of exploratory nature with a focus on uncovering the potential benefits of parks (more in Chapter 3: Theoretical Framework).

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<sup>4</sup> International Association of Science Parks (also included in list of abbreviations)

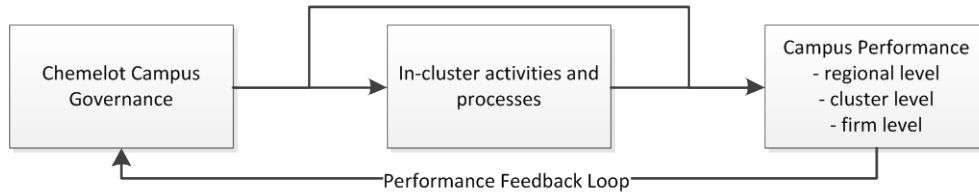
In summary, the Chemelot Consortium has set-up an ambitious plan to transform the ‘old DSM research campus’ into a ‘modern and open research campus’ in which many firms cooperate to create value. However, there are no tools available in practice and literature in order to guide this transformation. This means that park managers have no ‘easy’ way to implement the concept of OI, nor are they backed up by applied or scientific knowledge in their efforts to organize parks for optimal performance according to the goals of the various shareholders and the in-cluster residing firms.

## 1.2 PROJECT DEFINITION

The aim of this research is to create a performance evaluation tool that will assist managers in organizing and managing industrial parks for optimal performance. First to aid the transformation of the ‘old DSM research campus’ towards the modern and open Chemelot Campus. Second, researchers have not defined any standards or universally accepted governance policies for industrial parks (or science parks or any other closely related type of cluster). An important aspect for the development of this tool is the desire to develop an ‘open’ park led by the OI concept. However, literature on the topic is limited and OI is not an easy concept; implementing OI can be a very difficult task for all involved parties (Vanhaverbeke, Open Innovation, Exnovate, 2011). The following research problem will lead this research:

*Park managers indicate they are unable to monitor the perceived benefits or the performed activities and processes in an efficient and effective way. This means it is unclear to what extent goals are being achieved, and which activities or processes hamper performance, are beneficial for performance or are out of the focus of in-cluster residing firms. Furthermore, literature does not provide the tools to achieve or circumvent this problem. The creation of a performance evaluation tool is necessary to enable park managers to form governance policies, as well as to support the development of a widely accepted park governance theory.*

The ‘performance measurement tool’ will allow cluster managers to monitor the effect of activities and processes they pursue, and that are pursued within the park by the other parties. This will provide park managers with better information (displayed by the feedback loop in model 1.1) in order to (further) improve governance policies. Namely, it allows park managers to implement corrective action based on actual performance results instead of on expectations.



MODEL 1.1: PERFORMANCE FEEDBACK

Clearly, this study is design oriented and of exploratory nature. Much on the topic of industrial parks has not yet been the topic of research, and thus this thesis aims enlarge the understanding of the activities and processes that play a role in (industrial) parks. The information provided by a performance evaluation tool can aid in the creation of a normative model for the development and governance of industrial parks. The following research question, based on the project problem definition, aims to provide research with a generally applicable overview of the factors that drive performance in parks like the Chemelot Campus:

*What are the (most important) value sources of industrial parks (and in specific at the Chemelot Campus), and which are the (most important) activities and processes that influence these sources?*

An answer to this question identifies what factors make an industrial park valuable (its benefits). This includes the value of a park for shareholders, park residents and other stakeholders. Furthermore, it identifies what increases (or aids to maintain) this value. Identifying the factors that improve or hamper park performance enables park managers to evaluate these factors and improves the ability of park managers to determine whether the created value (performance) is in line with the goals of the shareholders, park residents and other stakeholders.

### 1.2.1 RESEARCH DESIGN

The research design used for this thesis is based upon the reflective cycle by Van Aken et al. (2007), see figure 1.1. This research design fits the design-oriented nature of this study especially regarding its focus on CIMO-logic or CMO<sup>5</sup> as described by Pawson and Tilley (1997). The basis of the cycle is the principle that a gap exists between existing theory and practice, such as the knowledge gap presented in the previous section. Depicted in figure 1.1, the cycle continues with the regulative cycle (figure 1.2) by Van Strien (1997). The regulative cycle is a problem solving cycle that used to create new designs for existing situations/problems. In a full study, the regulative cycle results in a design that is ready for

<sup>5</sup> Context (Intervention) Mechanism Outcome (also included in list of abbreviations)

implementation, hereafter evaluations and improvements of the design follow until the results are satisfactory, such that there can be continued with the reflective cycle. Continuing the reflective cycle implies a reflection on the results of regulative cycle follows. This included the elimination of case specific elements in order to develop technological rules based on the gained design knowledge. Repeating the reflective cycle can test these technological rules in order to create general theory.

This thesis however will only consist of the first three steps of the regulative cycle, which means its result is a design that is ready for implementation. The first step (see figure 1.2) is to define the project problem. This is not limited to the problem definition and research question as presented earlier this chapter. It includes the project plan and the approach towards the next steps of the regulative cycle (analysis, diagnosis and plan of action). The following section in this chapter present the project plan and the approach.

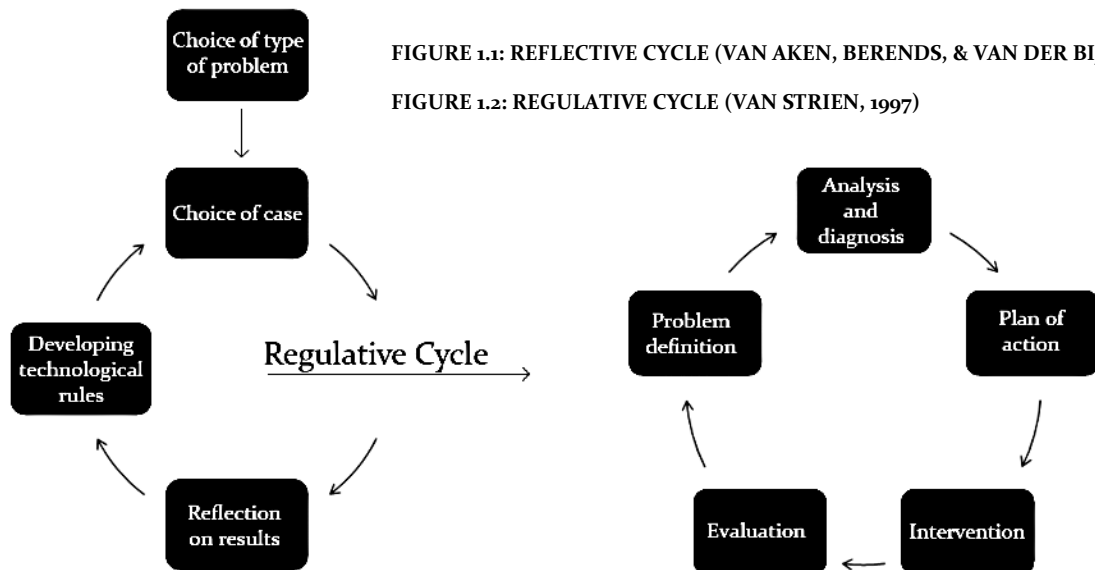


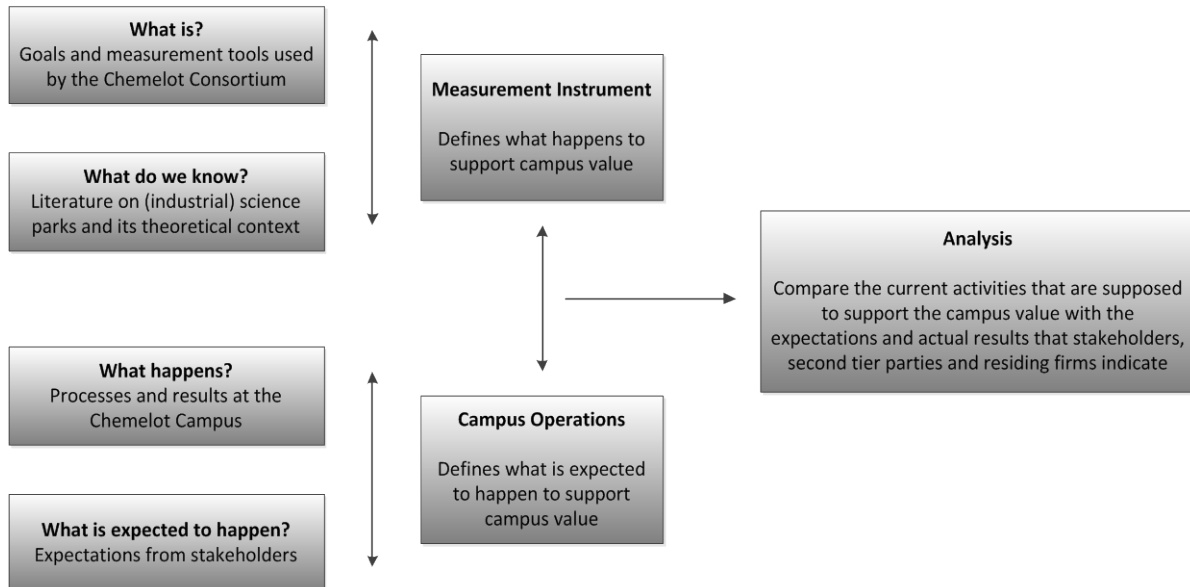
FIGURE 1.1: REFLECTIVE CYCLE (VAN AKEN, BERENDS, & VAN DER BIJ, 2007)

FIGURE 1.2: REGULATIVE CYCLE (VAN STRIEN, 1997)

### 1.2.2 PROJECT PLAN

Problem solving involves not only an analysis of the problem, but also of an analysis of its context. Furthermore, a business-problem solving (BPS) project needs to be theory-based (Van Aken, Berends, & Van der Bij, 2007). In this respect, a significant part of this study exists of a context and a literature review (see chapters 2 & 3). In addition, as this study is a BPS project, it includes a case study and thus case-specific knowledge. The research model (model 1.2) shows the way these items are included in this study. This research model is an adapted version of the model created by researchers from HsZuyd in their research proposal a project that encompasses this study<sup>6</sup>.

<sup>6</sup> Voorstel Chematerials (versie 4), written on behalf of Hogeschool Zuyd



MODEL 1.2: RESEARCH MODEL (SOURCE: 'VOORSTEL CHEMATERIALS' BY HSZUYD)

The top-left of the model represents the context and theory related to this study, the context and theoretical framework form the 'frame of reference' for a performance measurement tool. Namely, the context will provide insight into the Chemelot Campus, its associated parties and the goals and interests of these parties (performance depends on goals). The theoretical framework shows what processes play a role in industrial- and science parks, and as such, provides insight into the value the Chemelot Campus is able to provide. Comparing the state of the Chemelot Campus with this theoretical framework shows the weak- and strong aspects of the cluster and what are the most important activities & processes towards improving the performance of the Chemelot Campus. The lower left of the model represents the process and expectations; this part reflects whether 'frame of reference' gives a proper image of the important activities and processes related to performance at the Chemelot Campus. This will give an overview of the current state and potential of the Chemelot Campus.

Overall, this study exists of three parts. The two parts described in the previous paragraph (the top- and lower left of the research model), and the design of the performance measurement tool. To fulfill the first part, chapter 2 is a review of the Chemelot Campus. This review consists of its history, its development towards its current state, the roles and expectations of the various share- and stakeholders and the current developments regarding the Chemelot Consortium MasterPlan; most of the information displayed comes from the MasterPlan and the web sites of the various share- or stakeholders (appendix B is a list of other used sources). In addition, this first part includes a literature review; see chapter 3. This review exists of three parts; the first part briefly explains why the topic of this study (industrial parks) is important. The second part discusses the mainstream theories related to industrial- and

science parks in order to increase the understanding of the activities and processes that play a role at the Chemelot Campus. The third part reviews current results regarding park performance, meaning it gives insight into park organization and governance in relation to optimizing the park for performance; this includes possible performance evaluation methods as preparation for the design created with this study.

The second part of this study considers the goals of shareholders, park residents and other stakeholders, and the activities and processes they need to achieve these goals. This study will obtain this information through a series of interviews with the park shareholders, park residents and other stakeholders. Interviews are a necessary element because they provide a wider variety and more in-depth information than surveys are able to provide. Surveys are limited in their ability to gather useful new information, whereas interviews leave room for a higher variety of questions and questions that lead to a deeper understanding (e.g. through probing), which is necessary to uncover the high variety of aspects that influence park performance. A disadvantage that belongs to interviews is that results have a higher possibility to be biased, which limits validity and the possibility to generalize findings. Furthermore, interviews can produce a lot of difficult to analyze data. Discussing the results of interviews with the various interviewees improves reliability and minimizes these issues. In addition, focusing the topics of the questions increases the ability to compare results in a more objective way, which lowers bias. Overall, this thesis has limits regarding its validity and reliability; such limits are inherent to the exploratory nature of the research. Chapter 4 presents the preparation of the interviews, appendices D through G provide extra details and appendix H shows the summary of the results of the interviews.

The third part of this thesis is the analysis and diagnosis of the first two parts, this leads to the design of the measurement tool. The first part (the context: Chapter 2: The Chemelot Consortium) lays down a subdivision in order to create structure, meaning the performance of the park is divided over several levels (e.g. regional, cluster and firm-level as proposed by researchers from HsZuyd). The reviewed literature (Chapter 3: Theoretical Framework) suggests the important topics over which performance needs to be measured on each of these levels. The information from the interviews show which factors are important in practice, and thus whether the Chemelot Campus fits the proposed theory. The result is an overview of the topics deemed most important by theory and practice. With the functional requirements and constraints these topics lead to design of the tool; the list of performance indicators. The results can be found in chapter 5 supported by appendices I, J and K that provide more details on the development of the tool and they include the final design.

Further research will implement this tool and evaluate it, but that is outside of the scope of this thesis. Additionally, the design is most likely not the only result this study can present. Chapter 6 presents all other results that follow from the interviews in a discussion. This chapter also contains the conclusion and the limitations of this study.

In summary, the next chapter (chapter 2) provides insight into the context of this study; the Chemelot Consortium and the campus (attached are appendices A & B). The following chapter (chapter 3) concludes the theoretical background of this study by providing the theoretical context that belongs to the topic of Industrial- and Science Parks (Attached are appendices C & D). The following chapters discuss the inputs from practice, chapter 4 discusses the method of data collection and some results (Attached are Appendices E, F, G and H), and chapter 5 is the main analysis of this thesis. This main analysis contains the results of chapters 2, 3 and 4 and presents the design of the performance indicators (Appendices I, J, K and L belong to this chapter). The last chapter (chapter 6) discusses the main results of the analysis and provides an answer to the research question; also, the limitations of this study are included.

## Chapter 2: THE CHEMELOT CONSORTIUM

This chapter describes the context of this project. This includes the history and development of the Chemelot Campus its current state, an overview of the share- and stakeholders of the park, and what the roles and expectations of the various share- and stakeholders are regarding the Chemelot Consortium MasterPlan.

### 2.1 FROM DSM TO CHEMELOT

The Chemelot Campus is an industrial park with a focus on High-Chemistry and New-Materials. The park is located in the southern region of the Netherlands, in between the municipalities Stein and Sittard-Geleen, at the location of the former national mines of Geleen. The mines were closed in 1967 (over a 10 year period), and only until the last years of the 80's the region flourished again led by DSM the 'Dienst der StaatsMijnen' or as it titled itself since the 50's the 'Dutch State Mines'. DSM was able to grow its chemical branch towards the multi-national proportions it has today.

Today DSM N.V. is a global science-based company active in three key areas: health, nutrition and materials. Worldwide the firm has approximately 22,000 employees who achieve annual net sales close to €9 billion. Because of worldwide successes, DSM broadened its focus beyond business growth in various markets, and now clearly displays social responsibility. For example, its mission statement includes that the firm aims to create brighter lives for the people today and generations to come. Furthermore, sustainability (People, Planet, and Profit) is one of the companies 'core values'. Considering the figure on the lower right side of this page (figure 2.1), it is clear that DSM is a firm that finds itself in a continuous phase of transition.

The firm's profile of the year 2000 is very different of that from today, and continues to change. One of the key aspects in this change is a focus on innovation. Targets are defined as percentage of sales created by products that were introduced in the last five years instead of a fixed amount and this percentage is aimed to increase from approximately 12% to 20% by 2015.

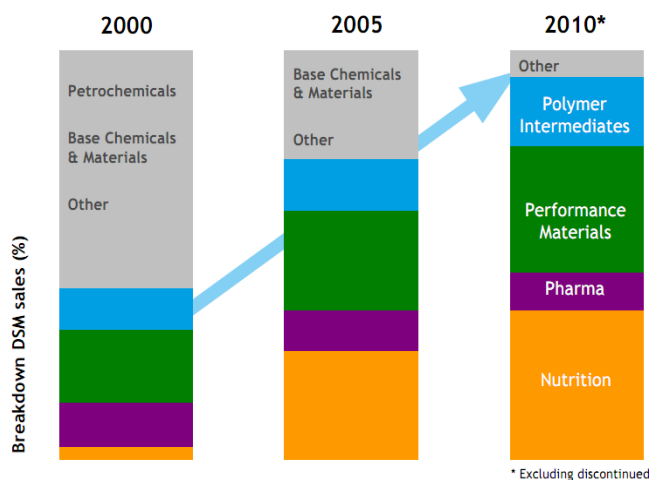


FIGURE 2.1: DSM TRANSITION (SOURCE: CHEMELOT MASTERPLAN)



### 2.1.1 CHEMELOT

One of the areas where innovation is stimulated on a high level is the Chemelot Campus. Chemelot was originally the industrial site of DSM located in Sittard-Geleen. In 2002 DSM sold its petrochemical branch to SABIC a Saudi-Arabian Company. At that same moment, DSM decided to change the name of the location into Chemelot, which is also the name of the organization that also services the industrial area<sup>7</sup>. Namely, ‘DSM research campus’ does not resemble a campus that has multiple residents performing research (and not just DSM). Chemelot is situated in the center of Europe in-between several knowledge/science centers (Leuven, Eindhoven, Aachen and Maastricht), and within reach of several airports, waterways (harbor) and train terminals (figure 2.2). The location and external infrastructure is acknowledged as strength of Chemelot by several residing firms, both SABIC and Sekisui S-Lec indicate<sup>8</sup> that one of the main reasons to choose the Chemelot Campus was location and professional infrastructure.

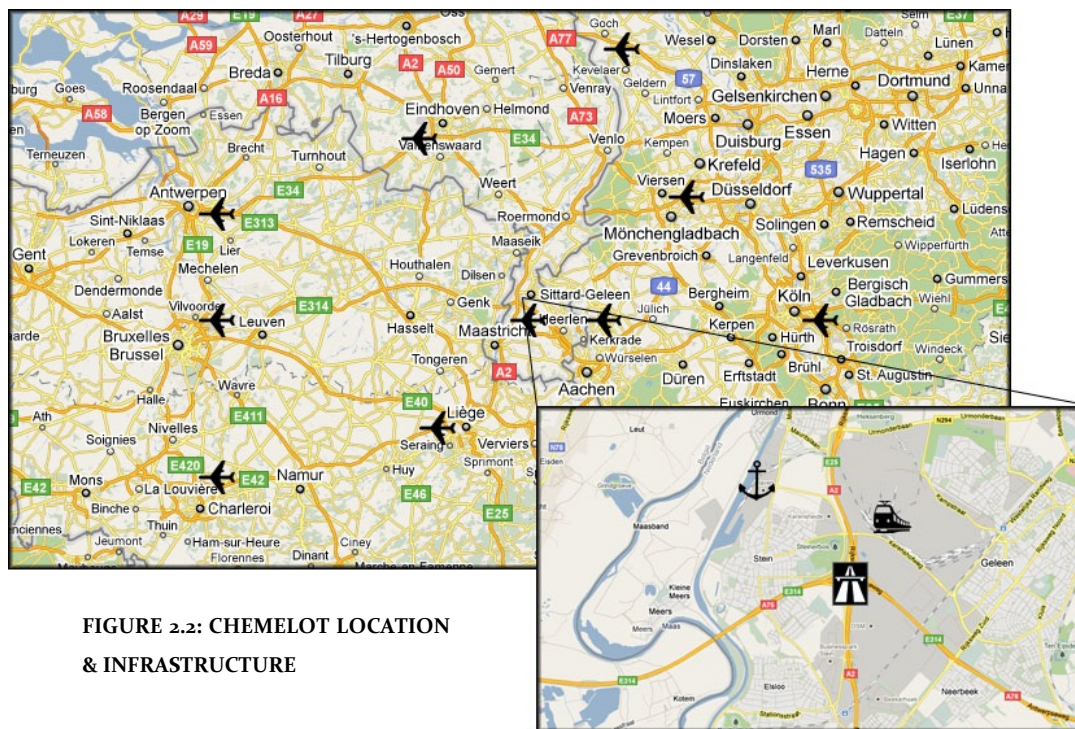


FIGURE 2.2: CHEMELOT LOCATION & INFRASTRUCTURE

Regarding its internal infrastructure, Chemelot has the characteristics of an ‘old’ research campus; also one of the main threats regarding the viability of the campus. The costs of maintaining (and refreshing) internal infrastructure are high and attractiveness of the location (for knowledge workers) is low. In 2004, a MasterPlan was set-up in order to redevelop the Chemelot Campus; appendix A provides a summary of this MasterPlan.

<sup>7</sup> <http://www.plaatsengids.nl/geleen> (accessed: 9<sup>th</sup> of June 2011)

<sup>8</sup> <http://www.chemelot.nl/> (accessed: 24<sup>th</sup> of February 2011 & 9<sup>th</sup> of June 2011)

## 2.2 ROLES AND EXPECTATIONS

With regard to this MasterPlan, every share- and stakeholder of the park has its individual role towards the functioning of the park. The following table (table 2.1) describes the roles of the three main partners of the Chemelot Consortium; a more detailed description follows in the rest of this chapter. First discussed are the firms (park residents), being the main stakeholders and the drivers of the parks success.

Strategic Intent			
	Strengthening the Socio-Economic Development of the Region	Strengthening the Education- and Research Programs	Improving Profitability (use of assets & strengthening innovation)
(local) Government (Province of Limburg)	X		
Knowledge Institute & Public Partner (UM/MUMC+)		X	
Private Partner (DSM)			X

TABLE 2.1: STRATEGIC INTENT (SOURCE: CHEMELOT MASTERPLAN)

### 2.2.1 FIRMS (PARK RESIDENTS)

The park residents are the main stakeholders around whom the campus is built. They are the motor of the campus, they determine whether the campus is a success or not. The Chemelot community website provides several testimonials that indicate the reasons of some of the companies for settling at the Chemelot Campus<sup>9</sup>.

- Sekisui S-Lec chose the Chemelot Campus after a thorough search across Europe. They decided to settle at Chemelot because of its professional infrastructure and the availability of an ‘analysis lab’ for specific research questions. Furthermore, they name the ability to procure needed chemicals from DSM.
- DSM Dyneema is a firm that exploits and researches an ultra-strong polyethylene fiber, developed at the campus. Dyneema is fond of using the knowledge of specialists and the IP assets the Chemelot Campus offers.
- Nano Specials is a rather young firm, settled at the campus in 2005. They settled at the campus because of the high variety of services (staffing, expertise and facilities) the campus offers for starting firms (without the high investment these services usually

<sup>9</sup> <https://www.chemelot.nl> (accessed: 24-2-2011)

require). However, the most important benefit is the availability of facilities to conduct analysis and try-outs with the corporation of specialists in plastics and coatings.

- SABIC is one of the larger partners of the Chemelot community. The company settled at the campus because it took over a part of the DSM-factories. However, they do recognize the benefits the campus offers in infrastructure, sharing facilities and resource procurements. A last important item is the innovative character of the campus, SABIC has its own research facility but nevertheless it benefits from the knowledge and facilities other firms offer.
- Stanyl is a 'high performance' polyaramide 46, the company can produce this high quality product at the Chemelot Campus for low cost due to its infrastructure, reliable utilities and waste-management and the involvement of knowledgeable employees in the community.
- BasicPharma has moved to the campus in 2007 because of its continuous growth. The company indicates that the campus is a perfect fit for the company due to its OI atmosphere, similar to the company's internal operating.

These testimonials show that various firms at the campus appreciate the infrastructure, resource/facilities/knowledge sharing and (open) innovative climate. It however does not indicate to what extent the companies actively share their internal resources and expertise, and what they further expect of the campus (management).

### 2.2.2 THE CHEMELOT CONSORTIUM

The Chemelot Consortium exists of three parties or partners: The Province of Limburg (local government), DSM Netherlands (the private partner) and UM/MUMC+ (the public partner or knowledge institute). The Consortium has the focus to support the development of a strong CHEMaterials cluster. The Consortium supports the cluster through facilitating the OI concept, this means it aims to maintain (and increase the amount of) knowledge and knowledge development in the region. This joint operation has the aim to improve the links between education, research (scientific and applied) and business development. Next to this common goal of the three partners, each has its own interests and with that its own role in the Consortium, see next sections for more information.

#### A THE PROVINCE OF LIMBURG

The local government desires to strengthen the regional economy. It does so through providing resources to create business opportunities, and to provide funds when the market fails to offer these opportunities. Furthermore, it desires to strengthen the connection between education & knowledge institutes and businesses through investing in shared research

facilities. Lastly, it desires to create an attractive environment for entrepreneurs, researchers and scholars; government facilitates this by with investments in the campus infrastructure

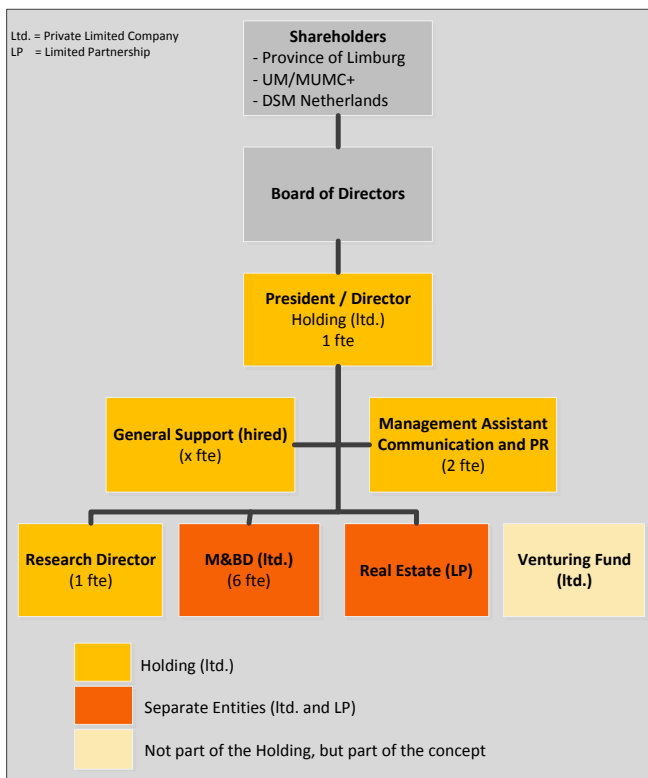
**B UM / MUMC+**

The university desires to take advantage of the campus to widen and deepen its education- and research programs; this should support its efforts towards knowledge valorization. The university focusses on education that fits the innovative character of the campus, and its business segment (scientific research directed to materials and health). Furthermore, it desires to intensify connections with other national and international education and knowledge institutes.

**C DSM NETHERLANDS**

DSM desires the OI business climate to have a positive influence on DSM regarding its innovativeness, through shorter development times and the creation of additional value. Setting-up the Chemelot Consortium means DSM is no longer the lead developer of the Chemelot Campus (meaning it gets the ability to spread risks and costs).

**D CHEMELOT CONSORTIUM STRUCTURE**



**MODEL 2.1: CHEMELOT CONSORTIUM ORGANIZATION (SOURCE: CHEMELOT MASTERPLAN)**

The model on the left (model 2.1) shows the organization of the Chemelot holding (Ltd.). There are four units directly related to Chemelot's day-to-day business, these are The Research Director, M&BD (Marketing & Business Development), Real Estate (LP), and the Venturing Fund.

The Research Director is responsible for strengthening knowledge as 'core competence' of the cluster through searching for links between K2K and K2B (knowledge to knowledge and knowledge to business). The M&BD director creates the B2B (business-to-business) roadmaps which lead to the creation of networks, cluster projects, new businesses, spin-offs and acquisition portfolio.

The director real estate takes care that sufficient accommodation is available for current and future cluster residents (firms). This includes existing real estate (currently owned by DSM) which is mainly available for third party rental, and new real estate that will largely be under the ownership of the province of Limburg (80%). Next to buildings, an important part is the internal and external infrastructure; expected to be an important asset for future settling firms. The venturing fund is not a part of the Chemelot organization, a separate organization is set-up somewhat similar to and lead by DSM venturing expertise. This organization, Limburg Ventures is an organization set-up specifically for the Chemelot Campus to increase the ability to attract firms to the campus through venturing. Limburg Ventures is different from regular venturing fund in that it secures that firms fit into the Chemelot concept and also that the fund is highly involved in the firms it invests in (e.g. by participating in the management board depending on the needs of the firm).

### 2.2.3 HSZUYD & TU/E

These knowledge institutes expect to be able to use the Chemelot Campus as a source of practical knowledge that is useful for improvements regarding the level of education of its students and employees. Furthermore, the campus can be a tool to valorize internally developed knowledge in the sense of out-licensing technologies and the creation of university/high-tech spin-offs.

The role of the knowledge institutes for the Chemelot Campus is that they are a source of well-educated (future) employees. Furthermore, junior researchers (bachelor and master students, and professors) can add to the technological level of the campus and the performance of its operations.

### 2.2.4 OUT-CLUSTER FIRMS

Out-cluster firms have no direct role towards the cluster, but may be expected to be drawn to it being a center of knowledge in chemistry and material science.

## 2.3 THE CHEMELOT CAMPUS REVIEWED

Important information regarding park performance comes from previous research performed at the Chemelot Campus towards the critical success factors and weaknesses of the Campus; the table below (table 2.2) shows these factors.

Success Factors	Weaknesses
<ul style="list-style-type: none"> <li>▪ High value location (i.e. geographically and external + internal infrastructure)</li> <li>▪ Presence of technology leaders (e.g. DSM and SABIC)</li> <li>▪ Stimulated knowledge transfer / OI (services providers like DPI value center)</li> <li>▪ (High density) presence of research facilities (+ high R&amp;D intensity and investment)</li> <li>▪ Critical mass / place to be (15.000 jobs, 20% of industrial employment + 55% of Dutch IP originates from south-east of the Netherlands)</li> <li>▪ High value real estate and services (competitive prices)</li> <li>▪ Campus brand / marketing</li> <li>▪ Vision, focus and wide support (triple helix – DSM, UM/MUMC+, Government)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Strong international competition mainly from China and European areas like Stockholm, Oberrhein (Basel, Mulhouse &amp; Freiburg) and Lyon. Chemelot is currently not a top-3 cluster</li> <li>▪ No structural development in supporting SMEs</li> <li>▪ Development of spin-offs is limited</li> <li>▪ No research/knowledge institute settled (physically) at location</li> <li>▪ Real estate has yet to be developed</li> <li>▪ No alignment between the various partners considering lobby and subsidy requests</li> </ul>

TABLE 2.2: SUCCESS FACTORS & WEAKNESSES (SOURCE: CHEMELOT MASTERPLAN)

In addition to this discussion on the practical context of this study, the following chapter adds the theoretical context. It discusses several theories that closely relate to the Chemelot concept and it provides some more in-depth information about Industrial Parks. Overall, the chapter shows why the Chemelot Campus is an interesting project for each of the shareholders, the residing firms and other stakeholders. Furthermore, it shows what approach literature suggests for the various associated parties towards developing and monitoring the development of the campus.



## Chapter 3: THEORETICAL FRAMEWORK

This chapter starts with briefly explaining why the topic of industrial parks is relevant and important in modern economies. The second part of this chapter discusses the mainstream theories related to the topic; these theories are Open Innovation (OI), Network Externalities and Innovation Diffusion. In addition, this chapter contains a review of literature considering the organization, governance and performance of Industrial- and Science Parks. This final part aims to create a basic structure with which a performance measurement tool can be build. Furthermore, this information is a preparation for the interviews, to be able to perform the interviews in a structured way.

### 3.1 THEORETICAL RELEVANCE

An important topic in the Chemelot MasterPlan is Open Innovation (OI). OI is an increasingly important research topic because modern economies require interplay between firms. Namely, characteristics of the 'modern' economy such as shorter development times, consumers that are more demanding and a higher mobility of employees (that cause the knowledge advantage of large firms to erode) cause large firms to require a connection with small innovative firms in order to stay up-to-date; think for example of disruptive innovations (Christensen & Bower, 1996). In addition, opportunity based smaller firms (Audretsch & Thurik, 2001) need their larger counterparts because they lack the resources to fund their (risky) internal development process (Ortega-Aragilés, Vivarelli, & Voigt, 2009). These developments require firms to make a transition from 'Closed Innovation' (CI) towards 'Open Innovation' (OI). CI being the traditional way to operate a business, meaning that firms develop their own ideas (the whole process of idea generation, development, production, marketing, distribution, service, financing and support is an internal process). A more external focus that modern businesses require is OI. The OI approach is based on the principles that not all the best people work inside the company, not all best ideas are generated internally, and internal R&D is not always the best option. When generated ideas do not fit the business model (BM) of a company product portfolio, it may be better not to pursue the idea internally. A good BM provides more value than being first-to-market, and internal intellectual property (IP) can create value when others use it (Chesbrough, 2003).

## 3.2 INNOVATION THEORY

The use of the OI concept at Chemelot has the intention to increase performance, and thus this review aims to uncover the way in which OI can support park performance. This is important because even though performance is a widely researched topic,<sup>10</sup> not much literature is available that discusses the performance of industrial parks like Chemelot. Moreover, no widely accepted definition of performance in these parks exists. A possible explanation is the wide variety of parks that exists (e.g. Research Park, Technology Park, Technology Incubator, Innovation Centre, Techno-park<sup>11</sup>), making it difficult to generalize findings. After discussing the mainstream theories in this section, the last section of this chapter (section 3.3) aims to provide a general image of park performance, including the relevance of the OI concept. Other theories that found relevant are Network Externalities and Innovation Diffusion. In addition to the information provided in this chapter, Appendix C provides more in-depth information on these theories.

### 3.2.1 OPEN INNOVATION

The ‘father’ of the OI concept (Henry Chesbrough) defines the concept as following: “*Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively*” (Chesbrough, Vanhaverbeke, & West, 2006). This definition means there are two equally important ways to pursue development. The first way considers the vast amount of knowledge available outside the firm, and thus requires firms to determine which external knowledge (or technology) is sufficiently valuable to incorporate in internal processes; this way is called inbound OI. The second way is that there is internal knowledge that may be (more) useful (and profitable) to be developed outside the firms boundaries. Firms need to determine which internal knowledge cannot be exploited internally (to a reasonable extent) and thus should be transferred to an external ‘path’ to create value; this way is called outbound OI (Van de Vrande, Vanhaverbeke, & Gassmann, 2010), (Bianchi, Campodall’Orto, Frattini, & Vercesi, 2010).

De Man et al. (2009) define a number of OI techniques and one of them is the campus model like that of Chemelot Campus and the High Tech Campus in Eindhoven (HTCE). However, though settling at a campus has the benefit of possible knowledge spillovers to occur, which may be useful to accelerate internal innovation (Siegel, Westhead, & Wright,

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<sup>10</sup> Referring to the wide number of performance evaluation tools available for firms such as the balanced scorecard, the performance prism, the SMART performance pyramid and the performance measurement questionnaire

<sup>11</sup> United Kingdom Science Park Association: [www.ukspa.org.uk/](http://www.ukspa.org.uk/) (accessed: 25<sup>th</sup> of June 2011)



2003). This does not make it an OI practice, but does show that a campus may be an environment that suits the incorporation of the concept. In the previous paragraph two OI types were defined (in- and outbound OI), for a campus however the ‘coupled process’ (Enkel, Gassmann, & Chesbrough, 2009) seems most interesting. These processes involve sharing, and thus not merely an inflow or outflow of knowledge, but both. Campuses are very suitable for these processes, namely they offer an environment of possible clients, suppliers, competitors and knowledge institutes in proximity and this proximity seems to improve the ability for these processes to emerge (Hu, 2008). The most important benefit of ‘proximity’ in a campus is that it increases the number of (strong) (in)formal relationships between parties. This can encourage mutual trust (Bakouros, Mardas, & Versakelis, 2002, p. 124) (Gretzinger, Hinz, & Matiaske, 2010, p. 199), and trust is an important issue because OI involves an inflow and outflow of knowledge, which is a difficult process as it means for firms they need to ‘let go’ and firms have problems with ‘losing control’ (Enkel, Gassmann, & Chesbrough, 2009). Furthermore, regarding the higher amount of relationships, networking is an important OI practice. Namely, networking can help to fill internal knowledge gaps and can provide information on activities that take place in competing or partner firms (EIM, 2007). In addition, networking enables to spread knowledge of internal activities, and thus makes other firms aware of the potential value the firm contains. This improves the likelihood firms are able to find the ‘right’ partner for collaborative practices (e.g. think of the diffusion of innovations through observability; see section 3.2.3). Other ‘coupled processes’ are related to co-creation, this means they involve alliances and joint ventures (Enkel, Gassmann, & Chesbrough, 2009). For similar reasons as given earlier this section, a campus seems very useful for these processes.

<b>Barriers to Open Innovation</b> (Enkel, Gassmann, & Chesbrough, 2009)	<b>Possibilities to remove barrier</b>
Loss of knowledge	Provide IP-protection service
Higher coordination cost	Align business models of in cluster firms with the park/ campus business model
Loss of control	Principles on the organization of OI in firms have not been developed in currently available literature
Higher complexity	Provide management/staff support service
Difficulties finding the right partner	Provide residents with information of all the facilities/ services the park and its residents offer
Imbalance between OI and daily activities,	Principles on the organization of OI in firms have not been developed in currently available literature
Insufficient time and financial resources	Set-up an adequate funding structure (e.g. venture capital)

**TABLE 3.1: MANAGING THE BARRIERS**

Unfortunately, no research towards optimal campus organization (organization in such a way that they spur these types of processes) seems to exist. An important remark by Campbell & Goold (1998) related to synergy provides some guidance. They state that the task of a management is not to actively search for the benefits that cooperation offers, but to remove possible blockages and to support the helpful aspects firms see when pursuing their goals. In this respect, following research by Enkel et al. (2009) the table presented on the previous page (table 3.1) shows the most important barriers to Open Innovation. Additionally, added are possibilities to remove these blockages, because these blockages may prove useful to organize park or campus management in response to the remark made by Campbell & Goold (1998).

#### THE BUSINESS MODEL & PARK VALUE SOURCES

An important aspect that remains is the difference between practicing OI, and performing OI practices. This main difference is the business model of the firms that adopt OI. Namely, practicing OI goes beyond scanning the environment for new business ideas, and thus disregarding internal knowledge and technologies that do not fit the internal development process. It becomes inherent to the business model to actively search for knowledge and technologies that can have value for the internal development process, as well as finding external partners to make value of internal knowledge.

Vanhaverbeke & Cloudt (2006) propose that a new business model has to identify different value sources; however, what these value sources are seems to differ over industries. The value sources used for this study are those proposed by Amit & Zott (2001), these value sources are efficiency, complementarities, lock-in and novelty. Efficiency means that something is performed without waste, for example waste being time or money. Complementarities are the benefits that arise when things are bundled, think of economies of scale. Lock-in is a value source because it provides security, for example important for firms that have customers or suppliers located in the park they reside. Novelty or innovativeness is valuable for firms in the highly competitive modern economies, because new ways of doing things are an important driver of sales (Bagchi-Sen, 2000); appendix D presents more details on these value sources. Previous research at HTCE performed by Van der Borgh (2007) combines the business model as presented by Osterwalder (2004) (2005) with these value sources provided by Amit & Zott (2001). This displays the value the HTCE offers, and identifies whether the value source as suggested by Amit & Zott (2001) fit the HTCE or if they need to be adapted in a similar way as done by Vanhaverbeke & Cloudt (2006). In case of the HTCE, this business model offered useful information for campus managers. Namely, Van der Brogh

(2007) found significant differences between campus residents. Service oriented firms seemed to have no interest in vertical complementarities (e.g. clean- and test rooms, laboratories and knowledge experts) but strongly depend on horizontal complementarities (e.g. management/staff support, financial support, IP service, conference rooms and catering). However, for technology-oriented companies it seemed to be the other way around. Unfortunately this research did not prove that the value sources have a direct relation to value creation and appropriation, nevertheless the value sources seem useful to identify the aspects campus resident perceive to be important for their business (development). Regarding the OI concept, these value sources may be a useful way to secure that new campus residents fit the business model of a Campus. Namely, coherence or synergy between the culture or characteristics of a parks and its residents is argued to be a critical success factor (Cabral, 1998), more on the relation between value sources and critical success factors of parks is presented in the last section of this chapter (section 3.3).

### 3.2.2 NETWORK EXTERNALITIES

According to the previous section, a campus is very useful in order to perform OI practices because they present an environment of clients, customers, competitors and commercial or public research institutes. This would mean that a larger campus is more suitable for these OI practices because it will contain a larger number of these knowledge sources. In the context of Network Externalities (see appendix C.2), this suggests that a campus needs to reach a certain critical mass in order for this benefit to emerge. However, a focus on growth may not always be the best option, namely there are possible negative side effects when a good has many users; think of traffic jams that exist because of the amount of users or cars. This negative effect is called the 'congestion effect', and thus in the context of clusters there may exist size constraints regarding efficiency; think of higher coordination complexity (Suomi, 2006) (Rallet & Torre, 1999). Growth beyond this constraint seems only to improve the image of such cluster (Hervás-Oliver & Albors-Garrigós, 2007, p. 118 & 131). This means park managers need to determine the value of image versus the value of the unique features of the cluster for each new settling firm. Namely, the image of a campus is important as this provides value for firms that settle at the campus (Amit & Zott, 2001) (Van Dinteren, 2011). However, on the other hand a brand needs underlying or functional value in order to be maintained and thus securing the 'unique features' of a campus remains critical.

A topic related to the network effect deals with the tendency to agglomerate (appendix C.2: economies of agglomerations). The important part for industrial parks is that when a significant amount of firms (critical mass) co-locates, they can have benefits; for example

through an increase in the amount of services and facilities they can attract to their proximity (Malmberg, 2002) (Rosenthal & Strange, 2003). However, a different reason for firms to agglomerate is image induced by a certain amount of firms that settles at a location. This makes that location the ‘place to be’, and thus what provides this value becomes less relevant (Van Dinteren, 2011). A last reason may be that the specific location is the only region that tolerates the specific industry/sector. For example, governments co-locate firms that are heavily polluting using their licensing policies, or also they may lure firms with subsidies to settle at a certain region with the aim to stimulate regional development. Nevertheless, these reasons that firms have to agglomerate have implications for park managers. Namely, a focus on the correct reason makes the efforts of park managers towards park development more efficient and effective, an important aspect when pursuing park development.

### 3.2.3 INNOVATION DIFFUSION

Section 3.2.1 stresses the importance of the ‘observability’ of an innovation in order to stimulate the diffusion of that innovation. When considering the Chemelot campus the OI concept is the innovation that needs to diffuse over the in-cluster firms, Innovation theory by Rogers (2003) explains the important factors that influence the diffusion of an innovation. Observability is one of the important factors in innovation diffusion theory, other factors are relative advantage, compatibility, complexity, trialability and observability of the innovation influence its diffusion. Next to the characteristics of the innovation, there are three other important elements. The first is the way the innovation is communicated, the second is the ‘time frame’ in which the innovation is (or has been) available, and the third is the social system (think of elements such as peer pressure) in which the innovation needs to be introduced. This theory is important in the context of industrial parks because it shows which factors park managers need to consider in order to incorporate the OI concept and its practices such as out-licensing IP and insourcing R&D into the parks regular activities (see table 3.2).


The Innovation	The Communication Channels	The Time Frame	The Social System
<p>Relative Advantage - what is the advantage over CI?</p> <p>Compatibility - how does it fit the BM?</p> <p>Complexity - how can firms perform OI?</p> <p>Trial-ability - OI is full commitment! What are some low-key practices to start with?</p> <p>Observability - who performs OI? Is it successful?</p>	<p>The Information - what do we need to communicate? (The Innovation)</p> <p>The Sender - who/what is Chemelot? what is it they do? (name@dsm.com??)</p> <p>The Receiver - who are they? (residents?, future residents?) what information needs to reach who?</p> <p>The Communication Channel - what information richness allowed by medium? website? magazines? e-mail? symposia?</p>	<p>Where is OI in the time frame? And how does this influence the way we communicate this concept?</p>  <p>(Rogers, 2003)</p> <p>- is everyone aware of the OI concept, and its potential?</p> <p>- who is ready for more than some low-key practices?</p>	<p>Is everyone ‘open’ to accept OI?</p> <p>- I am minding my own business and I am doing fine!</p> <p>- My firm does not really fit the OI concept!</p> <p>- OI is like having a lot of friends on facebook!</p> <p>- Chemelot is not a dating bureau firms choose their own partners!</p>

TABLE 3.2: DIFFUSION OF THE OI CONCEPT

This table shows what is important in order to diffuse the OI concept at Chemelot, important is that firms that reside at Chemelot need to be aware of the concept as characterized in the first column of the table. Factors that influence this awareness are the way and timespan in which the concept is communicated and the openness of firms toward the concept.

#### 3.2.4 IN SUMMARY

Literature does not provide tools towards governance of the OI concept beyond the alignment of business models, and an overview of the important topics and difficulties firms face when pursuing the OI concept. Park managers can use these topics to optimize the park to better facilitate the OI concept (also with regard to theory on network externalities and innovation diffusion), but which policies will actually be successful remains unclear. An important topic that remains unresolved considers the organization of individual firms that pursue OI (e.g. what are the boundaries of the firm? and what happens with the business model?); important as organizing the individual firms for OI is necessary in order to create a cluster that actively practices the concept. Principles of the theory have not fully matured and as such, park and firm managers have only limited ability to manage the concept in practice.

### 3.3 INDUSTRIAL PARK PERFORMANCE

The previous sections establish that governance and organization theory regarding performance of industrial parks like the Chemelot Campus is limited. To achieve some progress on this topic, this section provides a definition of (industrial) parks like the Chemelot Campus and shows what factors determine the performance in these parks.

#### 3.3.1 DEFINITION

There is no standard definition to characterize the Chemelot Campus. Namely, the description of 'campus', 'industrial park' and 'science park' do not properly fit the Chemelot Campus. According to these definitions, Chemelot is a mixture between an industrial- and science park, making it a science-based industrial park.

Campus	Industrial Park	Science Park
the buildings of a college or university and the land that surrounds them	a special area on the edge of a town where there are a lot of factories and businesses	an area, often started or supported by a college or university, where companies involved in scientific work and new technology are based

TABLE 3.3: DEFINITIONS OF PARKS (SOURCE: CAMBRIDGE ONLINE DICTIONARY<sup>12</sup>)

Research on industrial parks is limited, therefore the rest of this chapter will mostly relate to theory on Science Parks (SPs). A possible explanation for theory to be limited (as briefly touched upon in section 3.2) is that SPs exist in a variety of formats, making it difficult to create general theory. Most parks can be distinguished through the name of the park (such as a Research Park, Technology Park, Technology Incubator, Innovation Centre, and Technopark<sup>13</sup>), the name often indicates which type of companies the park supports (e.g. Technology incubators support start-up companies). Important differences between parks are the offspring and development of the SP over time, some SPs originate from universities others are government or private initiatives such as the Chemelot Campus. To characterize parks the IASP<sup>14</sup>, Luis Sanz<sup>15</sup>, the UKSPA, the OECD<sup>16</sup>, and Porter (1998) provide a number of definitions, a combination of these definitions results in a broad definition:

SPs are clusters (geographic concentrations) or communities of interconnected companies, specialized suppliers, service providers, associated institutions (i.e. universities, standard agencies, trade associations) and other professionals (in a particular field) in which a culture of knowledge and business creation is stimulated to generate more knowledge and business than the individual entities would be able to. This can be achieved through a high (park internal) flow of knowledge and technologies, the proximity of knowledge institutes, R&D institutions and technology leaders, and/or a large set of shared services, facilities and infrastructure which all may or may not be managed by a professional (central) organization. The aim of these SPs is to increase the competitiveness of its residents and with that the economic development of its region.

<sup>12</sup> by Cambridge University Press: <http://dictionary.cambridge.org> (accessed 25<sup>th</sup> of June 2011)

<sup>13</sup> United Kingdom Science Park Association: [www.ukspa.org.uk/](http://www.ukspa.org.uk/) (accessed: 25<sup>th</sup> of June 2011)

<sup>14</sup> The International Association of Science Parks: [www.iasp.ws](http://www.iasp.ws) (accessed: 25<sup>th</sup> of June 2011)

<sup>15</sup> Director General of the IASP: <http://www.iasp.ws/publico/index.jsp?enl=1> (accessed: 1<sup>st</sup> of July 2011)

<sup>16</sup> the Organisation for Economic Co-operation and Development <http://www.oecd.org/> (accessed: 1<sup>st</sup> of July 2011)

This definition has much in common with the Chemelot Campus, in specific the second part of the definition closely relates to the concept of OI; ‘a high flow of knowledge and technologies’. Furthermore, the definition seems to imply that parks can provide more than just cost reductions achieved through geographic approximation of buyers and suppliers, and more intense innovative efforts through the proximity of high-tech partners and competitors. Nonetheless, this definition may not be all encompassing, but it does contain sufficient information to be able to identify a set of key characteristics:

- SPs are clusters or communities, suggesting there is a common ground between the in-cluster residing parties. This may be a shared interest in a technology segment like electronics, chemistry or medical science or a shared market segment like a focus on the business to consumer (b2c) market.
- A central topic in clusters is stimulating knowledge and business creation. Some parks may focus on knowledge generation others on business creation, depending on the park’s nature (i.e. being a university, government or private initiative).
- The stimuli this definition reveals are knowledge-, technology-, services- and infrastructure-sharing. Thus, supposedly the main mechanisms that drive companies to settle and stay in a cluster are the benefits that ‘sharing’ provides.
- The community exists of a variety of firms (services providers, producing firms, etc.), knowledge institutes (such as universities) and R&D institutes (such as TNO<sup>17</sup>). The mix of firms may differ between parks, think of a focus on start-ups and small firms, or more matured technology leaders; can be the unique selling point (USP) of a park.
- Some parks have an independent professional management. Possible difference regards the influence of residing firms on the SPs activities. A park managed by one of the residents may allow less influence of the other residents than an independent management allows.
- The cluster can stimulate economic development of the region. This mainly relates to the involvement of a government, however economic development of the region can matter for in-cluster residing firms because this increases the probability to find high quality suppliers and consumers that are attracted to settle in (the better developed) proximity of the cluster.

These factors may enable some benefits to emerge. Namely, the characteristics of a cluster (e.g. university and regional development) can attract quality personnel and make personnel more likely to switch between in-cluster firms instead of leaving the cluster. In addition, clusters

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<sup>17</sup> Dutch organisation: Toegepast-Natuurwetenschappelijk Onderzoek <http://www.tno.nl/> (accessed: 1<sup>st</sup> of July 2011)



may foster the generation of new ideas through the high variety of technologies the cluster offers (e.g. combining technologies of different in-cluster firms, possibly developed in collaborations between the separate technology originators). Furthermore, the sharing and proximity factor can support IP in- or out-licensing. It is however not conclusive SPs actually foster these benefits, as comparisons between in-cluster and between in- and out-cluster firms do not consistently display significant differences (see appendix C.5). A sophisticated way to measure cluster performance is necessary to improve theory on the matter. The next section provides a wider discussion on these and other benefits parks may induce.

### 3.3.2 GOVERNANCE & PERFORMANCE

The aim of this study is to create a performance measurement tool in order to assist park managers in optimizing their management policies and park governance. To be able to create such tool it is necessary to identify the benefits these parks offer (like briefly touched upon in the previous section). This is necessary because these benefits make settled firms perform better than they would outside the park.

A difficulty in the management or governance of a park like Chemelot is the high number of stakeholders. This makes their governance similar to that of a network or alliance, which is different from corporate governance in that a corporation serves the interests of shareholders and employees that all have a somewhat similar goal (e.g. survival of the firm & profit). In a network/SP this is not necessarily the case namely, the university is mainly interested in creating knowledge/educating its students, a government focusses on regional development and employment, and residing firms are striving for survival and profits. These goals are not necessarily contradicting, but they do have impact in the SPs governance. Namely, the hierarchical approach of corporate governance does not fit the cooperation between parties that networks and alliances require. On the other hand, characteristics like the geographic proximity between firms, shared facilities, shared management and (as indicated before) the diversity of its stakeholders makes it very different from networks. SP governance is a different type of governance, and the success of this type of governance has yet to be determined (referring to the inconsistent findings regarding the performance of these parks; appendix C.5). Van der Borgh (2007) compared different governance structures in his research at HTCE and found SPs to be closely related to the network governance structure, but claims that a significant difference exists in the tone or climate of the relationships. Within SPs relationships are mainly focused on cooperation instead of co-opetition, furthermore a different type of contracts is used (contracts are of 'neoclassical' form instead of relational). Assuming the difference between contracts, the question remains what the exact role of the



third party is (or should be) in managing these neoclassical contracts between the cooperative parties (i.e. what is the role of park managers). Unfortunately, literature seems not to provide more insight into the matter.

Continuing with park performance, there are several ways to measure the performance of a park, one way is measuring general park performance using the 10 points of Cabral (1998); further discussed in appendix C.5. Another way is to assume that parks perform well when its residents perform well. However, performance depends on goals and a variety of share- and stakeholders includes a variety of goals different from that of an individual firm as was established in the previous paragraph. *When evaluating performance, it is important to determine whose performance is measured.* Bigliardi et al. (2006) propose to take into account each stakeholder, and thus measure over different variables: technical, economic, social and political variables. The measures they propose however, only account for the overlap in needs and expectation of the various stakeholders and thus leave out the specific needs of the individual stakeholders. Carpinetti et al. (2008) make a somewhat different proposition that includes some general variables (economic and social results, collective efficiency & social capital), but also some firm specific variables. They make this proposition after a thorough dissemination of a variety of measurement tools (the balanced scorecard, the performance prism, the SMART performance pyramid and the performance measurement questionnaire). Remarkably, after proposing to measure general and firm specific performance they suggest that measuring SP performance is similar to that of an enterprise. This is remarkable because the variety in share- and stakeholders clearly differentiate a park from a single firm. Carpinetti et al. (2008) seem not to accept the fact that a park is not a single firm, and that the variety of share- and stakeholders demands for a broader range of performance indicators. The performance evaluation of a park like Chemelot needs to include park performance in general and in specific regarding the needs and expectations of each individual share- and stakeholder. The following sections discuss these three parts:

- 1 General performance of the cluster (or Cluster Performance),
- 2 Firm-level performance (Performance of in-cluster residing firms), and
- 3 Shareholder performance (expectations of DSM, the government and UM/MUMC+).

The second part is ought the most important part because it includes the performance of the residing firms, and these are the drivers of the success of a park like Chemelot.

## A CLUSTER PERFORMANCE

Discussing the performance of an industrial- or science park considers the value the park offers, value that is not offered outside of the industrial- or science park. Van der Borgh (2007) used the four value sources by Amit & Zott (2001); earlier discussed in relation to the OI concept. When reviewing the (science park) performance variables that are proposed by several researchers (Cabral, 1998) (Chan & Lau, 2005) (Carpinetti, Galdámez, & Gerolamo, 2008), all of the variables can be divided over these four value sources. It seems these four value sources are the most all-encompassing, and thus they are used to create a structured overview of cluster performance; an extensive review of these four value sources is included in appendix D. Overall, these value sources show that cluster performance is a complex phenomenon because of the various cross-interferences between performance variables. The most important finding regarding structure is that one of the sources of value (complementarities) mostly represents the shared benefits a campus offers, this study will use complementarities to represent the SP concept (or the SP value driver). Thus, settling at a SP has some benefits characterized as complementarities (think of shared knowledge, infrastructure, services and facilities) and these benefits do not necessarily, but may lead towards efficiency, lock-in and/or novelty on firm-level. A park like Chemelot offers three types of complementarities: the brand/image, the knowledge dense/high-tech environment and the ability to share resources.

- 1 Brand & image. Researchers claim that the image of a cluster is one of the most important benefits a cluster provides (Stappers, 2010) (Van Dinteren, 2011) (Cabral, 1998). Firms can benefit the (high-tech) image of the cluster to increase the value of their brand. In addition, other stakeholders such as a local government or a university can benefit (e.g. to attract funding) because the topic (science parks) is high on national political agendas (Christensen, zu Köcker, Lämmer-Gamp, Thomsen, & Olesen, 2011).
- 2 The high-tech / knowledge dense environment is an important benefit to spot alternative technology applications (ATAs) (Bianchi, Campodall'Orto, Frattini, & Vercesi, 2010). Furthermore, it increases the availability of quality suppliers, service providers and quality personnel (think of the network effect).
- 3 Shared resources. This is a very broad term namely, the resources that can be shared are diverse (e.g. knowledge, personnel, facilities, infrastructure, license and other services). The benefit of shared resources is that firms can use a higher variety of resources without having to make the resources internally available.

Important to recognize is that each of the items (complementarities) proposed by Cabral (1998), Chan & Lau (2005) and Carpinetti et al. (2008) can all be divided over these three items,

meaning this structure seems to encompass all complementarities that literature suggests parks offer.

## **B FIRM-LEVEL PERFORMANCE**

Measuring firm performance is an important research topic, first of all because firms are the drivers of an industrial- or science park (without firms willing to operate in a park, there is no park), and secondly in general for firms that operate in highly competitive environments. The indicators often used in firms are 'key performance indicators' (KPI's), which are quantifiable measures which are supposed to reflect a firm's success or lack of it. KPI's exist in many forms as each type of firm and each business unit has its own goals, and thus its own requirements towards measuring performance. Measuring firm performance in clusters requires a set of KPI's that relate to being involved in a cluster, and if possible, they need to be comparable with the values reached by other on-campus firms. Firm performance indicators exist in four types: financial, technological, market and timing performance (Montoya-Weiss & Calantone, 1994), (Langerak & Hultink, 2005); the types are discussed one-by-one below.

### **B1 FINANCIAL PERFORMANCE**

Financial performance is relatively easy to measure using economic measures. Capon et al. (1990) performed a meta-analysis to find the determinants of financial performance, and found the most frequently used measures for financial performance. According to their research, the following indicators are most widely used: Growth and variability in profit (assets, investment, and owner equity), market value, assets, equity, cash flow, sales and market/book value. Bigliardi et al. (2006) acknowledge the frequent use of these financial measures. However, they question their usefulness regarding SPs. The result of measuring financial performance should be useful for a park management; company specific numbers are less useful, except when comparing these numbers with the level of cluster involvement over several years for every firm individually. Better measures have a direct link with the cluster and allow for generalization over firms. For example, Bigliardi et al. (2006) propose project returns (ROA & ROE). These measures are more useful, because they indicate whether the projects executed at the cluster are profitable. Especially when differentiating over projects that are executed by the firm individually or in collaboration with one or several on/off-cluster partner(s).

Another point in financial performance is the resource constraint smaller firms face when developing new products. SMEs are greatly influenced by the availability of external funds, information and capacity (Zeng, Xie, & Tam, 2010). For SMEs that reside in clusters this may be a specific reason to have settled at a cluster, and thus it may be useful to measure the ability of firms to acquire funds, information and capacity for internal development projects.

The other way around is interesting as well to measure the extent to which firms are involved in the cluster, thus measuring whether firms provide/share funds (e.g. investments), information and capacity with other cluster residents.

## **B2 TECHNOLOGICAL PERFORMANCE**

New products are the drivers of sales (Bagchi-Sen, 2000), (Maravelakis, Bilalis, Antoniadis, Jones, & Moustakis, 2006), and thus technological performance is an important determinant of financial performance. A main reason to settle in a cluster like Chemelot is to be in the center of new developments in a specific research field, in this case chemistry; companies expect to become more innovative when situated in a knowledge center.

Bigliardi et al. (2006) found several widely used 'innovation measures' related to technological performance: number of start-ups, number of patents (applied for and registered) and the number and type of new products launched. These measures correspond to factors that are supposedly positively influenced by SPs (Siegel, Westhead, & Wright, 2003) and may thus be useful measures. The number of start-ups touches upon an important aspect as most start-ups are started when firms develop technologies that are expected very profitable but that do not fit the firms' business model or core activity. This means that the number of start-ups can indicate the success of firms in creating new to the firm/campus technologies. The other two measures proposed (the number of patents and new products launched) require some more sophistication. Namely, SMEs often have troubles securing IP rights (Kitching & Blackburn, 1998), (Maravelakis, Bilalis, Antoniadis, Jones, & Moustakis, 2006) and product launches highly depend on the type of product that is developed (considering size of the projects & radicalness of the innovations). Chan (2010) suggests that the wide use by researchers of these indicators is the reason many previous studies on SP performance provide inconclusive results. She votes for using indicators like: the percentage of sales achieved with products/services that were new to the firm/new to the world and other innovative results (i.e. cost reductions, quality improvements, increased production capacity, improved delivery times, sales/profit increase). These indicators provide more insight into the innovativeness of a firm, as the creation of new products is not the only innovative activity firms perform. Kitching and Blackburn (1998) recognize the difficulties SMEs have in IP protection, however strong IP rights are found to be positively related to technology diffusion (Lichtenthaler, 2009), very important in the cluster context as described in section 3.2.3; the number of patents obtained may thus not be the best measure. The percentage of innovations covered by IP-rights may however be useful. Namely, this measure indicates the success of a park to assist firms in securing their IP.

### **B<sub>3</sub> MARKET PERFORMANCE**

An obvious measure of market performance is market share. It shows how well a company is performing in its business segment or with a certain product group, and maybe more important it can be an indicator of a company's market power. However, there are researchers that contradict this opinion and suggest that the underlying resources are a better measure of performance. As the better resources a firm possesses the more likely it is this firm can create value, market share itself has even been found as value destructing (Montgomery & Wernerfelt, 1991). This research suggests that it may be better to use indicators that measure market value to indicate market performance, market value is however difficult to grasp. Brand equity for example un-doubtedly makes a company's market value higher (Crimmins, 2000), but to what extend is difficult to determine (Aaker, 1996); especially in an interview such information is easier to obtain when of qualitative nature. An important value source that may be more easily covered is the (cap)ability of firms to set market standards, which gives firms a strategic advantage and a possibility to capitalize on a technology (Lichtenthaler, 2009).

### **B<sub>4</sub> TIME/TIMING PERFORMANCE**

Langerak et al. (2008) indicate the importance of development cycle time and proficiency in market entry timing on new product profitability. Whereas the latter is difficult to measure, development cycle time is a fixed number and can be related to development cost. This may be interesting as in cluster firms should be able to reduce development times and cost through collaborating efforts; i.e. some activities can be performed by only one firm which otherwise would have been performed by both firms (Chan & Lau, 2005).

### **IN SUMMARY**

Reviewing performance at the firm-level, shows that firm performance mostly considers efficiency, lock-in and novelty. Namely, financial and time measures are indications of the efficiency of residing firms, technological measures deal with the ability of firms to be novel and market performance has a link with lock-in. It seems that cluster performance is mostly related to complementarities and that performance at the firm-level considers the other value sources, the value sources may prove useful to characterize the performance indicators created for the performance measurement tool.

### **C SHAREHOLDER PERFORMANCE**

This section considers the individual expectations of shareholders regarding the performance of the cluster. DSM is regarded as an in-cluster firm and therefore belongs to the discussion given in the previous section, the other specific expectations of DSM are covered in chapter 2.

### C1 PERFORMANCE FOR THE LOCAL GOVERNMENT AND SUBSIDIARIES

Regional development is important for stakeholders outside of the cluster (e.g. local government). In addition, a cluster can benefit from its regional environment, as a higher developed region is better capable of supporting a cluster in its needs for resources and development possibilities. At the regional level some standard indicators may already give insight into the support of a cluster for the region: Employment (and educational level of these employees), number of new settling firms, number of start-ups (and number for bankruptcies) and the number of patents and new products the cluster/region brings forth (Siegel, Westhead, & Wright, 2003). However, next to the production provided by the cluster and region the cluster is also supposed to be an attracting factor for extra-regional and foreign parties. Bigliardi et al. (2006) suggest that foreign investments and personnel (in)flows are important boosts for regional development. Other regional development supporting changes they name are the installment of new laboratories and training facilities and the amount of collaborations the cluster forms with regional firms. Van de Borgh (2007) adds the money generating aspect a SP has for the government through taxation. This and other elements suggest that the park is not the only/main focal area of a local government, but any firm that can be attracted to the area is interesting even if they do not settle at the park.

### C2 PERFORMANCE FOR THE LOCAL UNIVERSITY AND OTHER KNOWLEDGE INSTITUTES

Most SP have a university attached to it, whether they actually spur performance can be a point of discussion. For example, Bakouros et al. (2002) discuss the performance of a SP through the type of relations it has with the local university. They find that universities forms mostly informal links, and do not indicate whether more formal or informal links are desired in order to spur innovation; they do indicate synergy as an important factor. An important question attached to the performance of the cluster regarding the university as park stakeholder is: *what is in it for the university?* When considering the goals of a university, its main interest lies in science with a focus on educating new scientists and performing research. For example, the mission statement of the Eindhoven University of Technology describes that its mission is to offer excellent teaching and research and thereby it contributes to the advancement of technical sciences and research<sup>18</sup>. A secondary goal is to use the advancements in science to develop business, or said otherwise to valorize knowledge. According to this mission statement, the educational level of students measures the performance of a university in relation to a SP. Other important items are the ability of the university to increase

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<sup>18</sup> <http://www.tue.nl/en/university/about-the-university/profile-tue/> (accessed: 20<sup>th</sup> of September 2011)

knowledge generation through cooperation with in-cluster firms, the ability of the university to valorize knowledge through in-cluster firms.

### 3.3.3 MEASURING PERFORMANCE

Previously we have identified a number of performance measurement tools researched by Carpinetti et al. (2008), the three most intensely used are the balanced scorecard, the performance prism, and the SMART performance pyramid. This section is included in this thesis to create a structured way towards forming a set of performance indicators.

The balanced scorecard uses KPIs, this is not ideal in this situation as for most topics a quantitative answer does not provide sufficient information to actually be useful with regard to policymaking (Pawson & Tilley, 1997). A nice aspect is that KPIs are very usable for long-term measurements and the balanced scorecard exists of four critical factors that each need to improve in order to reach the predetermined goals. The performance prism is based upon the need for organizations to have a clear picture of the needs of their stakeholders in order to be successful. Based upon the needs of stakeholder the strategies are formed that determine the processes that are initiated. These processes determine the need for capabilities and thus too what is needed from stakeholders to contribute. This thesis only includes indicators that assist managers in forming park policies, this means the performance prism is a too extensive method and out of the scope of this thesis. The SMART performance pyramid measures performance over all layers of an organization, the benefit is that measures at the lower levels correspond with the corporate vision. Also it differentiates between internal efficiency and external effectiveness, this may be useful when considering OI practices within the SP by differentiating between firm internal performance (e.g. profits and patent count) and firm external performance (e.g. SP satisfaction, SP image)

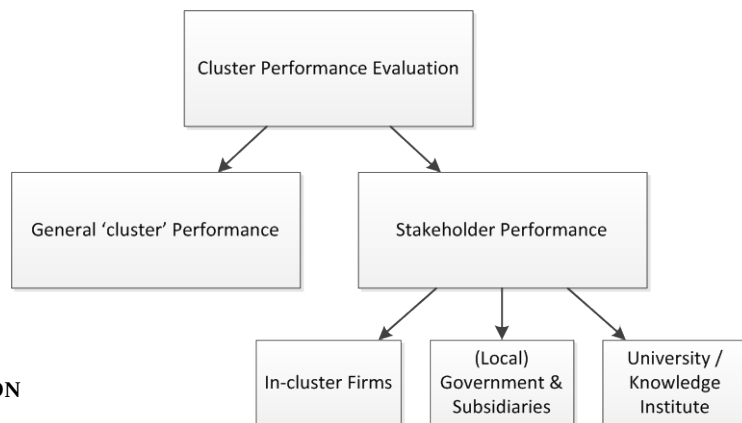
Neely (2007) summarized the main characteristics of these and some other methods:

- The results should provide a “balanced” overview (including financial/non-financial, internal/external, and efficiency and effectiveness measures),
- The method should be simple and intuitive,
- The set of measures should be multi-dimensional (there is no consensus on what the indicators for performance are and as such all aspects/sides need to be included),
- The measurements should be comprehensive (this way it can show what areas have been omitted or need focus),
- The measurements need to include not only organization wide measures but throughout hierarchical levels, and



- Measurements should provide data that not only shows past performance but also allows for future planning.

The second characteristic identified by Neely (2007) is very important in this discussion, the method should be simple and intuitive. This not only regards the way the measurements are performed, but also the way the results are displayed. “*What you measure is what you get!*” (Kaplan & Norton, 1991), this means that simple and intuitive measurement lead to simple and intuitive results which can understood and interpreted better, and thus will more likely lead to performance improvements. Considering these characteristics proposed by Neely (2007), cluster performance needs to include firm internal, general cluster and measures related to the other stakeholders. Furthermore, the measures need to consider the context and mechanisms that are into play. This agrees with the chosen thesis research design, partially based on theory proposed by Pawson and Tilley (1997) who touch upon this important aspect. They advocate that evaluation should be realistic; measurements should result in useful information only. This means measurements should not just indicate that something works, but also why something works. The model below (model 3.1) displays the various parts of a cluster that need to be included in order to create an evaluation tool that encompasses all aspects of the cluster.



**MODEL 3.1: EVALUATION DIMENSIONS**



## Chapter 4: INTERVIEW PREPARATION

The data for this research exists of data acquired from the Chemelot organization and literature (chapters 2 & 3), complemented with a series of interviews. Interviews are necessary for creating a performance measurement tool, firstly to make the tool specific for the Chemelot Campus and secondly because of the greater depth of information this provides which is necessary as described in section 1.2.2. This chapter will describe the preparation of these interviews. This includes the choice for the various interviewees and what information each of the interviews aimed to retrieve.

### 4.1 INTERVIEW SUBJECTS

The Chemelot Consortium Management is the first subject to discuss. Namely, they are the ones that will use the result of this project and will thus partially shape its content (appendix F). Furthermore, they are the subject of research; a performance measurement tool ultimately has the goal to improve/adapt their policies to stimulate performance improvements. The main/formal interview with this organization aims to obtain knowledge of the current strategies of the park management. This includes the way the organization perceives the needs that firms have regarding certain facilities, why firms choose to settle at Chemelot, and what makes them stay. Lastly, it includes the focus of the management concerning the ‘performance improvement’ of the cluster (what is performance and how will it be improved?).

Interviews with the Chemelot Consortium management resulted in a list of subjects for the interviews (Appendix E). First, for firms exist of four different categories represented by the quadrants in the table on the right (table 4.1). A differentiation between smaller and larger firms is interesting because of the significant differences between these firms regarding resources and their approach towards innovation, and because Chemelot is characterized by two significantly larger than average firms that reside at

	Small firms	Large(er) firms
LS		
MS		

**TABLE 4.1: FIRM TYPES**

the campus. Life Sciences (LS) and Material Sciences (MS) are the two business areas on which the Chemelot Campus focuses, these areas are interesting because these segments too are very different. LS is a new, small and very complex business area compared to MS which is a very large and established research area (also in the region of Chemelot; DSM). The information acquired from these firms is focused on their believe/experience regarding the benefits of the cluster for their business in terms of efficiency, complementarities, lock-in and novelty.

Furthermore, firms experience the important activities and processes that simulate/hamper the development of the Chemelot Campus. This information is useful to create measurement indicators and in addition, it provides direct feedback for park managers.

Whereas the in-cluster firms may have similar experiences, service providers are expected to have a different opinion. First of all the in-cluster firms are their customers, this means they have much less interest shared cluster facilities (i.e. licenses and labs); at least considering a direct interest in using such facilities. Service providers are more likely interested in the Chemelot Campus organization such that their customers will remain successful (the more successful their customers, the more likely they can do business; think of IP protection services are more likely to thrive in a very successful innovative cluster). The aim is that the service providers can provide a second opinion on the cluster organization and offered facilities next to the information Chemelot management and in-cluster firms provide.

The shareholder are a necessary element in this project, they provide insights on the goals of the Chemelot Campus regarding their own interests (performance depends on goals). DSM is the leading private partner and park resident, the main topic of the interview is why DSM has chosen for a transition of the DSM research Campus towards a new modern research park in which many other firms settle, and what DSM aims to achieve with this transition. The UM / MUMC+ is the leading knowledge institute. The aim of this interview is similar to that of DSM. Namely, what is their interest in the park and when do they consider their alliance with the park a success. The role of the government is somewhat different (according to the MasterPlan they agreed to enter the consortium taking a major share: 80%). The government can clarify what the role of Chemelot is in stimulating regional development and what they intend to do with their share in the consortium. This is interesting because a government institute cannot be expected to take a leading role in the parks development (think of government support which is restricted by European law and it is very unlike a government to take an active role as enterprise); managing a park is not a government core activity.

The other stakeholders involved in this project are two knowledge institutes, an organization that has been set-up to stimulate and accelerate regional (innovative) business activity and a venturing firm that has been set-up specifically for the Chemelot Campus. One of the knowledge institutes is not located in the direct proximity of the cluster, but has a significant overlap with the parks knowledge segment (Chemistry and Biomedical science). This knowledge institute, sporadically named in the Chemelot Consortium MasterPlan, may have some goals regarding possible cooperation with the cluster. The other knowledge institute already has active ties with the cluster and thus is able to provide information on the further development of the cluster regarding actual experience in their dealing with the park.

Furthermore these knowledge institutes will likely have an opinion on the cooperation between the UM/MUMC+ and the cluster. The other institutes need to be included firstly to clarify their role in the campus and its development efforts and secondly their experience may clarify difficulties the Chemelot Campus faces on a regional, national and possibly even international level.

## 4.2 INTERVIEW SET-UP

The interviews aim to gather knowledge on goals, experience and expectations of the selected variety of cluster share- and stakeholders. When choosing between types of interviews, the semi-structured and unstructured interview suit this purpose best. Namely, the topic is known and some more specifics have been defined (i.e. the value sources) but each subject will have a focus or its own interests, which means more in-depth information will be gathered using these types of interviews instead of a survey. A benefit of semi-structured interviews is that the information obtained is more likely to include information beyond the specific answers to the questions; such information is not obtained when structured interview format is used. The topics the interviews need to discuss are defined in the literature review (Chapter 3 and appendices C & D). These topics, previous research at HTCE performed by Van der Borgh (2007) and research by Amit & Zott (2001) (2002) considering the value sources resulted in an interview protocol for semi-structured interviews. The semi-structured type has the benefit that it remains relatively easy for the interviewer to keep track of- and discuss all of the topics. Appendix G presents the basic design of the interview protocol.

It was necessary to adapt each protocol for the needs of every individual interview (because of the extreme variety between the subjects). Every adapted version was based on the one displayed in appendix G. The basic version of the interview protocol was primarily designed for interviews with in-cluster firms. It shows open questions split up over three levels (firm, cluster and regional level); done in this way as proposed in the research proposal by HsZuyd. In a later stage, this division changed to two levels (cluster and stakeholders) as proposed in chapter 3 (for the interviews this only resulted in a minor change in structure). The main results of the interviews will be discussed in section 4.3, and a more extensive analysis is given in appendix H.

#### 4.2.1 VALIDITY AND RELIABILITY

The topics of validity and reliability have been touched upon in the first chapter of this thesis, which stated that this thesis has very limited validity and reliability, which is deemed inherent to the exploratory nature of this study. Efforts made to increase validity and reliability of this study are given below.

First of all the result of this study builds on three different information sources. These sources are literature, documentation provided by the Chemelot Consortium and a series of interviews. Using documentation from the Chemelot Consortium such as the MasterPlan improves internal validity, but it reduces the ability to generalize findings. Second, the interviewees consider all related parties except for the UM/MUMC+. This means that the information is not only obtained from directly involved parties, but also from parties that have a more distant relation with the Chemelot Campus. This means the study is provided with in-depth as well as general data. Moreover, including the perspectives of the shareholders clarifies the important aspects of the Chemelot campus for the different parties, providing this study with multiple perspectives on the performance of the Chemelot Campus. One of the major threats towards the validity of the data obtained with interviews is the 'social desirability'. Namely, the shareholders have committed to the Chemelot MasterPlan and thus need to respond according to this plan. Furthermore, an issue is that in-cluster residing firms are mostly influenced by the results of the CHEMaterials project and will thus mostly try to touch upon issues they desire to be resolved as soon as possible as opposed to issues related to the long term development of the Chemelot campus. Third, this thesis and the interview protocol are based on previous research performed at HTCE and on research performed by Amit & Zott (2001), in which the used questions were tested on validity and reliability. However, these studies focus on acquiring data usable for statistical analysis whereas this thesis focused on acquiring in-depth knowledge on the activities and processes that play a role in campus development. Furthermore, the questions proposed by these studies were found too difficult for entrepreneurs in order to lead to in depth knowledge, and thus have only been used as guidelines for the semi-structured interview protocol. Fourth, an effort to improve the reliability of this study was done by allowing the respondents to reflect on the results of the interviews. The reflections received were mostly positive; unfortunately, only few of the interviewees responded (2 out of 14 reflecting on the raw data and 2 out of 14 reflecting on the analysis of all interviews). The next section provides an overview of the main results of the interviews. Business professionals have acknowledged the topics mentioned, but overall validity and reliability of the results are low. This is mainly due to the low number of respondents and the exploratory nature of this study.

### 4.3 INTERVIEW ANALYSIS

The interviews are divided over 3 groups, next to the Chemelot Consortium these groups are the in-cluster firms, the shareholders and other stakeholders or 2<sup>nd</sup> tier parties. First, these three groups are discussed where after the insights of the Chemelot Consortium are given (a more extensive analysis is given in appendix H).

#### 4.3.1 FIRMS & SERVICE PROVIDERS

With regard to the performance of the cluster, most firms address three issues. These three issues are (1) basic utilities & infrastructure, (2) the ability to network and (3) the ability to obtain financing. The first issue is perceived as a negative aspect by non-DSM firms. Firms have trouble with organizing basic utilities, and indicate a relation with the differences in size between firms. The smaller firms believe they are not perceived as an important part of the campus because of their relative small size, they indicate that because of this their desires regarding basic utilities are not addressed properly. The second aspect is expected to have a lot of potential, most firms show interest in the ability to attend symposia and other meaningful events with the ability to meet other firms regarding these topics. The third aspect is the ability to obtain proper financing, which firms indicate to be one of the stronger aspects of the Chemelot Campus. This considers both the number of options to obtain financing and the support the Chemelot organization offers in this matter.

Some less often addressed, but important issues are:

- Producing/fabricating chemical goods is a unique selling point (USP) of the Chemelot Campus (also an important driver to settle at the campus),
- Firms indicate there are not enough sufficiently large firms that have the ability to cooperate on a significant level,
- Though, with regard to the previous item some firms stress that new large firms are not desired to settle regarding their need for employees (regarding the image benefit large firms have in order to attract quality staff); currently Chemelot seems to be a location that is sufficiently able to provide an inflow of personnel.

When addressing the value drivers, firms perceive the questions and topics as very difficult. Entrepreneurs do not speak the theoretical language used in the survey; mostly they refer to examples from practice. In general firms acknowledge that the shared services and facilities Chemelot offers drives them to settle or remain settled at the campus (e.g. shared licenses and production facilities). Efficiency is the weakest aspect of the campus, firms perceive the campus as an expensive location and firms indicate that organizing basic needs takes too much effort. Lock-in is perceived as very important by some firms (i.e their customers are located at

the campus), others perceive it as a natural phenomenon (i.e. their employees, and thus their knowledge only exists at this location). Novelty is not directly linked to the campus, firms indicate that innovations often originate from outside Chemelot.

#### 4.3.2 SHAREHOLDERS

The MasterPlan shows the common and individual interests of the three shareholders (the local government, DSM and UM/MUMC+). With regard to performance of the cluster, their main interest is growth (+1000 fte). The government needs growth because this aids them in their effort to develop the region. DSM desires growth in order to reduce their responsibility with regard to the development of the campus. The university benefits from growth because this increases their ability to perform applied research in cooperation with professionals (in order to increase their rank as a university on an international level). Other interests mostly regard individual needs of the shareholders, these are less relevant for the development of the campus but they do are the reason for the Chemelot Consortium to exist and thus do need to be included into a performance evaluation. Chapter 2 and appendix H provide more information on the individual needs of the shareholders. Some important remarks are:

- The local government perceives the image of DSM as an important factor to attract people to live in the region. Chemelot may be able to take over this role.
- The OI concept is an important part of DSM strategy, however (with regard to the interviews with in-cluster firms) not all firms believe to fit this concept very well.
- Some parties have pointed out some doubts about the ability of the university to incorporate into Chemelot in a successful way. The UM/MUMC+ has not been available for an interview, which may indicate that these doubts are not without grounds.

With regard to the value sources, the survey addresses in-cluster residing firms. When touching upon the topic with the shareholders they indicate that the complementarities and efficiency are the most important issues, lock-in and novelty are perceived a natural consequence of the other value sources.

#### 4.3.3 2ND TIER PARTIES (THE 'OTHER' STAKEHOLDERS)

The 2<sup>nd</sup> tier parties exist out of two groups: knowledge institutes and business accelerators. Each of the parties acknowledges they can or do play an important role in the development of the Chemelot Campus. The knowledge institutes stress the overlap they have with the Chemelot Campus and recognize that knowledge-to-business relations can make their institutes stronger. However, with regard to the performance of the cluster they currently see no benefits in a physical location at the campus because the cluster does not offer much

beyond what the knowledge institutes already possess. They do see the potential of a physical location, but the campus needs to offer:

- High-end facilities (also for educational purposes),
- Structural dynamic meetings between professionals and students, and
- A co-location for students of various levels and business professionals.

The other institutes (business accelerators) have the purpose to speed up economic development in the region, or at Chemelot in specific. These organizations provide venture capital and management support; the stronger aspects of the campus. The organizations believe that Chemelot is a young campus. A start is made with the first firms settling at the location, and plenty of space is made available for further development. However, Chemelot is not yet an established name, Chemelot is not (yet) a 'magnet' for chemical industry; development is ought to take 10+ years. They remark that in order to become this 'magnet', some elements that require attention. First, the basics need to be in order (utilities, infrastructure and critical mass in firms and services). Second, the government must facilitate beyond funds and thus actively assist the cluster to convince firms to settle at Chemelot. Lastly, the university can use Chemelot to climb in rank of universities worldwide, but starting a beta faculty in the Netherlands may lead to rivalry between universities; an undesired effect.

Overall, parties need to lose some of their identity in order to achieve the common goal! Firms that settle at Chemelot need to add something to the cluster; this reduces the speed of growth, but increases the relevance of the OI concept.

#### 4.3.4 CHEMELOT CONSORTIUM MANAGEMENT

The Chemelot organization that has the task of developing the campus stresses the transition of the location over time, and that Chemelot needs to be a hotel-like environment that facilitates transition. This means that Chemelot should only offer the services and facilities everyone uses, but which are not offered by other service providers. Firms pay a park premium to be located in proximity of other firms, and the services and facilities these firms offer. An example is that the Chemelot organization is not the specialist firms need to organizing basic utilities and infrastructure, and thus Chemelot should minimize its involvement.

The next chapter (chapter 5) will use this analysis and the structure created with literature to design a performance evaluation tool. This means the chapter will not address the four groups as used in this analysis but discusses performance of the cluster in general and in specific regarding the in-cluster firms and each shareholder. Furthermore, the tool will touch upon topics that are found important in general literature and specific in the case of Chemelot.



## Chapter 5: DESIGN OF THE PERFORMANCE MEASUREMENT TOOL

This chapter shows the design of the performance measurement tool. First the design specific requirements and constraints (section 5.1) based upon section 3.3 are discussed. The following sections analyze the data obtained with the interviews using the structure as proposed in chapter 3. Section 5.2 considers general cluster performance, discussing the common interest of the shareholders in Chemelot and the three main benefits that clusters are found to provide (brand & image, high-tech / knowledge density and sharing resources). Section 5.3 considers the performance of the cluster on firm-level. This means it covers the performance of the firms in relation to the cluster and not the performance of the cluster according to firms. The last part, section 5.4, considers the performance expectations of each shareholder, this mostly considers information that is considered important to keep track of by the specific shareholder. Figure 5.1 on the right hand side provides an overview. More information is provided in the appendices; appendix J provides the final designs in the form of questionnaires (the indicators are re-ordered by the subject that needs to provide the information for the indicator) and appendix K provides more details on each of the indicators.

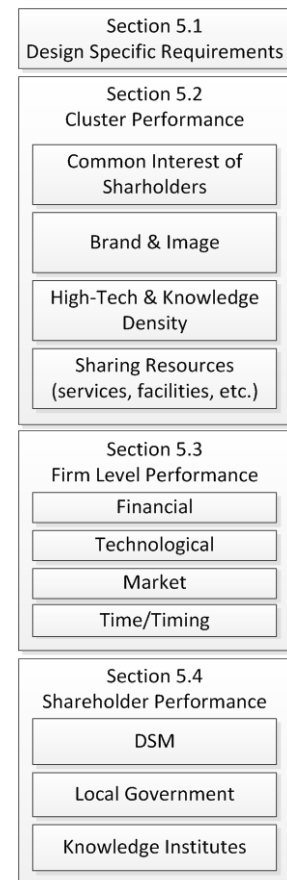


FIGURE 5.1: CHAPTER 5 STRUCTURE

According to section 3.3, measuring performance over four value sources (complementarities, efficiency, lock-in & novelty) as proposed by Amit & Zott (2001) provides the most comprehensive overview; encompassing performance measures provided by several researchers. Performance at the cluster- and firm-level closely relates to these value sources. The main benefits a cluster provides are benefits that firms have within the cluster that they would not have outside of the cluster as individual firms, closely relating to complementarities. Performance at the firm-level is measured with financial, technological, market and time/timing indicators, these indicators closely relate to efficiency, lock-in and novelty. For the sake of clarity there has been chosen not to organize the performance indicators over these value sources, but to uphold the structure that has been used throughout this thesis and as explained in figure 5.1. However, due to the clarity the value sources provide in order to explain performance, the constructs are mentioned when discussing the various indicators (in appendix L each of the indicators on cluster- and firm-level are related to a value source).



## 5.1 DESIGN SPECIFIC REQUIREMENTS & CONSTRAINTS

The design of the performance measurement tool has to adhere to a certain set of requirements. The last section in chapter 3 (section 3.3.3) gives some insight in requirements regarding the usability of a measurement tool. However, in addition to these there are specific requirements and constraints for the tool regarding its usability for the Chemelot Campus.

### 5.1.1 REQUIREMENTS

- The results should provide a “balanced” and “comprehensive” overview including the various dimensions related to a cluster.
  - Measure general cluster performance and stakeholder specific performance
  - Measure performance over the identified value sources
  - Measure on both quantitative and qualitative level
- The method should be simple and intuitive.
  - Data needs to be relatively easy to obtain
  - Data needs to be clear, data can be interpreted with limited effort
  - Data needs to be ‘user friendly’

### 5.1.2 SIDE CONSTRAINTS

- Measurements should provide data that represents campus development
  - shows past performance, current development and trends
  - indicators need to be relevant today, but also in the future
- Allow for governance policy making/adjustments
  - Information should provide relevant data
  - Information has sufficient breadth and depth
- Useable with regard to either data collection and presentation

Not all of the constraints are necessarily ‘hard constraints’, necessary is that a balanced overview of campus development is provided. The indicators formulated in the sections below cohere to the requirements listed in chapter 3 and those listed above. Appendix I shows a table that represents the extent to which each of indicators adheres to the requirements and constraints.

## 5.2 CLUSTER PERFORMANCE

Chapter 3 establishes which benefits (or complementarities) Chemelot is expected to offer (section 3.3.2, page 27), and it defines performance of the share- and stakeholders in specific. This performance measurement tool will not directly clarify whether the benefits induce

performance of the share- or stakeholders, but it will establish whether the expected benefits are perceived as such by share- and stakeholders as well as that it shows what the level of performance of the cluster is for each of the share- and stakeholders. This section will discuss the benefits a cluster is expected to offer and the indicators that may be used to measure whether these benefits are perceived as such by share- and stakeholders.

#### 5.2.1 COMMON INTEREST OF SHAREHOLDERS

In general, the aim of the cluster is to sustain and increase its current level of knowledge and knowledge development (see chapter 2). Knowledge mostly depends on people and thus this aim can be translated into growth (fte); see indicator 1.

- 1 Number of jobs (fte) the Chemelot Campus provides for.
- 2 Chemelot is an attractive location to reside/settle.

However, the number of jobs the park provides for does not allow for regulative actions, complementing the first indicator with indicator 2 provides more information. A combination of these two items shows stakeholders the actual growth Chemelot displays, and why Chemelot grows (or not); attractiveness is a measure of overall value, with a direct relation to image that is discussed in the next section.

#### 5.2.2 BRAND & IMAGE

Regarding the first complementarity (image), the Chemelot brand is an important asset for all stakeholders of the Chemelot Campus. The value of a brand can be increased either directly (with image) or indirectly (through its underlying or functional value; described in sections 6.1.2 & 6.1.3), in the context of the Chemelot Campus the latter is suggested more effective in the long run. However, when considering the different stakeholders there exists a variety of requirements considering brand & image. To attract firms to settle at the park the underlying (functional) value can be regarded the most important factor, but to attract people (employees and students) towards the region the image may be a more effective factor. To determine whether any effort towards either strategy is required measurements need to be performed over two levels: image and functional value. Functional value relates to the attractiveness of the cluster (indicator 2). Useful to measure concerning image is visibility (see discussion in section 6.1.1 and theory on innovation diffusion in section 3.2.3):

- 3 Chemelot improves visibility / observability?

Each stakeholder has its own interest in 'being visible' (cluster management: to attract new firms, firms: to attract new employees and/or business, knowledge institutes: to attract (foreign) students, research projects & investors/subsidies, local Government: to attract people

to live in the region) and thus this indicator may need some additional information for stakeholders before confronting them with the issue.

### 5.2.3 HIGH-TECH / KNOWLEDGE DENSITY

In a knowledge driven economy, it is very interesting for firms to reside in a high-tech and knowledge dense environment like the Chemelot Campus because of possible knowledge spillovers and networking potential. This can stimulate internal innovativeness, but also increases the ability to spot value for internal technologies outside the firm (OI). It is expected that the number of firms, the type of firms and the methods applied to spread information heavily influence the effect of the high-tech environment on firms (think of the network effect & innovation diffusion and see appendix D for diversity of knowledge regarding the value source: novelty). In the interviews, firms mostly agree that the campus needs to grow, some referring to a certain critical mass in order to consider the cluster successful. However, an important remark is that ‘the focus’ should lead park development, “*m<sup>2</sup> can only be used once*”. Firms indicate they prefer medium-large firms to settle because these firms have the resources to cooperate on a significant level.

- 4a Number of firms that reside at the campus.
- 4b Number of firms settling / leaving the cluster.
- 4c Size of settling / leaving firms.
- 4d The new firms add something ‘new’ (technology / service) to the cluster.

A knowledge institute is a critical component regarding the knowledge base of a campus (i.e. quality personnel, education, valorizing knowledge), incorporation of a knowledge institute in a park is considered an important aspect of cluster performance management.

- 5a Chemelot increases the ability of my firm to maintain and/or increase its knowledge base (Ability to attract quality employees including students/graduates, and the ability to complement internal expertise with external sources).
- 5b Chemelot increases the ability of my knowledge institute to maintain and/or increase its knowledge base (Improve the readiness of students for their professional life, and the ability to perform applied research with firm professionals).

### 5.2.4 RESOURCE SHARING

Sharing utilities, infrastructure, facilities and services has most potential to be a significant and visible value source for any stakeholder. This complementarity can be used to increase the efficiency of resources, to secure the survival of the cluster (lock-in) and to support and increase in knowledge and business development (novelty). With the following indicator,

managers can determine which of the shared resources the stakeholders have most difficulties with (managers need to focus on removing possible blockages; section 3.2.1). If a pilot measurement provides too little in depth information the indicator can be split up over the shared resources that are included in indicator 6.

- 6 Chemelot offers the utilities, infrastructure, facilities and services my firm needs to perform efficiently.

Next to removing possible blockages, expected from managers is that they stimulate performance. Sharing resources is an important aspect for the Chemelot Campus, and thus this is an important 'satisfaction' measure. Share- and stakeholders expect Chemelot management to develop the campus with the aim of stimulating this concept (e.g. attracting firms towards the park that are able to provide certain facilities or services). A visible strategy or focus of managers improves satisfaction and trust.

- 7 Chemelot has a clear strategy and focus in developing the Campus.

When considering the strategy and focus of the Chemelot Campus, some items are strong aspects of the park, and others as weak or underdeveloped. Furthermore, some of these items are important for the future development of the campus (opportunities and threats). Chapter 2 provided an assessment of the critical success factors and weaknesses of the park, with regard to the findings in this chapter the discussion in the next chapter reflects on these elements using the SWOT-model (model 6.1).

### 5.3 FIRM-LEVEL PERFORMANCE

This section covers the performance of the in-cluster residing firms. The structure of this 'firm-level' performance is similar as proposed in chapter 3, which means it uses traditional performance measurement indicators. As discussed earlier in this chapter, these traditional indicators have a close relation with the value sources efficiency, lock-in and novelty as proposed by Amit & Zott (2001), appendix L shows this relation (indicators 8 through 14). The traditional performance measurement indicators as proposed in chapter 3 are spread over four types of performance: financial, technological, market and time/timing performance. This section provides a discussion on each of these types.

Useful measures regarding cluster performance have a direct link with the cluster and allow generalizing over firms. Very useful for long-term measurements are project returns (Bigliardi, Dormio, Nosella, & Petroni, 2006) like return on assets (ROA) and return on equity (ROE). Project returns are useful because they give an indication of the profitability of projects executed at the cluster, especially when differentiating between projects executed by the firm individually or in collaboration with other (in-cluster) firms.

- 8a Average project returns (ROA and or ROE).
- 8b Chemelot enables my firm to achieve higher project returns.

Another aspect of financial performance with regard to the cluster is the resource constraint (smaller) firms face when developing new products, firms at Chemelot indicate they prefer some medium-large firms to settle at the cluster because these have the means to engage in significant joint operations. However, another possibility that may reduce this desire is improved financing possibilities for smaller firms; clusters should be able to provide better options for (smaller) firms to acquire funds or other types of resources.

- 9 Chemelot improves the ability of my firm to acquire resources (i.e. financial, knowledge or capacity) to support development projects.
- 10 My firm invests its resources (i.e. financial, knowledge or capacity) in products or project of other in-cluster firms.

The second indicator (indicator 10) added determines the extent to which firms are committed to the cluster (and thus locked-in), an addition to indicator 9.

Next to financial performance, firms expect clusters to provide some other benefits. An important aspect is 'novelty', which resembles the innovative strength of the cluster. One clear measure is the ability of the cluster to generate and attract start-ups because this shows the ability of the cluster to generate 'new' technologies and to support the development of these technologies.

- 11 Number of start-ups generated and attracted by the cluster.

Other standard measures of innovation need somewhat more sophisticated because of difficulties attached to these measures (see section 3.3.2).

- 12a Chemelot enables my firm to improve its innovativeness.
- 12b Percentage of sales/profit achieved with products/services introduced last 5 years.
- 12c Number of cost reductions achieved last year.
- 12d Number of quality improvements achieved last year.
- 12e Production capacity increased with ... (%).
- 12f Delivery times reduced with ... (%).
- 12g Number of innovations achieved last year and amount (%) covered with IP-rights?

The indicators 12b through 12g need to testing with a pilot measurement to see which of these indicators cluster residents most easily provide an answer to; in order to improve the user friendliness of the measurement tool.

Next to innovativeness, firms need to be able to capitalize on these innovations in order for innovations to be successful. However, measures such as market share, and brand value are difficult to grasp; the value of a firm related to the cluster is an indication of lock-in and

already included in measures previously proposed. An important cluster related aspect that is useful and measurable is that clusters can make it easier for firms to set market standards.

13 Chemelot improves my firms' ability to set market standards.

A last remark considers cluster efficiency. Firms that reside in a cluster should be able to reduce their development cycle time (e.g. because of the ability to use resources of other in-cluster residents). A benefit of a measure attached to cycle times is that it is less generic (than: Chemelot improves my efficiency?) and thus easier to answer for managers, while the answer will contain similar and possibly more information (if the indicator is complemented with an answer of qualitative nature).

14 Chemelot improves my firms ability to reduce development cycle times.

## 5.4 SHAREHOLDER PERFORMANCE

The section covers the performance of the cluster regarding the shareholders. The shareholders have combined their goals in the MasterPlan, but on top of this plan the interviews reveal the main interests of each individual shareholder that are covered in this section. DSM is considered as an in-cluster firm, but regarding its role as shareholder some specifics are included in this section. Next to DSM the performance expectations of the other shareholders are covered, these other shareholders are the local government (province of Limburg) and the knowledge institute (UM/MUMC+).

### 5.4.1 DSM

There are two main reasons for DSM to transform the DSM research campus into the Chemelot Campus. The first is that DSM no longer desires to have a majority share as campus resident; this in order to reduce the responsibilities other stakeholders expect DSM to act upon. The second is that a cluster in which small and large firms develop and produce provides benefits regarding overall knowledge and business development. Indicator 1b covers the first item by adding the share of DSM (fte) to indicator 1 (represented below by indicator 1a).

1a Number of jobs (fte) the Chemelot Campus provides for.

1b Share of DSM ( $\text{fte}^{\text{DSM}}/\text{fte}$ ) at the Chemelot Campus.

However, the share (in fte) DSM has at the cluster may not entirely give accurate insight into the actual influence of DSM on the clusters organization. Namely, a result of the interviews is that many firms see problems in the DSM culture that remains dominant, because this determines the operation and organization of the cluster. Indicator 15 is an addition to indicator 1b, especially interesting for DSM to acknowledge whether a difference exists between culture and facts and thus whether reducing its share (in fte) has the desired effect.

15 To what extent is Chemelot a DSM Campus? (%)

The second item named by DSM is partially included in previous measures that deliver quantitative information on the size of the cluster (number of jobs and firms), average project returns, improved innovativeness, and qualitative information on knowledge creation and retention. However, an overall quantitative number is interesting to see whether the cluster fairs well compared to the national and international situation. Furthermore, dividing this figure over cluster size provides information on the production achieved by in-cluster firms, supposedly higher than in out-cluster situations.

16 Total cluster turnover and growth (compared to previous year).

#### 5.4.2 THE PROVINCE OF LIMBURG

The government has mostly financial expectations of the cluster. Namely, it has a majority share in the consortium (with a significant investment attached), with the aim to stimulate regional development. To achieve this development the regional government needs a cluster with high brand equity (indicators 2 & 3), this enables them to attract people to live in the region. Ultimately, the government desires to sell its share in the consortium to a private party (as it is not a core activity of the government to manage an industrial park); a solid business plan will enable this (indicator 7 touches upon this matter). Next to these items, the financial involvement of the government involves the following items relating to real estate and funding:

17a Amount of buildings in use & change perspectives.

17b Cause of unused buildings / space.

17c Amount of rent money brought in.

17d Amount of funds used to cover losses.

17e Amount of area in use & change perspectives.

17f Amount of Venturing Fund used.

17g Use of funds to set-up/organize the Chemelot management.

Next to park performance and important topic is the performance of the government. Namely, the national government designates Chemelot as a cluster of national importance regarding the competitiveness of the national economy. As such, the governments' focus should be to provide the Chemelot management with the means and aid to maintain and increase this position according to the MasterPlan. However, because the government is 'content wise' only limitedly involved in the clusters affairs it is the task of the Chemelot management to indicate what means and aid should be provided (e.g. a business model and separate business cases);



this is resembled by a quote from the interviews: “The government can use its ‘power’ to regulate. For example it can ‘fix’ the location a firm settles at through providing a license, or not.”

18 The local government is effectively using its ‘power’ to assist Chemelot with the development of the campus.

### 5.4.3 UNIVERSITY MAASTRICHT / MAASTRICHT UNIVERSITY MEDICAL CENTER

The last shareholders is the UM/MUMC+, but because this shareholder did not participate in this study this section is partially based upon other knowledge institutes (stakeholders of the Chemelot campus). There are several institutes involved with the Chemelot Campus some more than others are located in its proximity. The MasterPlan provides some specific interests of the UM/MUMC+, but also the other knowledge institutes see potential in strengthening relations with businesses. This leads to an important aspect of the triple-helix concept, which is the successful incorporation of a knowledge institute in the cluster. A suggestion is to measure the successful incorporation with the number of relationships between institutes and businesses. In addition, the reasons why relations with universities form are important and thus a qualitative aspect needs to be included.

19a My firm has performed/performs projects in corporation with the local/regional knowledge institutes and will do so in the future.

19b My institute is able to connect with firms to perform (applied) research in cooperation with in-cluster firms.

Other items mentioned in the MasterPlan are mostly internal matters for the UM/MUMC+. The first is the ability to increase the inflow of international students (indicator 3). The second is setting-up a science division to increase the overlap with the cluster (see indicators 5 and 19b, as this should show an increase in the ability to find applications for the knowledge created at the university). The last is connecting with other (inter)national knowledge institutes. Other knowledge institutes acknowledge this last item; most desired is a successful co-location at the Chemelot Campus.

## 5.5 THE RESULT

The identified topics cover all information found relevant in theory and practice (the interviews). If no specific number or percentage is required the answers exist of a number using a certain spread (e.g. 1 through 7), this will give better insight in the

By Stakeholder	By Value Source
Chemelot Management: 20	Complementarities: 15
In-cluster firms: 20	Novelty: 8
Knowledge Institutes: 6	Efficiency: 4
Government: 4	Lock-in: 4
(3 questions overlap)	Specific interest of shareholders: 10

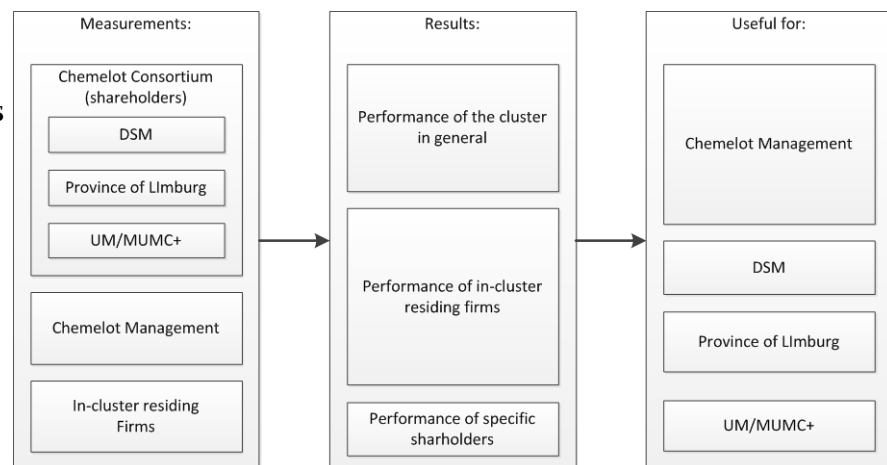
TABLE 5.1: INDICATORS BY STAKEHOLDER AND VALUE SOURCES (APPENDIX J & L, RESPECTIVELY)



development of the topic over several measurements (years). Furthermore, some topics require a qualitative addition to the answer to provide more insight that is useful for policymaking; appendix K provides more details. The total number of indicators (41), are spread over topics (19); the indicators are ordered by those that provide the information as well as by value source as indicated in the table (table 5.1).

In summary, the design of the tool exists of three parts. The first part exists of the measurements, with the indicators grouped by those who have the information needed in order to provide answers to the indicator questions (the measurements as given in appendix J). The second part is the result, an overview of the obtained information (this structure is used in this chapter; sections 5.2 through 5.4). The last part is the information ordered by those that need to keep track of the results of the performance measurements, when the information a question provides is interesting for another party than the Chemelot Consortium management this is indicated in appendix K. Model 5.1 presents these three parts in an overview.

**MODEL 5.1: MEASUREMENTS & RESULTS**



Another remark considers the value sources. These value sources can be important constructs in order to explain and further research the results of this thesis. Namely, performance on the cluster level is found to closely relate to complementarities and performance on the firm-level is found to closely relate to efficiency, lock-in and novelty. The relation between the indicators and the value sources is presented in appendix L. A last remark is that future users need to carefully use appendix K, this in order to implement each indicator with the correct intentions and thus with the result that the indicators are used to obtain the information that is proposed as useful with this study.

## Chapter 6: DISCUSSION & CONCLUSION

The result of this study exists of two parts, first a discussion regarding the basic results from the interviews. This focusses on the performance of the cluster in general, thus on the image, the high-tech / knowledge density, and the ability to share resources in the cluster. The second part will conclude this thesis by providing an answer to the research indicator and discusses the limitations of this study.

### 6.1 DISCUSSION

A discussion on the main cluster performance factors: image, high-tech / knowledge density and the ability to share resources is given below. In the discussion, theory and results from the interviews are combined and every factor is attached to each of the main stakeholders<sup>19</sup> of the Chemelot Campus.

#### 6.1.1 IMAGE OF THE CHEMELOT CAMPUS

(a) For Chemelot, a strong brand means the campus is more visible which makes it easier to attract new firms to settle at the cluster. Chemelot management indicates that Chemelot already is a success on international level. However, regarding its image, other parties indicate that international firms that desire to settle in Europe need to be prompted the possibility of Chemelot; some firms even repudiate that a Chemelot brand, especially regarding LS, is established. (b) For firms a strong cluster brand creates the possibility to promote the firms' brand by relating it to the high-tech environment/university. This supposedly enables firms to attract quality personnel, however some firms doubt the Chemelot brand will help them to attract personnel and believe this depends on the aspects of the individual firm; it may be more likely the Chemelot brand improve access to government support (such as financing/subsidies). Another aspect for firms is that a stronger cluster brand makes the in-cluster firms more visible, making it more likely for out-cluster firms to select in-cluster firms as their partners for business. However, as already indicated there is some doubt about the visibility of Chemelot on an international level. (c) Knowledge institutes are able to use strong clusters as political item to attract subsidies for (applied) research. Knowledge institutes linked with Chemelot have already been successful in acquiring significant amount of government funding. This shows that the cluster is useful to gain access to government support, it can however be debated whether this is due to the cluster brand or its significance regarding

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<sup>19</sup> The letters indicate 'the stakeholder' the succeeding text considers; (a) the cluster in general, (b) in-cluster firms, (c) knowledge institutes associated to the cluster, and (d) local/national governments

national and regional economy (the political agenda). (d) National/local governments can use strong clusters as political item, for example, local governments can use it to attract (educated) people to the region because they can get a quality job at Chemelot. The local government admits that a brand is important to attract personnel: *“Politically it is interesting to keep DSM located at the campus because of its image. The DSM brand is an important factor for the region to attract employees”*. The Chemelot brand is seemingly not (yet) able to fulfill this role.

### 6.1.2 HIGH-TECH / KNOWLEDGE DENSITY

(a) The environment that deals with the most modern technologies and in which the rate of new knowledge generation is high, can be considered underlying or functional value for the clusters' brand equity (section 6.1.1). Creating a strong brand is easier with a larger cluster that generates more technologies and new knowledge; this means the focus on growth remains important. The Chemelot management indicates this aspect (the high-tech and knowledge dense environment) is one of the reasons for firms to pay 'the park premium', thus to be located at this premium location. Whether Chemelot currently is a premium location is debatable for some parties, especially regarding its infrastructure: *“Housing should be organized according to efficiency, currently a premium prize is charged for a B-location. Costs should be equal to the image of the Campus”*. Chemelot needs to grow in order to build-up its image and to make sure firms have no problem with paying a premium. (b) For firms the high-tech environment (in their business segment) means they are more likely to spot ATAs. Furthermore, the high density of knowledge makes it easier to acquire the expertise needed for development (i.e. through knowledge spillovers, knowledge workers, knowledge institutes). Several parties acknowledge the usefulness and potential of the large amount of expertise the cluster contains, however this (currently) mainly regards expertise regarding facilities and services; thus on a transactional basis. Only few parties show fruitful cooperation considering a (new) technology (or a combination of technologies). (c) For universities, the knowledge dense environment is an important aspect considering their ability to maintain or increase the level of education in such environment. This study had no direct input from the local university (UM), but sufficient information is available to make some remarks. First, there are parties that suggest the university desires to climb in rank compared to other international knowledge institutes. This should support a universities ability to attract funding as well as an inflow of international students, important because competition with other universities is undesirable; other local knowledge institutes are successful in attracting funds. Second, considering the high-tech environment, knowledge institutes seem willing to close the gap between knowledge (education) and business (k2b): *“knowledge to business relations makes a university stronger”*.

Besides the idea to bring education and business closer there are other arguments for Chemelot to be closely involved with knowledge institutes, a reason given by one of the interviewees: *“I believe a campus without students is not a campus”*. The idea is that students are able to do business at Chemelot, some individually some in cooperation with settled firms. Smaller firms are deemed very suitable for cooperation with knowledge institutes, a university like the UM however, may be too ‘high level’ for smaller firms. A specific use for the connection between the smaller firms and knowledge institutes regards the difficulties between smaller and larger firms considering IP protection and financing: *“knowledge institutes can be ‘the bridge’ between smaller and larger firms, students are a safe and inexpensive way to perform research”*. (d) National/local government can use the high-tech and knowledge at Chemelot to strengthen their political agenda, for example to ‘lobby’ for European subsidies. Moreover, the successes achieved within the cluster (by firms and the related knowledge institutes) help to attract foreign investments as well as foreign firms to settle in the region.

### 6.1.3 RESOURCE SHARING (SOFT & HARDWARE)

(a) Equal to the previous section, a clusters’ underlying or functional value is higher when it has more, better and less expensive utilities (gas/water/electricity and data), infrastructure (buildings, roads, pipelines, etc.), facilities (cleanrooms, conference rooms, etc.) and services (IP protection, financing, knowledge specialists, etc.) to share with (or between) in-cluster residents. Regarding the utilities Chemelot has a difficult position, namely all of the utilities are ‘controlled’ by DSM and SABIC; the site is created by DSM, and SABIC is the first large firm that took over a large part of the infrastructure. The main difficulty is that these parties are not familiar with the situation in which they have to deal with other firms to share these utilities. Moreover, it is not a ‘core’ activity and all these ‘other firms’ are only small: *“when we desire a contract for the delivery of gas we’re told to ‘come back tomorrow’, because the amount of natural gas we need over a year is equal to their daily usage, we are not important enough!”*. For the firms without a connection to the existing infrastructure of DSM this means that it takes a lot of effort to organize basic utilities. An extra remark regarding data-connections, their availability and infrastructure is that: *“this building has fiber-glass infrastructure, but connection speeds comparable to the old dial-up connections”* and *“we’re forced to use DSM servers, what happens with my confidential data?”* This shows that the basic needs provide many worries for firms, and consumes time that would have been useful regarding their core activities. Organizing basic utilities in a professional way should make firms more aware of the potential Chemelot has to offer their firm. Moreover, this allows these firms to provide better

information concerning the way they desire the Chemelot organization to operate beyond basic needs: *“it takes me a whole day to arrange a data connection, time I could have used to connect with other in-cluster firms, Chemelot is more attractive when it offers a plug-and-play concept”*. Besides basic utilities, other infrastructure is underdeveloped. While some firms have acknowledged being happy with ‘where they are’ even in the oldest of buildings. Some claim infrastructure to be the weakest aspect of the campus. Examples are: the ‘Van Itterson’ building and Gate 2 (the first is a very nice building that lacks a decent place to park a car; the second, Gate 2 is an attractive entrance but it requires visitors to wait for ± half an hour before being allowed to enter the site). There are funds available to improve infrastructure, but before investing in infrastructure, Chemelot has two options:

- a Split-up the business and industrial park, and thus relieving the business park from all safety regulations etc. (not without reason several firms decide to locate right outside the gates), or
- b Change the entrance towards a hotel-like environment with a shared entrance where guests are nurtured and shown directions to their ‘rooms’, keeping the common aspect of ‘being together at this site bound by gates’.

The shared facilities and services at Chemelot are better developed. Many in-cluster firms at Chemelot share facilities such as cleanrooms and laboratories with a high level of expertise attached. Furthermore, firms that settle at Chemelot supported with some kind of financing are required to ‘add’ something to the cluster, which means that more facilities or customers for these facilities are available with every settling firm. The services at Chemelot are an important part of the development of the campus. Available is a virtual service boulevard in which Chemelot presents associated parties regarding a variety of services. A physical location for service providers is part of the construction plans. This service boulevard can become an important ‘hub’ for Chemelot in that it will become very easy for entrepreneurs to connect, or get informed on any topic; a high number of services offered within walking distance. A danger for Chemelot regarding these services is that the providers of these services will charge a ‘campus premium’. Higher pricing is possible because in-cluster settled service providers acquire a monopoly position being the exclusive Chemelot provider of a certain service. (b) This is an important aspect for firms because they already pay a premium for residing at the campus. Paid for settling at a location in close proximity of other firms and service providers in the same business segment with all the extras attached; an extra premium to use these services in proximity is not a development that supports the attractiveness of the campus. The main benefit that sharing resources/facilities induces for firms is that this enables firms to use these resources/facilities, without having to make the full investment to have these

resources/facilities available internally. Additional to lower investment costs, specialists share these facilities. This means that firms have access to the specialists of other firms to outsource non-core activities, making these activities more efficient and of higher quality; without making them more expensive, an effect not achieved when ‘campus premiums’ are charged. (c) Another benefit of specialized facilities exists for knowledge institutes (like universities). They can benefit from shared resources similar to firms, but than with the aim of developing an improved education for its students, theory on cleanrooms is different from experience in one. Furthermore, the knowledge institutes can become a shared resource (expertise and the link between applied and basic research), this has the possibility for knowledge institutes to valorize internal expertise (also described in the previous section). (d) National/local governments can use this underlying brand value for similar reasons as named in the previous section.

**6.1.4 COMPARISON WITH PREVIOUS RESULTS AND HTCE**

Based on the information obtained with interviews, a SWOT model presents the most important remarks (model 6.1).

	Cluster Positives	Cluster Negatives
Internal Factors	<p style="text-align: right;">Strengths</p> <ul style="list-style-type: none"> <li>• Geographic Location</li> <li>• Strong support from dynamic and stable economic &amp; politic actors</li> <li>• Availability of Licenses</li> <li>• Availability of hard- and software &amp; ability to expand</li> </ul>	<p style="text-align: right;">Weaknesses</p> <ul style="list-style-type: none"> <li>• Chemelot as cluster brand</li> <li>• Basic Utilities &amp; Infrastructure (cluster can be designated as an old campus)</li> <li>• Visibility of strategy and focus</li> </ul>
External Factors	<ul style="list-style-type: none"> <li>• Ability to share facilities and services</li> <li>• Ability to become dominant knowledge hub in new business segments (Life Sciences and Bio-based Material Sciences)</li> <li>• The ability to cluster a strong network of firms in the Chemistry sector</li> </ul> <p style="text-align: right;">Opportunities</p>	<ul style="list-style-type: none"> <li>• DSM as dominant cluster resident &amp; Park history may hamper development and establishment of an ‘open’ park culture</li> <li>• Ratio small/medium/large firms</li> <li>• Costs (expensive location to expanding or settle + monopoly for campus associated service providers)</li> </ul> <p style="text-align: right;">Threats</p>

**MODEL 6.1: CHEMELOT CAMPUS SWOT**

Comparing this SWOT with previous studies performed at the Chemelot Campus (table 2.2) and the HTCE by Van der Borgh (2007), some important differences and similarities show up. First with regard to the study performed at Chemelot. In the MasterPlan the presence of

technology leaders is claimed a critical success factor, this study does not contradict this but adds that this issue may be a threat. Namely, it may hamper the development of the cluster towards a strong cluster of a large number of firms instead of a strong DSM cluster. In addition, this SWOT defines some of the success factors named in the MasterPlan as strong or weak, which contains more information than merely marking the items as critical success factors. For example, the study at Chemelot marks stimulated knowledge transfer as a critical success factor, while the creation of an open park has yet to establish. Furthermore, the models are (mostly) complementary to each other. With regard to the study performed at HTCE, only few differences appear. This is rather surprising considering the significant differences between the Chemelot Campus and HTCE in the size (HTCE is 8 times larger in fte), the modern facilities<sup>20</sup>, the number of (horizontal) services (Van der Borgh, 2007), and the mix of firms that resides at the campus<sup>21</sup>. This shows Chemelot is a relatively successful park, though room for improvement exists (for example through the implementation of the performance evaluation tool created with this study!).

## 6.2 CONCLUSION

This study adds a relevant step towards theory on park performance, governance and policy. Namely, by identifying the important sources of value and its influencing factors, policy makers can focus their efforts towards park development. Another result is that the performance measurement tool improves the abilities of park managers to provide shareholders with the information they require regarding their performance goals.

The main conclusion of this thesis is the answer to the research question:

*What are the (most important) value sources of industrial parks (and in specific at the Chemelot Campus), and which are the (most important) activities and processes that influence these sources?*

Namely, an answer to this question identifies what is valuable and which are the main activities and processes that influence this value in a park like Chemelot. The value of a park exists of value characterized by the value sources provided by Amit & Zott (2001) complemented with the specific performance expectations of various shareholders (value for the shareholders). The value sources closely relate to the general benefits a park offers, and to the performance of cluster residents. Chapter 5 shows the important factors and the indicators that are constructed using general theory on clusters, firm performance, other related topics,

<sup>20</sup> The Strip: [http://www.hightechcampus.nl/go/pages/the\\_strip-477](http://www.hightechcampus.nl/go/pages/the_strip-477)

<sup>21</sup> Services and facilities at HTCE: [http://www.hightechcampus.nl/go/pages/services\\_and\\_facilities](http://www.hightechcampus.nl/go/pages/services_and_facilities)



and a series of interviews with shareholders, cluster residents and other stakeholders. Overall, the main benefits in a cluster exist of complementarities; these benefits are the main factors of park performance. Evaluating these complementarities helps to identify whether the park performs regarding the benefits that parks are supposed to offer. The other value sources closely relate to firm-level performance. Firm-level performance evaluation is approached with traditional firm performance theory, though adapted to the cluster context. Measures are of financial, technological, market and time/timing nature, the constructed indicators relate to the value sources efficiency, novelty and lock-in. This does not show that complementarities necessary lead to efficiency, novelty and lock-in, but it does clarify that the value sources are useful to characterize cluster performance over two levels (general and specific performance).

In summary, complementarities are proposed as main value drivers of a park. Efficiency, novelty and lock-in are proposed being the value sources for firms and a park management that may be obtained easier through the benefits (complementarities) a park offers.

### 6.3 LIMITATIONS

First, this thesis is a study performed (to a large extent) independent from the Chemelot organization. This means that regular contact with managers from Chemelot has shaped this study, but only to a limited extend. The advantage is that the study is more likely to provide new insights, but a disadvantage attached is that the study had less in-depth knowledge available regarding the current activities and practices of the Chemelot park management.

Second, only a limited number of interviews are performed. This is partly due to the time constraints of this study; a thesis at Eindhoven University of Technology generally covers 30 credits, which means the study needs to be finished in half a year. Furthermore, managers at Chemelot try to minimize the load they present the in-cluster residing firms with, and thus the number is limited for a reason. Unfortunately, of the limited amount of contacts, 4 of the in-cluster firms were not included in this study because they have not responded to the request for interview; this means that only 4 technology oriented firms are included. In addition the UM/MUMC+ has not been available for an interview, this is unfortunate because this means one of the shareholders has not been able to include any specifics into this study. On the other hand, this issue only strengthens the doubts that some parties have regarding the strategy and ability of the university to successfully incorporate itself into the cluster. However, the interviews performed all consider the persons that are on the top management of their business or institute, and have a direct relation to the Chemelot Campus. This implies that the information that was gathered is highly valuable and practical knowledge.



Third, a content related limitation is the amount and type of theory available. Firstly, theory on the Open Innovation and related theories are limited to theoretical principles and examples of best practices. Principles on the way to implement open innovation as a business strategy do not exist. Suggestions are limited to tackling the barriers to OI and the way park managers can assist firms with this matter, and suggestions to improve the implementation of the OI into the park. Furthermore, theory available considers Science Parks, and as defined in section 3.3 these do not exactly resemble the Chemelot Campus. Main differences are that Chemelot is a private initiative, and that no knowledge institute resides at cluster. Significant differences are that the Chemelot Campus has a focus on business development, and Science Parks have a focus on knowledge generation and valorization.

#### 6.4 SUGGESTIONS FOR FUTURE RESEARCH

The OI concept is not an easy concept to implement. Firms at Chemelot do perform OI practices, but they do not show in-depth knowledge of the concept. Firms do not perceive the OI concept as a different from regular business, and thus do not implement the concept into the business model as critical part of the business strategy. This means there is room left for improvement regarding the implementation of the concept as 'core' of the Chemelot Campus. A first possibility is covering the barriers towards innovation as proposed by Chesbrough (2003), and secondly firms need more information of the concept; in specific regarding the strategic part attached to the concept. In this respect, the Chemelot management should lead the concept by demonstrating open governance of the cluster (indicator 7).

Future performance of the ecosystem depends on its ability to grow. Researchers propose a method to measure the health of parks by regarding them as business ecosystem (referring to biology). When Chemelot has reached a certain critical mass, this method can be useful in future research to show the strengths of the relations between firms and what the 'weak spots' of the ecosystem are. Namely, the method measures the health of firms related to their network and value chain, this method may show knowledge or technology gaps in the cluster and thus can identify what the cluster needs in order to increase its robustness (den Hartigh, Tol, & Visscher, 2006), (Iansiti & Levien, The Keystone Advantage, 2004a).

## BIBLIOGRAPHY

- Aaker, D. A. (1996). Measuring brand equity across products and markets. *california management review*, 102-120.
- Abrahamson, E., & Rosenkopf, L. (1997). Social Network Effects on the Extent of Innovation Diffusion: A Computer Simulation. *Organization Science*, 289-309.
- Adler, P. S., Goldoftas, B., & Levine, D. I. (1999). Flexibility versus Efficiency? A case study of model changes in the Toyota Production System. *Organization Science*, 43-68.
- Amit, R., & Zott, C. (2001). Value Creation in E-Business. *Strategic Management Journal*, 493-520.
- Anderson, G. (1994). Industry Clustering For Economic Development. *Economic Development Review*, 26-32.
- Asvanund, A., Clay, K., Krishnan, R., & Smith, M. D. (2004). An Emperical Analysis of Network Externalities in Peer-to-Peer Music-Sharing Networks. *Information Systems Research*, 155-174.
- Audretsch, D. B., & Thurik, A. R. (2001). What's new about the new economy? Sources of growth in the managed and entrepreneurial economies. *industrial and corporate change*, 267-315.
- Bagchi-Sen, S. (2000). Product innovation and competitive advantage in an area of industrial decline: the Niagara region of Canada. *Technovation*, 45-54.
- Bakouros, Y. L., Mardas, D. C., & Versakelis, N. C. (2002). Science Park, a high tech fantasy?: an analysis of the science parks of greece. *Technovation*, 123-128.
- Basile, A. (2011). Networking System and Innovation Outputs: The Role of Science and Technology Parks. *International Journal of Business and Management*, 3-15.
- Bianchi, M., Campodall'Orto, S., Frattini, F., & Vercesi, P. (2010). Enabling open innovation in small- and medium-sized enterprises: how to find alternative applications for your technologies. *R&D Management*, 414-431.
- Bigliardi, B., Dormio, A. I., Nosella, A., & Petroni, G. (2006). Assessing Science Parks' Performances: directions from selected italian case studies. *Technovation*, 489-505.
- Brown, A. S. (2009). Building a place for Innovation. *Mechanical Engineering*, 38-43.
- Cabral, R. (1998). Refining the Cabral-Dahab Science Park Management Paradigm. *International Journal of Technology Management*, 813-818.
- Campbell, A., & Goold, M. (1998). *Synergy - Why links between business units often fail and how to make them work*. Oxford: Capstone Publishing.

- Capon, N., Farley, J. U., & Hoenig, S. (1990). Determinants of Financial Performance: A Meta-Analysis. *Management Science*, 1143-1159.
- Carpinetti, L., Galdámez, E., & Gerolamo, M. (2008). A measurement system for managing performance of industrial clusters - a conceptual model and research cases. *International Journal of Productivity and Performance Management*, 405-419.
- Chan, K., & Lau, T. (2005). Assessing technology incubator programs in science park: the good, the bad and the ugly. *technovation*, 1215-1228.
- Chan, K.-Y. A. (2010). *Interorganizational knowledge flows between and innovative performance of science park firms: an exploratory study of south african new technology based firms*. Pretoria: University of Pretoria.
- Chan, K.-Y. A., Oerlemans, L. A., & Pretorius, M. W. (2010). Knowledge exchange behaviours of science park firms: the innovation hub case. *Technology analysis & strategic management*, 207-228.
- Chesbrough, H. (2003). *Open Innovation - The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.
- Chesbrough, H., Vanhaverbeke, W., & West, J. (2006). *Open Innovation: Researching a New Paradigm*. Oxford: Oxford University Press.
- Christensen, C. M., & Bower, J. L. (1996). Customer Power, Strategic Investment, and the Failure of Leading Firms. *Strategic Management Journal*, 197-218.
- Christensen, T. A., zu Köcker, G. M., Lämmer-Gamp, T., Thomsen, M. S., & Olesen, K. (2011). *Cluster and network policy programmes in Europe*. Cluster Collaboration Platform.
- Crimmins, J. C. (2000). Better measurement and management of brand value. *Journal of advertising research*, 136-144.
- de Man, A.-P., Hoogduyn, C., & Dekkers, K. (2009). De implementatie van open innovatie: wat is de stand van zaken. *Holland Management Review*, 2-7.
- den Hartigh, E., Tol, M., & Visscher, W. (2006). The health measurement of a business ecosystem. *ECCON 2006 annual meeting* (pp. 1-39). -: Delft University of Technology.
- Dettwiler, P., Lindelof, P., & Lofsten, H. (2006). Utility of location: A comparative survey between small new technology-based firms located on and off Science Parks - implications for facilities management. *Technovation*, 506-517.
- EIM. (2007). *Entrepreneurs in the Netherlands - High growth enterprises; Running fast but still keeping control*. Zoetermeer: FWA-Drukwerk.
- Eisingerich, A. B., Bell, S. J., & Tracey, P. (2010). How can clusters sustain performance? The role of network strength, network openness, and environmental uncertainty. *Research Policy*, 239-253.

- Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&D Management*, 311-316.
- Felsenstein, D. (1994). University-related Science Parks - 'Seedbeds' of 'Enclaves' of innovation? *Technovation*, 93-110.
- Ferguson, R., & Olofsson, C. (2004). Science Parks and the Development of NTBFs - Location, Survival and Growth. *Journal of Technology Transfer*, 5-17.
- Frenken, K. (2010). *Geography of Scientific Knowledge: A Proximity Approach*. Eindhoven: Eindhoven Centre for Innovation Studies.
- Gretzinger, S., Hinz, H., & Matiaske, W. (2010). Cooperation in Innovation Networks: The Case of Danish and German SMEs. *Management Revue*, 193-216.
- Hamel, G., & Prahalad, C. (2005). Strategic Intent. *Harvard Business Review*, 1-17.
- Hansson, F. (2007). Science Parks as knowledge organizations - the "ba" in action? *European Journal of Innovation Management*, 348-366.
- Hervás-Oliver, J. L., & Albors-Garrigós, J. (2007). Do clusters capabilities matter? An empirical application of the resource-based view in clusters. *Entrepreneurship & Regional Development*, 113-136.
- Hu, T.-S. (2008). Interaction among High-tech Talent and its Impact on Innovation Performance: A Comparison of Taiwanese Science Parks at Different Stages of Development. *European Planning Studies*, 163-187.
- Iansiti, M., & Levien, R. (2004a). *The Keystone Advantage*. Boston: Harvard Business School Publishing Corporation.
- Iansiti, M., & Levien, R. (2004b). Strategy as Ecology. *Harvard Business Review*, 1-11.
- Kaplan, R. S., & Norton, D. P. (1991). The Balanced Scorecard - Measures That Drive Performance. *Harvard Business Review*, 71-79.
- Katz, M. L., & Shapiro, C. (1985). Network Externalities, Competition, and Compatibility. *The American Economic Review*, 424-440.
- Kitching, J., & Blackburn, R. (1998). Intellectual property management in the small and medium enterprise (SME). *Journal of small business and enterprise development*, 327-335.
- Langerak, F., & Hultink, E. J. (2005). The Impact of New Product Development Acceleration Approaches on Speed and Profitability: Lessons for Pioneers and Fast Followers. *IEEE Transactions on Engineering Management*, 30-42.
- Langerak, F., Hultink, E. J., & Griffin, A. (2008). Exploring mediating and moderating influences on the links among cycle time, proficiency in entry timing, and new product profitability. *Journal of Product Innovation Management*, 370-385.

- Lichtenthaler, U. (2008). Open Innovation in Practice: An Analysis of Strategic Approaches to Technology Transactions. *IEEE Transactions on Engineering Management*, 148-157.
- Lichtenthaler, U. (2009). Outbound open innovation and its effect on firm performance: examining environmental influences. *R&D Management*, 317-330.
- Lindelof, P., & Lofsten, H. (2003). Science Park Location and New Technology-based firms in Sweden - implications for strategy and performance. *Small Business Economics*, 245-258.
- Lipparini, A., & Sobrero, M. (1994). The Glue and the Pieces: Entrepreneurship and Innovation in Small-firm Networks. *Journal of Business Venturing*, 125-140.
- Lofsten, H., & Lindelof, P. (2003). Determinants for an entrepreneurial milieu: Science Parks and business policy in growing firms. *Technovation*, 51-64.
- Malmberg, A. (2002). The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering. *Environment and Planning*, 429-449.
- Maravelakis, E., Bilalis, N., Antoniadis, A., Jones, K., & Moustakis, V. (2006). Measuring and benchmarking the innovativeness of SMEs: A three-dimensional fuzzy logic approach. *Production, Planning & Control*, 283-292.
- Massey, D., Quintas, P., & Wield, D. (1992). Academic-industry links and innovation: questioning the science park model. *Technovation*, 161-175.
- Montgomery, C. A., & Wernerfelt, B. (1991). Sources of superior Performance: Market Share versus Industry Effects in the U.S. Brewing Industry. *Management Science*, 954-959.
- Montoya-Weiss, M. M., & Calantone, R. (1994). Determinants of New Product Performance: A review and Meta-Analysis. *Journal of Product Innovation Management*, 397-417.
- Neely, A. (2007). *Business Performance Measurement - Unifying Theory and Integrating Practice*. Cambridge: University Press, Cambridge.
- Ortega-Aragilés, R., Vivarelli, M., & Voigt, p. (2009). R&D in SMEs: a paradox? *Small Business Economics*, 3-11.
- Osterwalder, A. (2004). *The Business Model Ontology - A Proposition in a Design Science Approach*. Lausanne: Universite de Lausanne.
- Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying Business Models: Origins, Present, and Future of the Concept. *Communications of AIS*, 1-40.
- Pawson, R., & Tilley, N. (1997). *Realistic Evaluation*. Wiltshire: The Cromwell Press Ltd.
- Porter, M. E. (1998). *Clusters and the New Economics of Competition*. Harvard Business Review.
- Rallet, A., & Torre, A. (1999). Is Geographical Proximity necessary in the innovation networks in the era of global economy? *GEOJOURNAL*, 373-380.
- Ratinho, T., & Henriques, E. (2010). The role of science parks and business incubators in converging countries: evidence from portugal. *Technovation*, 278-290.

- Rogers, E. M. (2003). *Diffusion of Innovation*. New York: The Free Press.
- Rosenthal, S. S., & Strange, W. C. (2003). Geography, industrial organization, and agglomeration. *The review of economics and statistics*, 377-393.
- Siegel, D. S., Westhead, P., & Wright, M. (2003). Assessing the impact of university Science Parks on research productivity: exploratory firm-level evidence from the United Kingdom. *International Journal of Industrial Organization*, 1357-1369.
- Squicciarini, M. (2008). Science parks' tenants versus out-of-park firms: who innovates more? a duration model. *Journal of Technology Transfer*, 45-71.
- Squicciarini, M. (2009a). Science Parks, Knowledge Spillovers, and Firm's Innovative Performance. Evidence from Finland. *Small Business Economics*, 169-190.
- Squicciarini, M. (2009b). Science Parks: Seedbeds of innovation? A duration analysis of firms' patenting activity. *Small Business Economics*, 169-190.
- Stappers, J. (2010). *Een Succesformule voor thematische kennisparken*. Den Haag: Triarii B.V.
- Suomi, R. (2006). Evaluating Network Externalities. *Proceedings of the 13th European Conference on Information Technology Evaluation* (pp. 469-475). Genoa, Italy: Academic Conferences Limited.
- SurrIDGE, R. W., Dewit Martin, C. M., & Kilko, C. L. (1997). Using Industry Clustering for Business Retention and Expansion. *Economic Development Review*, 20-22.
- Tsai, M.-T., & Tsai, C.-L. (2010). Innovation capability and the performance in Taiwanese science parks: exploring the moderating effects industrial clusters fabric. *The International Journal of Organizational Innovation*, 80-103.
- Van Aken, J. E., Berends, H., & Van der Bij, H. (2007). *Problem Solving in Organizations*. Cambridge: Cambridge University Press.
- van de Vrande, V., de Jong, J. P., Vanhaverbeke, W., & de Rochemont, M. (2009). Open Innovation in SMEs: Trends, motives and management challenges. *Technovation*, 423-437.
- Van de Vrande, V., Vanhaverbeke, W., & Gassmann, O. (2010). Broadening the scope of open innovation: past research, current state and future directions. *International Journal of Technology Management*, 221-235.
- Van der Borgh, W. (. (2007). *Governance and Business Models at the HTCE: Disrupting Science Parks*. Eindhoven: Industrial Engineering and Management Science - University of Technology Eindhoven.
- Van Dinteren, J. (2011). Science Parks: innovation of image? *Royal Haskoning - urban solutions*, 1-28.

- Van Strien, P. J. (1997). Towards a Methodology of Psychological Practice. *Theory & Psychology*, 683-700.
- Vanhaverbeke, W. (2011). *Open Innovation, Exnovate*. Retrieved October 26, 2011, from Ideaconnection: <http://www.ideaconnection.com/open-innovation/exnovate.html>
- Vanhaverbeke, W., & Cloudt, M. (2006). Open Innovation in Value Networks. In H. Chesbrough, W. Vanhaverbeke, & J. West, *Open Innovation: Researching a new Paradigm* (pp. 1-43). Oxford: Oxford University Press.
- Zeng, S., Xie, X., & Tam, C. (2010). Relationship between cooperation networks and innovative performance of SMEs. *Technovation*, 181-194.
- Zott, C., & Amit, R. (2002). Measuring the Performance Implications of Business Model Design: Evidence from Emerging Growth Public Firms. *INSEAD Working Paper Series*, 1-47.



## GLOSSARY

Business Incubator	A program with the aim of accelerating the development of entrepreneurial companies, main difference with science and technology parks is the focus on start-ups
Campus	The buildings of a college or university and the land that surrounds them, definition in section 3.3.1 page 21
Coopetition	Contraction of the words cooperation and competition (resulting in: cooperative competition)
Contract	
Neoclassical	Contract managed by a third party, wherein the parties that enter into the agreement are bilaterally dependent, but remain independent
Relational	Contract based upon trust in-between the parties that enter into the agreement (in which the parties are bilaterally dependent, but remain independent)
Industrial Park	A special area on the edge of a town where there are a lot of factories and businesses, definition in section 3.3.1 page 21
Innovation Diffusion	Theory that explains how and why new technologies and ideas spread
Network Externalities	Theory on the effect of the number of users on the value of a product or service
Open Innovation	<i>“Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively”</i> (Chesbrough, Vanhaverbeke, & West, 2006), section 3.2.1

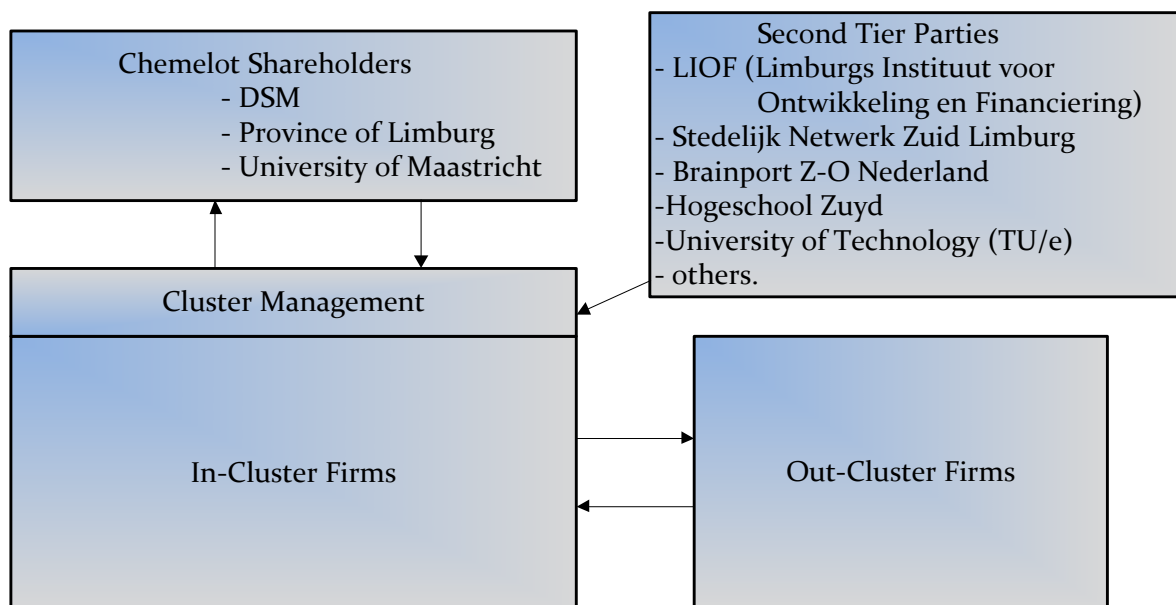


Reflective Cycle	Business problem solving activity that follows the regulative cycle and tries to generalize results in order to generate design knowledge
Regulative Cycle	Classic problem solving cycle, it is a design orientated problem solving method existing of a design, change and learning part
Residents	Synonyms: in-cluster firms, settled firms/companies and (in-cluster) residing firms Antonyms: off/out-cluster firms, non-residents
Science Park	An area, often started or supported by a college or university, where companies involved in scientific work and new technology are based, definition in section 3.3.1 page 21.

## APPENDICES

### APPENDIX A - CHEMELOT CONSORTIUM MASTERPLAN

The MasterPlan is a plan in which housing at an industrial business site is combined with offering certain facilities in order to stimulate business growth. A key aspect of this MasterPlan is the ‘triple-helix’ approach. This means that next to the firms an authority (as in a local government) and a knowledge institute are involved in the development of the site. The model below (model appendix A.1) represents the structure of the Chemelot Campus and its ties with out-cluster firms and institutes.



MODEL APPENDIX A.1: CHEMELOT CAMPUS STRUCTURE

The triple helix is an important aspect for the campus, as innovation becomes a more complex and knowledge driven process. The knowledge of universities and political support of a government (think for example of licenses and government funding) are necessary to create and sustain a competitive industry. Universities are interested in the cluster, because they are a location that is very suitable to educate their students (practical environment with business professionals). The government is involved because they expect the cluster to be a driver of regional development (socio-economic and technological). Further discussing the model, it clearly shows that Chemelot exists of a set of firms and a park management (the Chemelot Consortium). The park management is visualized as being a supporting function for the in-cluster firms. The park management is the link between stakeholders and the in-cluster firms. Outside of Chemelot there are several science institutes (University Maastricht as stakeholder

and HsZuyd & Eindhoven University of Technology as research institutes) there are several projects between the Chemelot Consortium and these science institutes for the benefit of education and performance of the cluster (of which one is this project in cooperation with HsZuyd and Eindhoven University of Technology). The most important out-cluster tie is with out-cluster firms, as the cluster is not a self-supporting entity and needs its environment for its resources and output.

Next to the triple-helix approach, the aim is to transform the campus into a dynamic inspiring environment in which OI is stimulated. This fits the aim of the province of Limburg to create and maintain current employment (type and level), to stimulate regional economy and to create a link between education and businesses (k2b)<sup>22</sup>. The idea is that at an open campus firms and knowledge institutes together can achieve a higher level of business development. Namely, through OI new settling firms are better able to benefit from the knowledge the cluster already possesses. The OI concept is supported with the geographic proximity of firms that operate in complementary business segments with a focus on life sciences and material sciences. Furthermore, the availability of high-value real estate supports the concept; high-value housing means housing that fits the need of the various new to acquire firms (e.g. plug-and-play office space) and an area with a high-level of attractiveness / openness. Lastly, the concept is stimulated with an extensive set of services and facilities. The campus management takes care of regular tenant obligations and some common facilities (e.g. a food court and conference rooms), but more important at the campus a high number of facilitators and service providers will settle to support a high variety of needs the campus residents may face (e.g. IP security support). In summary, the MasterPlan suggests that the Chemelot Campus will aim to:

- Maintain current and increase the number of knowledge workers (100% growth up to 2000 fte by 2019, spread over 100 specialized firms in CHEMaterials),
- Stimulate the OI concept (and knowledge development):
  - Geographic proximity of firms that offer knowledge to the cluster complementary to knowledge the cluster already possesses (focus on LS and MS), and
  - Link with knowledge institutes on all levels (elementary, basic and higher education). This strengthens the (beta) sciences, as in education in the technology sector.
- Stimulate and support start-ups with specific for this target group designed housing (accelerator building), and more mature firms with modern facilities.

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<sup>22</sup> <http://www.versnellingsagenda.nl> (accessed: 22<sup>th</sup> of September 2011)

To make the ambitions reality the MasterPlan contains a wide planning considering organizational structure, real estate and financing (figure appendix A.1).

High value real estate at Chemelot:



FIGURE APPENDIX A.1: PLANNED INFRASTRUCTURE CHEMELOT CAMPUS  
(WWW.CHEMELOT.NL)

## APPENDIX B - CHEMELOT CONTEXT INFORMATION SOURCES

The sources listed are those that are used next to interviews and are other than research papers (etc.) that can be found in the bibliography. The list only contains sources that have helped the researcher to acquire a better understanding of the park context and that may help the reader to increase its understanding of this thesis.

- 1 Automatisering Gids. Werken in Silicon Valley – de do's en don'ts. 16 September 2011; nr. 37; p. 16-17
- 2 Bieshaar, Chantal & Soetermeer-Gabriëls, Anique. Life Sciences Network Book South East Netherlands. 2011; edition 2
- 3 DSM Nederland B.V.. Jaarverslag 2010 – Change, een integraal perspectief. 2010
- 4 European Chemical Regions Network (ECRN). „Chemical Parks as Regional Growth Engines for European Chemical Regions”. December 2005; [www.ecrn.net](http://www.ecrn.net)
- 5 Gaalman, A.E., Aalbers, S.G. & Deiman, E.P.. Case: Chemelot-Campus. 2010/68; p. 35-38
- 6 Link (special). Ambitious Growth Plans Limburg Campuses. April 2011; vol. 13; issue 2; p. 48-49
- 7 Keizer, J., Heine, R., Heckman, M., Slots, Y., Swelsen, L.; Voorstel Chematerials, written on behalf of Hogeschool Zuyd. 2010; versie 4
- 8 Wagemans, Ger & Przybyiski, Veronique. Consortium Chemelot Campus MasterPlan 2010-2020. 11 Januari 2011; final version
- 9 [www.chemelot.nl](http://www.chemelot.nl), next to generally displayed information:
  - Newsletters (December 2009-july 2011)
  - Testimonials (Sekisui S-Lec, DSM Dyneema, Nano Specials, SABIC & Stanyl)
  - Consortium Chemelot Campus: signing letter of intent Chemelot Campus

## APPENDIX C - INNOVATION THEORY AND SCIENCE PARKS

Chapter 2 tells us what Chemelot is, this provides however only a limited view. It does give insight in what Industrial Parks are, but not why they have grown to their current form and what is achieved with them. To give a better insight into the true purpose of Industrial- and Science Parks this appendix gives information on theories that form the basis on which SPs are built: Open Innovation, Network Externalities and Innovation Diffusion.

### 1 OPEN INNOVATION PRACTICES

The reason for parks to come into existence is that they (supposedly) improve the possibilities of processes that involve any kind of collaboration or cooperation between knowledge institutes, R&D labs and firms. This 'external orientation' has become a more important factor for firms in the last few decades. Innovation processes become more complex and a higher development speed is required, this means they require more resources, and thus firms are forced to obtain new sources of funds, knowledge and capacity to fulfill these new needs. Internal sources are limited and thus the most obvious path is to search for partners in innovation, in the easiest way possible (at a Science Park!). An important concept in the external orientation of firms is Open Innovation (OI). The 'father' of this concept, Henry William Chesbrough describes the transition of firms from an internal and 'closed' process towards a more external and 'open' process (Chesbrough, 2003). Next to the need to overcome resource constraints as described in the previous section he indicates that purely internal development became less practical for firms. Skilled workforce became more mobile (skilled employees transfer easier to other employers when a better offer is made), making it difficult for companies to keep a sufficiently skilled workforce internally available. Furthermore, an increase in overall educational level and the creation of start-ups with venture capital (VC) caused firms to realize that they do not necessarily possess the best source of knowledge and development internally. In his book, Chesbrough gives an overview of the mechanism that makes firms to change from a closed to an open approach towards innovation (table appendix C.1):

<b>Contrasting Principles of Closed and Open Innovation</b>	
<b>Closed Innovation Principles</b>	<b>Open Innovation Principles</b>
The smart people in our field work for us.	Not all the smart people work for us. We need to work with smart people inside <i>and</i> outside our company.
To profit from R&D, we must discover it, develop it, and ship it ourselves.	External R&D can create significant value; internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to market first will win.	Building a better business model is better than getting to market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our IP, so that our competitors don't profit from our ideas.	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our own business model.

TABLE APPENDIX.C.1: CLOSED VS. OPEN INNOVATION (CHESBROUGH, 2003, P. XXVI)

The above seems all very promising, but it doesn't tell much about the 'how', thus the activities inclined to OI and also the difficulties firms face when adopting the OI concept. For example Van de Vrande et al. (2010, p. 227) indicate that OI practices are not the same for large MNEs and SMEs, that more complex products are more likely to be created through OI practices, and that the number and quality of a firm's patenting portfolio influences the type of OI practices pursued by firms. Following the theory developed by Chesbrough (2003) OI is a process that can be divided over two main aspects. The first aspect considers the vast amount of knowledge available outside the firm, and thus the determination of which external knowledge is sufficiently valuable to incorporate in internal processes. The second aspect is that there is internal knowledge that may be (more) useful (and profitable) to be developed outside the firm's boundaries), and thus it is important to determine which internal knowledge is insufficiently exploited internally and should be transferred to an external 'path' to create value (Van de Vrande, Vanhaverbeke, & Gassmann, 2010). There are two common divisions used by researchers that relate to these aspects: Outbound vs. Inbound OI and technology exploration vs. technology exploitation (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009). The following sections will further discuss the concept of OI using this differentiation, however mainly using the terms: inbound and outbound OI. Inbound OI or the 'outside-in' approach, means using external resources to support the internal development process. The outbound OI refers logically to using internal information to create value outside the firm's boundaries. There are several ways in which firms can actively operate Inbound and Outbound OI practices firstly the Inbound practices are discussed followed by outbound practices.

The most obvious way for firms to acquire knowledge from external sources is via market research. Some may object this as being an OI practice, but it is a practice to bring external knowledge into the firm. In the park context, an important aspect of market research is the competitor analysis. It is important to know who operates in the SP and in its region to more easily find partners for cooperation and best practices within the business segment, because it helps to determine internal strategies for 'future to develop' products (Hamel & Prahalad, 2005). Other Inbound OI practices that may support development of strategies, are less often used by companies even though they show great promise. Crowdsourcing for example can take various forms. It may involve a mass brainstorm to generate new product ideas or product functions a company should pursue in future development projects, but also the general population can benefit referring to a famous example of crowdsourcing: Wikipedia ([www.wikipedia.org](http://www.wikipedia.org)), an open source encyclopedia created by everyone who is interested in contributing. Innovation mediators are another information source that aims at searching for alternative technology applications (ATAs) of firm internal technologies (Bianchi, Campodall'Orto, Frattini, & Vercesi, 2010). Both of these techniques are only recently developing and therefore not often used by firms (de Man, Hoogduyn, & Dekkers, 2009, p. 6). Another explanation may be that a barrier is thrown up to these techniques because they require some internal knowledge sharing. Other practices that do not suffer from this barrier are based upon acquiring knowledge and/or technologies; this can be outsourcing R&D and in-licensing IP. Outsourcing R&D deals with direct 'contracts' to external partners to develop a certain technology, often this considers suppliers and universities (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009, pp. 428-429) but it may also involve more radical alliances (think of the recent alliance between Nokia and Microsoft<sup>23</sup>). Outsourcing R&D has the benefit that it relieves firms from pressure on its resources, on the other hand suppliers can secure the survival of their buyer-supplier relationship by developing innovative competitive products; and thus a mutual benefit can be created. IP in-licensing can be another strategy to reduce internal pressure on development time and capacity. A last type of inbound OI is related to networking, networking is an important stimulator of innovation diffusion (a topic discussed in Appendix C.3). In relation to inbound OI, networking can be an information source that complements market research. An extensive set of information and formal connections can help to fill internal knowledge gaps and provide information of the activities that take place in competing or partner firms (EIM, 2007). An important side effect of

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<sup>23</sup> Microsoft press release: <http://www.microsoft.com/presspass/press/2011/april/04-21msftnokia.mspx> (accessed 22<sup>th</sup> of July 2011)



networking and thus intentional knowledge sharing are knowledge spillovers, that may be intentional also but are often unintentional also (creating a need for IP protection). SPs are suggested as promoters of innovation by facilitating an increased intensity of communication between residents and thus 'managing' the knowledge spillovers. SPs are supposed to have the ability to hold on to knowledge and residing firms to be able to build on this knowledge (Squicciarini, 2009a), (Squicciarini, 2009b).

Outbound (inside-out) activities are less frequently used than the inbound activities described above (de Man, Hoogduyn, & Dekkers, 2009, p. 8) (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009, p. 429). Furthermore, de Man et al. (2009, p. 6) researched the current practices of OI and found that more recent techniques are also less often used techniques, and thus may induce new opportunities. A possibly important more recent outbound practice is the use of Venture Capital (VC) from external sources and Corporate Venture Capital (CVC). Literature suggests that VC and CVC provide grand opportunities, referring to the success of Xerox whose new ventures now exceed the value of the parent company (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009, p. 424); this clearly shows that venturing can be a very lucrative way to exploit internal expertise. Next to the use of VC to create spin-offs, there are two other ways to make value of internal expertise: Insourcing R&D and out-licensing IP. Insourcing R&D is an outbound activity because in this case a firm develops a technology for an external firm, which means that knowledge leaves the firm. R&D insourcing mostly happens when firms are development specialists and that is their core activity, because once the technology leaves the firm its value leaves too. A more broadly used practice is out-licensing IP, which means that external firms can buy the right to use a certain technology. The benefit of licensing is that the developer will still be able to generate value with the technology in other ways, unlike the case of insourcing R&D. This benefit makes out-licensing a method to create extra value with a technology in the form of ATAs (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009, p. 424), meaning that other firms may see value in a technology not yet discovered by the technology owner. A threat in this is that the licensee will use the technology to compete with the technology owner, deteriorating sales of the licensor. However, if a competitor will use the technology to compete the chances are that this technology will become a market standard, which may increase the technologies value beyond the threat the new competitor induces (Abrahamson & Rosenkopf, 1997), (Lichtenthaler, 2008, pp. 151-152), (Lichtenthaler, 2009, p. 319).

Exploration and exploitation have some similarity with inbound and outbound OI. Technology Exploration means searching for new knowledge and technologies, this is mostly related to

inbound OI like market research, outsourcing R&D and in-licensing IP. Technology Exploitation means making value of owned technologies, thus venturing methods, insourcing R&D and out-licensing IP, which seems similar to outbound OI. There do are however some important differences, and the two differentiations should not be confused. Inbound and Outbound OI consider either a knowledge inflow or outflow, whereas technology exploration and exploitation focus on a search for knowledge and making value of knowledge. This chapter used the first distinction because of *trust*. Trust is an important issue for firms when it involves knowledge and technology sharing with external parties, because making knowledge public means losing the ability to be the only party who can valorize the expertise (Enkel, Gassmann, & Chesbrough, 2009, p. 312). This issue makes the distinction between inbound and outbound OI more suitable when an OI environment is created, such as in a SP. Next to the ‘trust-barrier’ firms perceive OI as more difficult regarding its coordination and keeping control, also finding the right partner for OI practices and a balance between OI and daily activities seem important (Enkel, Gassmann, & Chesbrough, 2009, p. 312). When looking at the different OI practices Van de Vrande et al. (2009, pp. 432-433) give some more insight. They indicate that venturing seems to be used mostly to achieve innovations, possibly through the creation of spin-offs. Participating in spin-offs then again is used to keep track of market developments and to a lesser extent to achieve innovations. Surprisingly, even though this participation is an exploratory practice it is not used for its knowledge flows, unlike networking and outsourcing R&. These remarks show the complexity of the underlying reasons to pursue OI practices, and that they cannot be discussed as being similar when grouping them under terms like inbound & outbound OI or technology exploring and exploiting. A last interesting remark by this research is that they too find the most important hampering factor to be the balance between OI and daily activities.

## 2 NETWORK EXTERNALITIES

It may seem strange to include network externalities or the network effect into the theoretical frame of this thesis. The network effect namely means that the value of a good (or the consumption of a good) increases with the total number of consumers of the good (Katz & Shapiro, 1985). There may seem no relation with SPs, but first lets explain the effect more in-depth. There are several causes for this effect. The first is that value can increase directly, for example, the value of a phone increases when more of your acquaintances use one. The second is that when more people use a product more complementary products appear that increase the products value, for example the android OS became more valuable when the number of users increased through the increase of ‘apps’. The third is somewhat similar to the second

namely the amount of after-sales service increases when more items of the good are sold, for example the first owner of a car did not have the wide availability of service points that are available today.

Network externalities are closely related to the adoption theory by Rogers (2003) described in the next section, but mainly it indicates that adoption of an innovation increases in speed when the 'first wave' of users has adopted the innovation. When a product has a strong network effect, it means that this 'first wave' may need to be quite large in order for the adoption rate to increase. Think of the phone that increases in value when more people use it, however if only few people have a phone and among these people there is no one you know the probability you adopt the phone as an innovation is very slim. This means a certain 'critical mass' needs to be reached in order for the network effect to come into play. Thus in the case of the phone, the critical mass would exist of some useful services (like doctors, police officers and firefighters) and some acquaintances like colleagues having a phone number.

Some research also describes negative network effects (thus, the value of a product decreases with the number of consumers) however, this mostly this negative effect seems to follow a positive network effect. Suomi (2006) gives an example: cars have a network effect in the sense that when more people use cars governments will decide to build more roads (for example for economic reasons). A negative effect follows, namely congestion decreases the value of the car as transportation method. This example indicates that the network effect may have to deal with size constraints (Asvanund, Clay, Krishnan, & Smith, 2004). This has some interesting implications when considering the case of SPs. Hervás-Oliver & Albors-Garrigós (2007, p. 118 & 131) hypothesize that external linkages 'upgrade' clusters and their unique set of resources and capabilities; they conclude however that the network effect is closer to the clusters reputation building process. This does not mean a network of buyers, suppliers and service providers within certain proximity does not improve the networks efficiency (Rallet & Torre, 1999). Possibly some regional network building is beneficial for a clusters resources and capabilities, but there may be a size constraint in that a further increase of network size only adds to a clusters image building and not to its unique features.

When taking a closer look SPs there may well be an internal networks effect present. A larger number of firms residing in one cluster increases the diversity of knowledge, and the availability of specialists and (production) capacity, meaning the larger number of residents increase the value of the cluster (Squicciarini, 2009b). For firms this means that being in the cluster is valuable, making the firms to be bound or 'locked-in' in the cluster. Other network effects also related to the value of a cluster for residing firms, such as the firm's brand name that may increase in value with the cluster brand (Amit & Zott, 2001). Furthermore, in-cluster

firms may be able to use the cluster to present their firm as 'dominant'. This makes customers willing to pay more for the firm's products, and in-cluster firms may more easily adjust their technologies to be compatible, which would have advantages for consumers and can increase demand (Katz & Shapiro, 1985, p. 425); possibly also through the creation of a dominant design caused by larger scale compatibility of in-cluster technologies. There is no certainty in the actual effects for firms being a resident cluster, but the network effect should be reckoned as a powerful aspect when researching lock-in as a cluster or SP value source.

## 2.1 ECONOMIES OF AGGLOMERATION

This topic is very much alike the network effect and deals with the tendency to agglomerate. Think of people that live together in cities while there are still many places that have hardly anyone living there (i.e. urbanization economies). Moreover, somewhat more specific, think of car dealers, they mostly settle within proximity of their competitors (i.e. localization economies). It relates to the network effect because when a certain amount of people or firms (critical mass) co-locate, they can have benefits. For example when people co-locate they have the benefit of an increase in the amount of services and facilities they can attract to their proximity (e.g. a supermarket will only locate in a region where it can find a sufficient amount of customers). Similar effects are true for firms, when they co-locate the more likely it is that their suppliers and customers will locate in their proximity and moreover their co-location can induce the benefits of economies-of-scale: the higher amount of similar products that are needed in one location can induce cost reduction (Malmberg, 2002) (Rosenthal & Strange, 2003).

These benefits however may not necessarily be the reason for firms to co-locate. In the park context, firms may locate there for a variety of reasons:

- The reason as described above, locating at the specific SP has benefits that can provide the firm with certain benefits (e.g. firms can use each other's expensive equipment and thus reduce their individual investments in 'fixed' assets).
- The SP is the 'place-to-be' when dealing with the specific industry/sector (e.g. firms in the semi-conductor industry in the U.S.A. locate at Silicon Valley because that is the location where all mayor businesses in this sector are located), this means the image of the SP can be used to promote the firm (Van Dinteren, 2011).
- The SP is the only location that tolerates the specific industry/sector or it is the location where it is desired to be situated (e.g., firms that are heavily polluting are often co-located by governments through licensing or underdeveloped regions that are under the influence of government stimulation policies).

This variety of reasons may have implications for a SP management as its policies to stimulate the growth of the SP should be according to the 'mechanisms' that lead to the creation of the SP. For example, heavily focusing on the brand of a SP may not be very effective when the in-cluster firms have only located at the SP because there was no other location available. These firms may be more interested in acquiring the hardware (e.g. buildings) and software (e.g. people) against low cost; meaning SP facilitators may better focus on efficiency issues to reduce costs.

### 3 INNOVATION DIFFUSION THEORY

The innovation diffusion theory has mainly been established by Rogers (2003). To indicate the main difficulty of the diffusion of innovation an often-named example is the (non-diffusion of the) Dvorak Keyboard. The keyboard most of us use today is the QWERTY keyboard, a strange phenomenon as today's research has provided several alternatives that allow for faster typing. However the switching cost appear too high compared to the advantages to convince a larger number of people (needed to create a network effect) to switch to for example the Dvorak key-layout. To relate this theory to OI in SPs the theory laid down by Rogers is given, a link with OI in SPs will be clarified throughout this explanation.

Rogers's theory contains four elements: the innovation, the communication channels, the time frame and the social system; the adoption of an innovation depends on these four elements.

#### 3.1 THE INNOVATION

The innovation is an obvious element described by Rogers as something that is perceived as new, a fairly simple descriptions but is indicates clearly what the main barrier is of an innovation and why it has to adhere to some 'attributes' in order to be adopted. Namely, something new always faces resistance as a natural reaction to change. The attributes of an innovation are relative advantage, compatibility, complexity, trialability and observability. Thus, an innovation is necessary to have a certain advantage over than what it supersedes, which means in the SP context that it must be clear to the SP residents what the advantage of OI is over CI. Next the innovation (or thus the transfer from CI to OI) needs some degree of compatibility, which means that is needs to be somehow connected to previous/past beliefs and experiences. Think of the resistance people displayed when the idea the world was not flat confronted them! An idea or innovation that is incompatible is perceived as impossible or complex, which brings us to the third attribute: complexity. Somewhat similar to incompatibility it is difficult for people to change to or learn things that are complex, and people will show resistance because the results of the innovation are unclear and much time and effort needs to be spend to understand it. For SPs incompatibility and complexity should

be kept low in order for the OI concept to be adopted, this means that its practices need to be explained clearly and introduced slowly (for example one after another). Trialability is a difficult aspect for SPs, as trying OI is not an option without committing to its practice; just like it is impossible to do 'a bit' of innovation. However, SP residents may be introduced to some practices that have less impact on a firm's daily operations before committing to the OI concept completely; this may also help to overcome some of the most often named difficulty when dealing with OI: finding a balance between OI practices and daily activities (see Appendix C.1). This connects to observability as the last attribute, by slowly introducing the OI practices firms can become aware of its potential. However, remains that without actually pursuing its practices it is difficult for OI to be actually observable. OI experts can say what the results of OI can be, but these 'second hand intangible' observations cannot make clear what the real process of OI includes; thus being observable for deeper understanding.

### 3.2 THE COMMUNICATION CHANNELS

Rogers describes the importance of the communication channel as a process that involves four critical items: the innovation, the sender of information (or the specialist), the receiver of information and the channel over which is communicated between the two. A communication channel needs to be chosen based on the attributes of the innovation (as this influences the type of 'quality' the information that is transferred can have). Highly visible innovations need little communication (low quality) like e-mail or other general media, in contrary to complex and incompatible innovations that need intensive, more direct communication (high quality communication) like group meetings or face-to-face discussions or interviews.

Within a park, the communication of innovation or the OI concept towards firms needs to be informative and partially persuasive. This implies that two types of communication are required, regular media and face-to-face or personal communication. First, regular media like magazines, brochures and internet pages are of informative nature. Within parks, these magazines serve the purpose of informing cluster residents of the success that OI practices provided to co-residents. Furthermore, the internet serves as a media to inform firms of all happenings related to the cluster: new 'future' residents, new services the cluster offers, and new investments done in the clusters area. This information shows residents what is being done in relation to cluster activities and thus informs them what they can do or in what they can participate. Next to information, the cluster residents need some persuasion to adopt the concept of OI more actively for it to be a success. Also (referring to the previous section) visibility of the innovation is important in order for it to be adopted. These two reasons show a need for personal communication; this can be in different forms like group meetings and face-

to-face meetings. The first are meetings in which an open discussion between residents can be held to elaborate on a certain topic, this clarifies the intentions of the park management towards its residents and the desires and worries of residents towards the park management. The second can be used to create a more in-depth understanding, for example through interviews a better understanding of the mechanisms that drive residents to pursue OI (or not) can be obtained this way. For example, larger firms in a cluster may be more interested in attracting university research towards a cluster with the purpose of acquiring knowledge, whereas smaller firms may be more interested in the university for the potential in it to deliver new employees.

### 3.3 THE TIME FRAME

Closely connected to the communication channels is the time frame. A greater number of channels used and a more direct way of communication will lower the time needed to adopt the innovation. Rogers (2003) divides the time frame into three parts: the decision process, the innovativeness of the individual (receiver) and the (general) adoption rate.

The decision process exists of five steps. The first step is related to the innovations observability, where the receiver acknowledges the innovations existence. The second step is the receiver being persuaded to adopt the innovation, thus in which the advantages, compatibility and complexity of the innovation are weighed against its predecessor. The third and following steps are the decision to adopt, the implementation and evaluation of the innovation.

The second part concerns the characteristics of the individual (receiver); the innovation adoption curve created by Rogers describes this topic. In this model (figure appendix C.2) people are divided in groups, the first group existing of innovators or those that actively search for the newest technologies and are eager to try them out. Later groups are less active in searching for innovations (early adopters & early majority) or are even somewhat resistant to adopt (late majority & laggards). As last part there is the overall time the adoption process takes, this is closely related to the adoption curve. However, instead of a bell shaped curve, an S-shaped curve characterized the adoption rate. This means that at the top of the adoption curve a decrease in adoption rate commences (figure appendix C.3). The speed of adoption is different depending on the attributes of the innovation (relative advantage, complexity, compatibility, etc.)



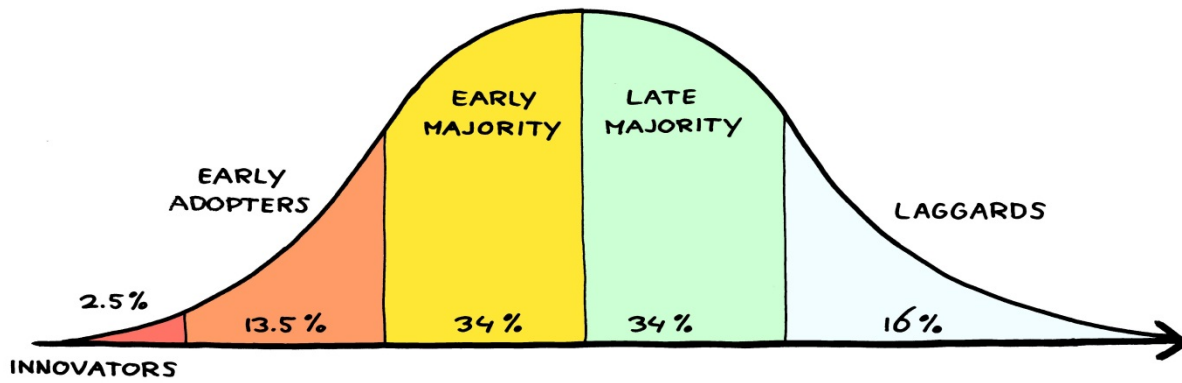


FIGURE APPENDIX C.2: ADOPTION CURVE (ROGERS, 2003)

OI is a relatively new concept (even though its activities may already be accepted, the concept is still relatively new). This means that innovators and early adopters already tried to implement the concept in their strategies and now OI is in the stage of early adopters and the early majority; for parks displayed by the amount of literature on OI that is small but slowly increasing.

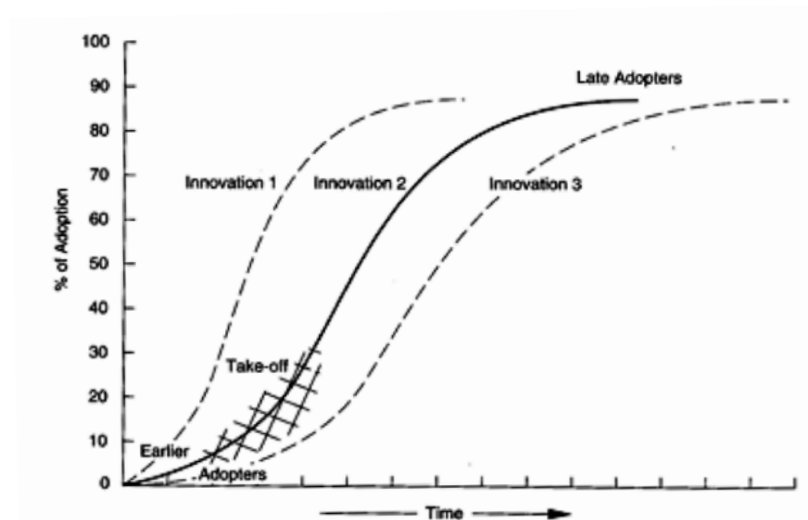


FIGURE APPENDIX C.3: ADOPTION RATE (ROGERS, 2003)

The implication is that when information considering OI is spread it should reckon with the higher probability that 'receivers' are unaware of the full potential of OI and all of its practices. Furthermore, in a park, some may be innovators, early adopters or belong to the early majority, but other residents may belong to the late majority or laggards who will display more resistance towards adopting the concept of OI and need pressure from partners in order to cooperate.



### 3.4 THE SOCIAL SYSTEM

The last main item of innovation diffusion theory is the social system. Rogers gives several examples in which the social system of a certain group was too strong for 'innovations' to break through, for example a group of Native Peruvians who resisted the ideas of cooking water in order to exterminate germs because they believed warm water was only to be taken by the sick and weak. In this respect, it is probably harder to convince a firm that has been successfully developing internally for several years or decades. Then to convince start-ups that have not yet determined on which levels they can achieve a competitive advantage over other already established firms that in their field of technology.

Within a park, the residents' social system should circumfuse cooperation and a certain level of thrust in order to achieve a high(er) level of OI. Decreasing the barriers to OI and maintaining a high level of communication and activities on this topic may create and/or sustain a social structure in which OI is one of the drivers towards growth.

## 4 SCIENCE PARK & INNOVATION ANALYSIS

OI is found not only to be an opportunity for firms to increase their potential, but also a negative effect is clear when firms do not cooperate and exchange know-how; they reduce their internal knowledge base and experience reduced capabilities to enter into exchange relationships (Enkel, Gassmann, & Chesbrough, 2009). When going through the barriers towards OI listed in Appendix C.1, the potential that parks offer becomes clear. Namely, it is possible to achieve an increase in mutual trust through the higher number of (strong) (in)formal relationships geographical proximity allows for (Bakouros, Mardas, & Versakelis, 2002) (Gretzinger, Hinz, & Matiaske, 2010). Furthermore, the trust barrier can be reduced through IP protection support (Lichtenthaler, 2009), and other difficulties can be managed through (or with the aid of) the central park management. Lastly, finding the right partner may be easier in a park where firms within a certain business segment concentrate.

Innovation requires effort, and so does OI. To successfully form collaborations of any kind (e.g. shared resource procurement and joint research & business development) an active approach is necessary (Enkel, Gassmann, & Chesbrough, 2009). This includes that firms align internal strategy with OI practices, and furthermore stimulate the active approach towards OI opportunities possibly through adapting reward structures as such (de Man, Hoogduyn, & Dekkers, 2009, p. 8). SPs may induce effort towards OI practices, but there may well be possibilities to improve these efforts. As described in Appendices A.2 & A.3 there are significant network effects in play that can be stimulated. Think of the dominance of park residents that can be put under attention towards potential new residents and the attributes of

the innovation (OI can be communicated in a more effective way when prove of the advantages of OI become clear through performance measurements and direct communication).

## 5 HISTORY AND THEORY OF SCIENCE PARKS

Science Parks have their origin in the United States of America. This first SP is named Silicon Valley; it owes its name to the high density of semiconductor and computer industry in the area. It may be so that parks are not of similar format and not created with the same intentions as modern parks in Europe and the rest of the world, but most parks pursue the success of Silicon Valley<sup>24</sup>. The park was originally created by Stanford University, due to a need for financing they started to lease-out land to high-tech firms. The foundation and/or settlement of Varian Associates, Hewlett-Packard and later Eastman Kodak and General Electric at the grounds of Stanford display the success of the high-tech environment the university created.

As Silicon Valley, the success of other SPs is often related to the successful incorporation of a knowledge institute (Basile, 2011) (Dettwiler, Lindelof, & Lofsten, 2006) (Ferguson & Olofsson, 2004) (Lofsten & Lindelof, 2003). The main idea of these University Science Parks (USPs) is that knowledge institutes are able to increase and improve their knowledge generation capabilities at the SP (Siegel, Westhead, & Wright, 2003) and sequentially valorize this knowledge, and thus businesses are able to use the knowledge institute to support their internal innovative activities also. However, there is no general agreement on the relation between a SP's success and the proximity of a university. Researchers are found to claim that very little extra technology transfer is achieved (Massey, Quintas, & Wield, 1992), but others are found to see the importance of Universities for the success of SPs and its residents (Bigliardi, Dormio, Nosella, & Petroni, 2006). Bakouros et al. (2002) discuss the situation in Greece and find that firms and Universities mostly form informal ties, but strongly suggests this may be due to the limited size of the parks in Greece and their 'young age'. This 'age' effect has been confirmed by Brown (2009), however this does not mean older SPs perform better by definition (Squicciarini, 2009a). Brown (2009) is one of the researchers that claim universities to be a critical aspect for SP performance, but remarks that not only universities cause the potential success of a SP to emerge. Namely, the performance of a SP is (most often) measured by its growth and the innovativeness of the in-cluster residing firms. In that respect he remarks the importance of large (multi-national: MN) firms for SPs, relating the presence of large (MN)

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<sup>24</sup> United Nations Educational, Scientific and Cultural Organization: <http://www.unesco.org/> (accessed: 14<sup>th</sup> of July 2011)

firms to some of the most successful SPs worldwide (e.g. IBM in the Research Triangle Park). He claims that presence of a business leader is a critical aspect of a potential successful SP:

*The success (the innovativeness of the in-cluster residing firms) is created through the presence of the most 'bright and innovative' minds who are attracted by the atmosphere surrounding the university and the business leader that reside in each others proximity.*

Proximity has been confirmed by other researchers as one of the most important contributing factors of SPs performance (Hu, 2008) (Frenken, 2010). However to return to the doubt considering SP performance, some researchers claim SPs to be (mostly) 'property based' initiatives (Massey, Quintas, & Wiold, 1992), (IASP) or believe SPs are merely used as image builders (Van Dinteren, 2011). Felsenstein (1994) even questions the fact that SPs spur innovation; he suggests that SPs are more likely to entrench innovation. This would mean that SPs are attractive locations to settle due to the real estate they offer and the image (perceived status) a firm acquires when settling at a SP, and not for the benefits that SPs are suggested to induce (e.g. technology transfer and information flow). Others however, like Brown (2009) indicate these type of SPs are most likely to fail, moreover other types of SPs have been found able to support innovative activities (Lindelof & Lofsten, 2003). While Felsenstein (1994) questions the benefits SPs induce for firms, he does see possibilities for policy makers to develop SPs beyond being a 'collection of firms'. A critique relating to this is that SPs are not the result of ration in the sense of creating a platform for technology transfer, referring to the way Silicon Valley has been formed (Hansson, 2007). SPs are perceived as clusters of firms, instead of being knowledge organizations, Hansson (2007) suggests that SPs need to extend their management functions beyond 'tangible and practical' (see table appendix C.2).

	Characterization of the knowledge organization ( <i>ba</i> )	Characterization of science parks
Basic unit of operation	Knowledge creation (tacit, explicit)	Innovations, products, entrepreneurs
Principles of organization	Networking, complexity, communities of practice, knowledge spiral	Firm building, local or regional economy, entrepreneurs, start-ups
Measures of success	Learning processes, transfer of knowledge, intellectual capital	Profits, returns, commercialization
Management functions	Self-managing, knowledge management	Support management, location management, consultancy

TABLE APPENDIX C.2: SCIENCE PARKS AS KNOWLEDGE ORGANIZATIONS (HANSSON, 2007)

One of the stronger aspects of SPs as indicated by researchers is their ability to support new technology based firms (NTBFs). It appears that in-cluster NTBFs perform better than their out-cluster counterparts. For example, Lofsten & Lindelof (2003) associate on-park NTBFs with higher sales and employee growth and Ferguson & Olofsson (2004) found higher survival rates

among in-cluster NTBFs. Furthermore, they indicate that the ‘image factor’ of SPs cannot explain this effect as was suggested earlier in this thesis. Dettwiler et al. (2006) remark that NTBFs that reside within SPs are better able to establish formal as well as informal networks comparing with off-park NTBFs. This was also found for on-park firms in general by Basile (2011). He indicates that SPs support innovation diffusion through the higher amount and greater intensity of communication (see appendix C.3). Dettwiler et al. (2006) relate this greater intensity to the SPs facility management (FM), and they indicate that FM may be a driver for NTBFs to settle in a SP. An important remark is that only little research shows that a significant difference between on- and off-park NTBFs regarding their innovative performance (e.g. number of patents / new products launched) exists (Squicciarini, 2009a). This is surprising considering the positive influence SPs seem to have on NTBF performance (e.g. the higher amount of ties on-park NTBFs have with universities). Lindelof & Löfsten (2003) argue this is due to the nature of research that universities perform (basic research vs. applied research); there may be room for improvement considering the nature of cooperation between universities and NTBFs that reside in SPs.

To conclude, researchers agree that not only universities turn toward SPs in order to make something of their technologies, but also (local) governments in order to the potential of SPs to ‘revitalize’ local economies (Brown, 2009), (Ratinho & Henriques, 2010). Brown (2009) found that SPs seem less affected by economic recessions and recover faster. However, a remark is that these SPs are not just locations where a lot of researchers and creative people work in proximity, active collaborations are a necessity in order for SPs to become more than just industrial parks.

## 6 SCIENCE PARK PERFORMANCE

Cabral (1998) designed a 10 point system to assess existing and planned SPs, these points have been recognized by various other researchers in independent research (Bakouros, Mardas, & Versakelis, 2002) (Chan & Lau, 2005) (Carpinetti, Galdámez, & Gerolamo, 2008). According to his design, SPs need to adhere to these 10 points in order for them to consider them SPs. However, he also argues these 10 points do not necessarily define SPs, but are necessary elements of a SPs organization in order for them to be successful. According to the 10 points formed by Cabral (1998) a Science Park must:

- 1 Have access to qualified research and development personnel in the areas of knowledge in which the park has its identity (high quality personnel; resource),
- 2 Be able to market its high-valued products and services (access to infrastructure),

- 3 Have the capability to provide marketing expertise and managerial skills to firms, particularly SMEs, lacking such a resource (management support service),
- 4 Be inserted in a society which allows for the protection of product or process secrets, via patents, security or any other means (IP protection service),
- 5 Have the capability to select or reject which firms will enter the park. The firm's business plan is expected to be coherent with the SP's identity (selection at the gate based on firm branch/sector, identity (through business plan fit), market potential, etc.),
- 6 Have a clear identity, quite often expressed symbolically, as the park's choice of name, its logo or the management discourse (SP Image/brand recognition),
- 7 Have a management with established or recognized expertise in financial matters, and which has presented long-term economic development plans (experienced financial management),
- 8 Have the backing of powerful, dynamic and stable national and/or local economic actors, for instance funding agencies, political institutions or the local university (broad base of support),
- 9 Include in its management an active person of vision, with power of decision and with high and visible profile, who is perceived by relevant actors in society as embodying the interface between academia and industry, long-term plans and good management — 'Mr/Ms Science Park' (partial hierarchical (corporate) management structure), and
- 10 Include a prominent percentage of consultancy firms, as well as technical services firms, including laboratories and quality control firms (service and facility providers on location).

Stappers (2010) indicates that the most important factors are image, and focus (i.e. a clear business plan) which relates to points 5, 6 & 7 only. This clarifies that SPs are more than real estate development projects (i.e. the SP should be organized not only to provide proximity to competing and partner firms) as was a point of discussion earlier this chapter. SPs need to provide access to knowledge workers and access to the market in which most of the SPs residents operate, furthermore its management should be able to support the managing of SMEs and start-ups, and also it should be well recognizable through for example its image and its business plan should be broadly supported. This shows that SPs cannot be governed as similar to networks as proposed earlier in being merely the third party in the formation of (neoclassical) contracts. SPs organization should be somewhat more similar to a firm internal organization with a well recognizable management (and spokesperson) and with a variety in value creating tasks (relating the 10 points provided by Cabral (1998)).

## APPENDIX D - VALUE SOURCES

### 1 EFFICIENCY

Looking up the term in a dictionary will result in a variety of definitions, for example, the online Cambridge dictionary<sup>25</sup> defines it as following: “*when someone or something uses time and energy well, without wasting any*”. Mainly all definitions state that one is efficient when something is accomplished with minimum expenditure (expenditure in the broad sense, meaning (financial) cost, time and/or effort). In economics, this means that costs (or waste, as in any undesirable result) minimization leads to efficiency. Efficiency in a SP would thus result in a state that all processes in the cluster are optimized in order to reach a collective efficiency. One way to determine the efficiency of a collective is to determine the efficiency of collaboration. Tsai & Tsai (2010) define the following potential way of collaborating to increase efficiency: Shared expertise, shared tangible resources, pooled negotiating power, coordinated strategies, vertical integration and combined new business development. However, an important remark is that the task of the (cluster) management is not to actively search for these benefits, their task is to remove possible blockages and to support the helpful aspects firms see when pursuing their goals (Campbell & Goold, 1998). Several researchers propose measures that relate to efficiency of collaborating. Trust is found to benefit the amount and depth of relationships (Gretzinger, Hinz, & Matiaske, 2010) (Lipparini & Sobrero, 1994), possibly influenced by higher geographic proximity (Chan, Oerlemans, & Pretorius, 2010) and strong IP protection (Lichtenthaler, 2009). Furthermore, in relation to trust and its influence on relationships: the frequency, intensity and stability of interactions are found to relate positive with cluster performance (Eisingerich, Bell, & Tracey, 2010). Amit and Zott (2001) add that information is not only an important aspect in relation to transaction efficiency (e.g. increased error rates through information asymmetries), but also when determining the trustworthiness of involved parties. Other variables found to have a positive influence on efficiency in the context of collaborating are shared resources (Carpinetti, Galdámez, & Gerolamo, 2008) and network openness measured by the high diversity and acceptance of new members and number of off-cluster relations (Eisingerich, Bell, & Tracey, 2010).

Amit & Zott (2001) propose another way to look at efficiency; they propose transaction efficiency as the main efficiency driver referring to the theory on transaction cost economics. This would mean that in order to reach a collective efficiency the transactions between firms in a cluster should inflict minimal extra costs. Amit & Zott (2001) propose efficiency in e-

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<sup>25</sup> <http://dictionary.cambridge.org/dictionary/british/efficiency?q=efficiency> (accessed: 8<sup>th</sup> of September 2011)



commerce to be able to be higher relative to traditional markets, the same can be argued for in-cluster firms that have the possibility to be more efficient than out-cluster firms in the following ways:

- Information asymmetry can be avoided through higher interaction intensity between parties (resulting in for example lower search and bargaining cost),
- The speed of information transfer is higher through greater geographic proximity of the parties (also allowing for higher quality of information, see Appendix C.3),
- Next to information also other distribution cost can be lowered, and distribution speed can be increased through geographic proximity of the value chain (think of physical goods),
- Clustering allows for benefits regarding 'economies of scale' reducing resource costs (physical goods),
- Marketing and sales cost can be lowered (or its effect can be increased) by using a common brand / image and the ability of cross-referring (in-cluster firms promoting other *non-competing* in-cluster firms), and
- Contract cost can be lowered because of the ability to enter into informal contracts (through mutual trust between in-cluster parties).

Most of these items do not require further explanation, it is clear that proximity can be used to increase efficiency and therefore become a critical aspect in SP development (Hu, 2008). One of these items has been researched more extensively regarding the topic of SPs. Namely, item 3 that considers the proximity of the value chain is discussed extensively by among others den Hartigh et al. (2006) and Iansiti & Levien (2004b) and (2004a). The topic of research discusses not particularly the value chain, but takes on a broader view including the value chain as part of an (business) ecosystem; explained as a network around a certain technology. In this sense a SP are comparable to an ecosystem, (though the value chain aspect may be less relevant) most SPs distinguish by a focus on a certain technology sector:

- Silicon Valley whose name is derived from the high density of semi-conductor industry in the area,
- Sofia Antipolis is one of the major SPs in Europe focusing on two sectors namely, computing & electronics and pharmacology & biotechnology,
- High Tech Campus Eindhoven (HTCE) is the major SP in the Netherlands focusing on health, experience (e.g. infotainment) and energy, and
- Chemelot Campus in Sittard-Geleen (as the focus of this thesis) is mainly active in the sectors Material Sciences and Life Sciences.

The research by Iansiti & Levien (2004b) proposes that the health of an ecosystem can be measured according to three variables (productivity, robustness & niche creation), one of them directly relates to efficiency (the two other factors are discussed under the topics: complementarities and novelty):

- Productivity, is the efficiency of converting inputs into outputs.

This can be related to collective efficiency of the ecosystem, thus using minimal amounts of cost (energy, money and other resources) to produce goods. Den Hartigh et al. (2006) continued the research performed by Iansiti & Levien (2004a) and propose a number of indicators that help to identify the strength of the three variables. They propose to measure the build-up of assets (technology value, patents, brands, cash & securities) over time. In the context of a SP the asset build-up over time seems relevant in order to see whether the cluster becomes more productive (of course correcting for cluster growth), however a disadvantage of the measure is that it does not allow for corrective actions if results are not what they were expected to be. A more relative measure is necessary in order to determine whether cluster facilities increase the efficiency of firms relative to not having these facilities available. Iansiti & Levien (2004a) mention an important aspect of efficiency that is very relevant in the context of SPs, namely: Leverage (value creation through asset sharing). Discussing 'leverage' mostly relates to the complementarities a cluster can offer; through 'leveraging' assets, it is possible to achieve an increase of the efficiency of the collective. The item will be discussed in more depth the following section that discusses this as complementarity (asset sharing). Nevertheless, it shows that efficiency and complementarities are closely related when discussing SPs.

## 2 COMPLEMENTARITIES

Referring back to the three variables that are proposed to measure the health of an ecosystem (Iansiti & Levien, 2004b), one of them relates to complementarities:

- Robustness, the ability of the ecosystem to survive (e.g. a worldwide economic crisis),

Its relation with complementarities may seem vague, as the variable may seem to relate to more to efficiency (again a relation between complementarities and efficiency). However, it robustness closer relates to complementarities than efficiency. Namely, the ability for a business to survive depends on its competitive advantage. If a business has a competitive advantage, and it can use this advantage in order to stay ahead of competition, it obviously has an increased propensity to grow, be profitable and thus survive. In the SP context, next to the firm internal possibilities to create a competitive advantage there is the ability to create an advantage with the possibilities a SP offers above an out-cluster location. These possibilities directly relate to complementarities as SP value driver, complementarities are suggested as



being the 'concept' that a SP offers. Namely, complementarities mean that locating on a SP has some extra 'benefits':

- The cluster 'brand' can be used by firms to promote the firms image; firms can claim to have a beneficial connection/relation with a knowledge institute (Squicciarini, 2008), and benefits of operating in a high-tech environment, etc.
- The High-Tech environment can help firms in finding the right partner and increase the possibility to 'spot' ATAs (Bianchi, Campodall'Orto, Frattini, & Vercesi, 2010).
- The ability to share resources and facilities; expensive labs can be shared to reduce the costs for the individual, and within the labs experts can cross-transfer their know-how.
- In-cluster firms are more likely being backed-up with (strong) financial support from a national and regional government (clusters are a popular political item).

Next to these benefits that clusters offer an important (possibly the most important) aspect of clusters is their culture, meaning their structure, the relations and connections between cluster residents (Iansiti & Levien, 2004a). As in today's economy, the competitive advantage of a firm no longer depends solely on its internal activities, but also on its ability to make a transition towards new technologies that beyond the borders of the firm. This relates to disruptive innovations (Christensen & Bower, 1996). Culture is what distinguishes a cluster from an industrial site (or even more general: a technology sector). Iansiti & Levien (2004b) describe it as an ecosystem; every species has its unique features and role within the ecosystem, when one of the species is extinct the other species will probably have trouble to survive (e.g. think of the food chain). This is similar to the culture, described by Den Hartigh et al. (2006) as one in which every firm that enters it, increases its value by bringing in unique features that it can share with 'the group'. This means also the reverse is true and thus mutual dependence occurs: a firm leaving the cluster decreases the value of the cluster for the other firms, and a firm entering the cluster increases the value for the other firms; meaning that when such culture is established *lock-in* occurs.

As indicated one of the important complementarities of clusters (closely related to efficiency and previously in this section briefly included as benefit) is 'leverage'. In generic terms, leverage means that any activity can be performed more efficiently, effective, be more useful or in financial terms be more profitable when its use increases (in size/amount). The previously given example was the ability of in-cluster firms to share resources and facilities, in more detail leverage includes:

- Sharing any type of resource creates the possibility to share and/or reduce costs and expertise:

- Employees are a valuable, but also expensive resource and thus sharing this resource may be more cost-efficient,
  - Sharing raw-material means larger amounts can be acquired at once, which will lower costs (economy of scale), and
  - Sharing investment cost for new equipment, instead of one firm making a large investment the investment (and thus risk) can be spread while every party is able to use the equipment as it desires (also the expert that operates the new equipment can be shared).
- Creating information standards increase mutual understanding, and thus reduces transaction cost and increases the ability to create standards (monitoring performance over the whole cluster reduces the need for every individual monitoring).
  - Acquiring (venture) capital may become easier when firms propose projects in which they collaborate; this reduces the risk for the (venture) capitalist who can regain the investment from a diversity of firms.

A suggestion is that leverage is the main attractor for firms to settle at a SP; however, an important aspect in this is that all of these possibilities are in small (geographic) range. This means that when a firm identifies an opportunity it only takes a small walk to bring it into action, significantly reducing the threshold for actually taking action because of the following:

- The work and difficulties coordinating actions over distance may induce,
- The established understanding/trust that already exists between possible partners that also reside in the cluster, and
- The greater knowledge the firm has of the partner that gets involved (firms are better able to know what the other firm is capable of because they are neighbors).

Hu (2008) claims that geographic proximity is an important factor in the amount of interaction and the size of a professional network, furthermore organizational and social proximity evolve from physical proximity. Frenken (2010) extends this claim and states that proximity is a critical factor for the replication of and building on knowledge in a cumulative manner.

### 3 LOCK-IN

Described in the previous section was the comparison between an ecosystem, as it exists in biology and the business ecosystem. In an ecosystem there is a certain mutual dependence between species, one of the species leaving the ecosystem means the value of the ecosystem decreases, each species depends on the 'health' of the whole ecosystem in order to survive. A similar effect exists in business ecosystems by a variety of researchers, and in relation to lock-

in, this means that in order to protect the ecosystem it is imperative the individual members stay in the ecosystem for it to keep its value.

There are two interesting aspects in this:

- 1 The ecosystem or culture creates value for firms and makes that firms are to some extent locked-in. As not only the value of the ecosystem drops when the firm leaves, also the firm loses the value gained by the ecosystem when leaving. Furthermore, the more secure a firm is that the ecosystem will maintain (or even increase) in value the more likely the firm is to invest in the ecosystem and thus become (more) locked-in.
- 2 Firms do not desire a situation of lock-in as this makes them vulnerable. When a firm is unable to leave the ecosystem because it delivers a significant amount of value for the firm, others can exploit this dependence and gain from this vulnerability (for example by charging a high rent for the buildings the firm in question uses).

The first aspect relates to the network effect (as described in Appendix C.2), if someone is secure of the value of a product (e.g. because it has a certain user base) the person is more likely to also invest in this product. The second aspect relates to switching cost (as briefly named in Appendix C.3), as the higher the costs a firm faces of leaving the ecosystem, the more willing the firm is to pay a higher premium to be able to stay in the ecosystem. A SP management will try to increase lock-in in order to be able to ask for this premium, without taking care for the 'health' of the ecosystem. However, this may not be a problem when firms use this lock-in as a reason to invest in the park to improve their efficiency and the potential the park offers to make use of the benefits it offers; the complementarities. In other words, the value-drivers may spur each other. Research by Amit & Zott (2001) shows such effect may exist because efficiency, complementarities, lock-in and novelty are highly correlated; with the exception of efficiency and novelty between which the coefficient is low.

#### 4 NOVELTY

The lower coefficient found between efficiency and novelty as described in the previous section, can be explained with the popular research topic that discussed the trade-off between efficiency and flexibility or routine and creativity (Adler, Goldoftas, & Levine, 1999). As such, this means that within a SP it may not be beneficial to focus on either of these value sources. A SP often has the aim to be a location in which innovation is promoted (a focus on Novelty), and thus creating an environment in which efficiency is one of the main stimulated aspects may be counterproductive. On the other hand, however, creating an efficient environment enables firms to focus on their core activities. Either way, novelty is the value source that is somewhat harder to grasp than the value sources previously discussed (efficiency,

complementarities and lock-in); not surprisingly, as ‘innovation’ is one of the most intensively researched topics.

The last of the three variables that are proposed to measure the health of an ecosystem by Inansiti & Levien (2004b) relates to novelty:

- Niche creation, means the ability of an ecosystem to be novel/innovative (generating meaningful new products and ways of doing things).

The use of ‘niche’ may be somewhat confusing because it refers to something specific, for example a distinct segment of a market. Clearly, a SP will not have the goal to have residents focus on creating new market segments. Accordingly, this measure does not show all aspects of novelty, but the capability of the ecosystem to be diverse does say something about its creativity. The indicators Inansiti & Levien (2004b) propose are firm and product diversity; thus, the (growth in the) number of firms that operate in different product/market segments and the (growth in the) number of products that can be characterized as significantly different from products that already existed (in the cluster). These indicators are interesting for park managers because they actually provide insight in the ‘state’ of the SP. Not only do these measures provide ‘direct’ information (thus, the variety of firms/products that can be found in the SP), also they give some estimate on the probability of novel things emerging. Namely, Bianchi et al. (2010) state that a focused product portfolio make it harder to identify ATAs, which is in line with research by Lichtenthaler (2008) who claims that diversified firms are relatively more open than other firms for which product development is mostly an internal activity. Thus possibly the ‘diverseness’ of the SP is an indication for the openness of the firms within the SP (regarding OI) and too the likeliness that knowledge spillovers occur (a complementarity that is expected in SPs). This is in line with research by Eisingerich, Bell and Tracey (2010) who claim that a more open network (which they explain by high diversity, acceptance of new cluster members and the amount of off-cluster relations) has a positive influence on performance. This may also be because a more open firm is more proficient (or efficient) in forming relations with other (competing and non-competing) firms.

When discussing ‘novelty’, an important aspect is IP. The aspect was briefly touched upon when discussing trust in business relationships as an indication of efficiency. In the context of innovation, trust is mostly seen as a barrier (the trust barrier). Chan et al. (2005) indicate that especially start-ups are found to lack trust. They explain this with start-ups considering themselves as technology experts in their field. A remark they make is that they did not find a trust-barrier when a university is involved as consulting party. This is in line by research performed by Bakouros et al. (2002) who show that synergies between universities and firms promotes innovations, especially in the case of smaller firms.

## APPENDIX E - INTERVIEW RESPONDENTS

### A. BasicPharma

- Bob Kool (CEO)

### B. CHEMELOT

- Frank Schaap (Director Marketing & Business Development)
- Ger Wagemans (Managing Director)
- Hans Kierkels (Account Manager)
- Leo Visser (Account Manager – replaced Hans Kierkels)

### C. DPI Value Center

- Arie Brouwer (Managing Director)

### D. DSM

- Jos Schneiders (CEO - DSM Nederland)
- Koen Janssen (Director - DSM Ahead)
- Bert Kip (Director - DSM Resolve)

### E. Eindhoven University of Technology

- Prof. Dr. Ir. Jaap Schouten (Dean, Department Chemical Engineering and Chemistry)

### F. Hogeschool Zuyd (HsZuyd)

- Rob Ruijgrok (Director department Technology)

### G. Kriya-Materials

- Edwin Currie (CEO)

### H. Limburg Ventures

- Casper Bruens (Investment Director)

### I. LIOF

- Bert de Wit (Director Development & Innovation)

### J. Province of Limburg

- Jan Smeelen (Director)
- Frank van Lissum (Program Manager)

### K. TiGenix

- Dieter Hauwaerts (Head Manufacturing)

## APPENDIX F - INTERVIEWS TO CREATE TOPIC FRAMEWORK

27<sup>TH</sup> OF MAY – MEETING 1

Attending: dhr. F. (Frank) Schaap & dhr. J. (Jimme) Keizer

Main findings:

- (for the first time in its existence) DSM has fixed a long-term strategy; this means that DSM will remain stakeholder of the Chemelot Campus.
- Chemelot started a project because DSM experiences it was unable to fill all of its real estate with its own business activities. It started a project to attract other firms to the area with promoting the ability to get close to the unique knowledge DSM has to offer, thus an ecosystem was created in which open innovation was the main element.
- Change appeared in 2005 when Chemelot appeared on political agenda. Fifteen firms were aimed for to attract to Chemelot, however 27 were achieved. Meaning a higher growth is achieved than expected for and currently plans are developed for new real estate.
- This process has a contrast with the High Tech Campus Eindhoven (HTCE), which started as a real estate development project, and right now, it is aiming for the creation of an ecosystem with open innovation as key element. Thus, its creation has followed the path Chemelot followed but the other way around.
- In 2010/2011 an intention was signed by DSM, the Province of Limburg and University Maastricht / Maastricht University Medical Center+ (UM/MUMC+) for the future development of the Campus. (A document: Consortium MasterPlan was retrieved which contains the mission and activities that are planned for the near future).
- The Park Management (Chemelot) has the following aims:
  - Realize the goals that stakeholders define, and
  - Rent out the available real estate

The Park Management believes it can better achieve these goals when it is able to measure the value drivers of the cluster. This should clarify if stakeholders pursue similar drivers or if some conflicts exist between the goals that stakeholders define and what residing firms expect the cluster to deliver them. Main questions this measuring system should provide answer to are:

- Why do firms settle in this cluster? (e.g. location, infrastructure, open innovation)
- What are the activities and goals firms perform/aim for?
- What do they need for these activities and to achieve these goals?
- Does the cluster provide this?

The core target group is the ‘producing companies’, thus those involved with product and processes (these are firms that perform R&D, running businesses and start-ups).

This project will involve interview with several stakeholders and residing firms:

- DSM, Province of Limburg and UM/MUMC+)
  - Fred Offrijn (UM/MUMC+)
  - Edwin Bakker (Province of Limburg)
  - Frank Schaap, Jos Snijders and/or Aad Brouwer (DSM)
  - Frank Schaap, Ger Wageman & Hans Kierkels (park management)
  - Jimme Keizer (HsZuyd Zuyd & TU/e)
- Up to 10 firms divided over 4 categories

Small & Recently settled @ Chemelot	Large & Recently settled @ Chemelot
Small & Matured Resident @ Chemelot	Large & Matured resident @ Chemelot

10<sup>TH</sup> OF JUNE – MEETING 2

Attending: F. (Frank) Schaap & H. (Hans) Kierkels

Main elements:

- Hans Kierkels will be the main contact person throughout the project and where possible/needed assist in the process (possibly be present during interviews).
- We have agreed upon a list of interviewees:

**1 Bedrijven op Chemelot Campus**

Klein – Life Sciences (LS)

- Cellmade – Ronald Bronsaer
- Tigenix – Dieter Hauwaerts

Klein – Material Sciences (MS)

- Avantium – Charles Kamphuis
- Kriya Materials – Edwin Currie

Groot – Life Sciences (LS)

- DSM Innovative Synthesis & Catalysis - Rinus Broxterman
- Basicpharma – Bob Kool

Groot – Material Sciences (MS)

- DSM AHEAD – Koen Janssen
- SABIC – Rene Borman

Service providers

- DSM Resolve – Bert Kip

- DPI Value Center – Arie Brouwer

## 2 Stakeholders

- Chemelot Campus Consortium – Ger Wagemans (kwartiermaker)
  - DSM Nederland – Jos Schneiders (President)
  - UM – Martin Paul (Voorzitter RvB)
  - Provincie Limburg – Jan Smeelen (top ambtenaar EZ)
  - Hoge School Zuyd – Rob Ruijgrok (kwartiermaker CIVEC)
  - LIOF – Bert de Wit (Hoofd Ontwikkeling & Innovatie)
  - Limburg Ventures – Casper Bruens (Investment Manager)
  - TU/e – Jaap Schouten (Professor)
- I will prepare a letter as introduction for the interviews in cooperation with Hans Kierkels
  - Interviews will be prepared carefully in cooperation with Hans Kierkels
  - The main goal of the project is again understated: to find what the processes are that drive the firms on the campus, how these can be supported by the Chemelot management, to what extent this is in line with the desires and expectations of stakeholders, and thus whether adjustments are necessary.
    - My part in this project is to use the interview to gather information that leads to the creation of a complete measurement model that provides managers with the information that aids them in improving the opportunity for business development at Chemelot.
  - I will be given contact details of all interviewees in order to make appointments for the interviews.



## APPENDIX G - SEMI-STRUCTURE INTERVIEWS: PROTOCOL (BASIC VERSION)

### General information

**Company Name** :

**Date settled at Chemelot** :

**Company Size** :

**nr. Of Employees** :

**Yearly Turnover** :

**Life Sciences / Material Sciences** :

*First, we need to determine what the current situation, goals and strategies to reach these goals of firms are to enable the creation of optimized strategies by the park management.*

### Firm-level

1. Why have you chosen to settle on the campus? Which alternative have you considered?
  - Did the 'open innovation' concept of the campus motivate you to settle here?
  - Were there any other efforts to attract your firm in settling at Chemelot?
  
2. What are the main activities of the company?
  - What facilities do you use? (transport / shared resources / legal support / venture capital)

3. Is the company able to perform its activities efficiently?
  - Resources, supplier/buyers proximity, transportation
  - What hampers?
4. Do the services offered by the cluster aid in the company's performance?
  - In addition, what about the presence of other 'innovative' firms, Technology leaders, Universities and Real estate?
5. Do you believe that the services the cluster offers mostly benefit larger or smaller firms? Why is this so?
  - In addition, do the smaller firms benefit more from the technology leaders? Or vice versa?
  - What about the university? (knowledge flow / student projects / researchers)
6. Is the number and type of companies that has settled at Chemelot sufficient? Or is it desired to attract more (diverse) firms?
  - Moreover, if so, what type of firms would this be (which technologies are missing in the cluster that would aid your performance)?
7. Do you believe your firm is better able to perform its activities within the cluster (compared to the outside situation)?
8. What are the goals of the company / what does 'the company' desire to have achieved in 1 (short term) and 5 (long-term) years from now?
  - Also: what results do you hope to gain from the campus (short/long term)
9. What (facilities or circumstances) does 'the company' need (from the campus) to achieve these goals?
10. Do the services currently offered by the cluster sufficiently support your strategy?
  - Are services missing that would enable the company to better reach its goals?

## Campus level

In the MasterPlan Consortium Chemelot Campus, the definition of the mission statement is as following:

*Stimulating and organizing Open Innovation through strengthened cooperation and joint competence and knowledge development / preservation in the area of CHEMaterials in order to create value.*

Value creation can be described as:

*Developing the Chemelot Campus to become the Euregional and international settlement for firms, research institutes in the area of CHEMaterials*

11. Do you believe the Chemelot Consortium is able to achieve this mission? And are you attached in any way to this mission?
  - Are you willing to participate (have an active role) in activities to realize this mission?
  - What is the major threat Chemelot faces?
  
12. Is the Chemelot Campus an attractive location to settle for national, euregional or international firms, and entrepreneurs?
  - Do you believe that the nearby industrial park (high tech factories) is important?
  - And what about Open Innovation?
  - Proximity of value chain / coopetitors?
  
13. What do you believe does Open Innovation offer to residents of Chemelot?
  - Cost reduction etc.
  
14. What are the most important services Chemelot offers to your business?
  - And what is the most important benefit of Chemelot in general?

## Regional level

15. What will be the influence of a strong partnership between the campus and a knowledge institute (such as UM / MUMC+)?
  - What about the bachelor and master that are developed?
  - What about the 'inlooplab' (walk-in laboratory) that is created in cooperation with Hogeschool Zuyd?
  - Pool of new talent (campusevent 30 juni 2011)
  
16. Does Open Innovation at Chemelot stimulate to collaborate with regional out-cluster firms? (does you experience with open innovation within the cluster stimulate you do perform similar activities outside the cluster?)
  
17. Is the region sufficiently developed to support your business development (i.e. infrastructure, availability of partner firms, suppliers/buyers, transportation)
  
18. In what technological field should the region develop to match activities at Chemelot? (leading to more collaboration on a regional level).

Value Driver Identification (Efficiency, Complementarities, Lock-in & Novelty)

**Efficiency:**

**do not agree - agree**

1 Chemelot enables the reduction of transaction costs

1 - 2 - 3 - 4 - 5

1b The most important enabling factor(s) is/are (mark with + or - if desired so):

- Geographic proximity
- Infrastructure
- High density of informal/formal relationships in the Chemelot Campus
- Size (economy of scale)
- Other, namely...

2 Chemelot enables the increase of transaction speed

1 - 2 - 3 - 4 - 5

2b The most important enabling factor(s) is/are (mark with + or - if desired so):

- Geographical proximity
- Infrastructure
- High number of informal/formal relationships in the Chemelot Campus
- Other, namely...

**do not agree - agree**

1 - 2 - 3 - 4 - 5

3 Chemelot enables to reduce (resource) costs

3b The most important shared services are (mark with + or - if desired so):

- Shared resource procurement
- Shared office equipment procurement
- Shared campus security & fire department
- Shared licensing (e.g. environmental permit)
- Proximity of resources
- Proximity of services (IP-protection, Management & organization)
- Other, namely...

4 Information supplied in/by Chemelot (Consortium) enables me to reduce search and bargaining costs

1 - 2 - 3 - 4 - 5

4b The most important information source is (mark with + or - if desired so):

- Chemelot information system
- (collaboration) partner firms
- Informal meetings with cluster residents
- Other, namely...

**do not agree** - **agree**

- |    |   |                   |
|----|---|-------------------|
| 5  | Chemelot increases my ability to perceive the quality and nature of goods that are exchanged in-between cluster residents   | 1 - 2 - 3 - 4 - 5 |
| 6  | Chemelot increases my knowledge of other in-cluster residents<br>(e.g. what are their products, services and/or specialties)  | 1 - 2 - 3 - 4 - 5 |
| 6b | This increases my access to these other in-cluster residents (e.g. via accelerator building)  | 1 - 2 - 3 - 4 - 5 |
| 6c | This allows me to better support my customers because I am able to suggest additional technologies to my customers  | 1 - 2 - 3 - 4 - 5 |
| 6d | This causes me to be more aware of the trustworthiness of sellers, and the needs of my customers  | 1 - 2 - 3 - 4 - 5 |
| 7  | Chemelot provides access to a larger number of sellers/buyers   | 1 - 2 - 3 - 4 - 5 |
| 7b | With the benefit of increased buy/sale power  | 1 - 2 - 3 - 4 - 5 |
| 8  | Overall Chemelot enables me to (better) achieve (internal) goals  | 1 - 2 - 3 - 4 - 5 |
| 8b | These goals are:  |                   |
|    | <input type="checkbox"/> Financial (Sales growth, Turnover growth, ROA targets)   |                   |
|    | <input type="checkbox"/> Technological (Number of new products in development, Number of new products developed and marketed (i.e. distributed),<br>Number of Patents applied for/granted, Number of new technologies mastered) |                   |
|    | <input type="checkbox"/> Capacity (Increase of machinery/capital goods, Increase of employees)  |                   |
|    | <input type="checkbox"/> Other, namely...   |                   |

**Complementarities:**

**do not agree - agree**

The presence of a university or other knowledge institute at the Chemelot Campus:

- |   |                   |
|---|-------------------|
| 9 provides new talent which I may benefit from in the future                | 1 - 2 - 3 - 4 - 5 |
| 10 provides more/better opportunities to attract trainees/graduate students | 1 - 2 - 3 - 4 - 5 |
| 11 increases my knowledge base  | 1 - 2 - 3 - 4 - 5 |
| 11b - that helps me to develop business                                     | 1 - 2 - 3 - 4 - 5 |

The Chemelot Brand:

- |   |                   |
|---|-------------------|
| 12 supports in retaining/attracting new business                                    | 1 - 2 - 3 - 4 - 5 |
| 13 increases in value with the new (planned) real estate                            | 1 - 2 - 3 - 4 - 5 |
| 14 enables support from outside the cluster (government funds, manufacturing firms) | 1 - 2 - 3 - 4 - 5 |
| 15 enables me to attract new personnel  | 1 - 2 - 3 - 4 - 5 |

The Chemelot Campus concept:

- |  |                   |
|--|-------------------|
| 16 Causes me to be more involved with suppliers and buyers                                   | 1 - 2 - 3 - 4 - 5 |
| 16b This is also the case when it concerns out-cluster firms                                 | 1 - 2 - 3 - 4 - 5 |
| 17 Increases the technological level of my internal innovations                              | 1 - 2 - 3 - 4 - 5 |
| 17b Through providing services like: shared research facilities & knowledge experts          | 1 - 2 - 3 - 4 - 5 |
| 17c Through providing services like: management/financial/IP support, conference rooms, etc. | 1 - 2 - 3 - 4 - 5 |
| 18 helps me to identify new services and products in my market segment                       | 1 - 2 - 3 - 4 - 5 |



**do not agree - agree**

1 - 2 - 3 - 4 - 5

19 helps me to identify new supporting services and products for my firm

### Lock-in

20 The new real estate that is planned for will better support my activities

1 - 2 - 3 - 4 - 5

21 The new real estate will attract new/other firms to settle at Chemelot

1 - 2 - 3 - 4 - 5

21b The most important aspect is:

Overall image improvement

The Accelerator

The Networkplaza

Other, namely...

22 My business is involved in collaborative activities

Yes / No

22b Most of my collaborative activities:

are with in-cluster firms

are with out-cluster firms

involve knowledge sharing

involve facility sharing

involve resource sharing

other, namely...

**do not agree** - **agree**

1 - 2 - 3 - 4 - 5

Chemelot stimulates collaborative activities

22c Its most important stimulations are:

- Presence of Technology leaders (DSM, SABIC)
- Presence of knowledge institutes
- Ability to share research facilities
- Chemelot provides a 'knowledge sharing' environment
- Chemelot supports IP-protection
- Other, namely...

23 My firm is able to adjust services at Chemelot to personal needs

1 - 2 - 3 - 4 - 5

23b This mostly relevant for:

- Research facilities
- Office space
- Security services
- Others, namely...

**do not agree - agree**

I can trust Chemelot because I and my employees

- |   |                   |
|---|-------------------|
| 24 can control the information my firms shares (contact information, internal news, new technology)         | 1 - 2 - 3 - 4 - 5 |
| 25 are continuously informed of all activities Chemelot performs  | 1 - 2 - 3 - 4 - 5 |
| 26 get access to all information Chemelot possesses concerning other cluster residents                      | 1 - 2 - 3 - 4 - 5 |
| 27 can influence the strategies of Chemelot that concern my firm  | 1 - 2 - 3 - 4 - 5 |
| 28 Chemelot is the best location for my firm to reside  | 1 - 2 - 3 - 4 - 5 |
| 29 Without Chemelot I would lose an important part of my network  | 1 - 2 - 3 - 4 - 5 |
| 30 My firm has made considerable investments in order to benefit from the Chemelot-concept                  | 1 - 2 - 3 - 4 - 5 |
| 30b However, outside of Chemelot these investments would not have been sufficient to reach similar benefits | 1 - 2 - 3 - 4 - 5 |

## Novelty

31 Chemelot increases my level of innovativeness

1 - 2 - 3 - 4 - 5

31b The most important factor is:

- Presence of Technology leaders (DSM, SABIC)
- Presence of knowledge institutes
- Ability to share research facilities
- Chemelot provides a highly innovative environment
- Other, namely...

31c

**do not agree** - **agree**

My innovativeness improves because at Chemelot:

- I can easier detect alternative technology applications
- I can easier find new technology combinations
- I can easier find specialists to assist in technology development
- I have the facilities in order to perform the necessary R&D close by
- Other, namely...

32 Chemelot increases my ability to find new markets for my technology

1 - 2 - 3 - 4 - 5

33 Chemelot continuously improves its products, services and facilities

1 - 2 - 3 - 4 - 5

## APPENDIX H - THE DATA (SUMMARY)

Overall, the interviews aim to retrieve information on the goals, activities, needs & expectations regarding the cluster and the four value sources. The research proposal from HsZuyd contains a list of questions regarding goals, activities, needs & expectations. The research by Amit & Zott (2001) and Van der Borgh (2007) contain questions regarding the four value sources. Considering the literature that has been gathered and the lists of questions prepared by the researchers named above it is clear that some topics need to be touched upon with qualitative questions (e.g. the goals, activities, etc.), and that for others more quantitative questions are sufficient (i.e. the value sources).

The interviews can be divided over 3 groups next to the Chemelot consortium: the in-cluster firms, the shareholders and other stakeholders or 2<sup>nd</sup> tier parties. First, a summary of the data acquired from the three groups is provided, a summary of the insights the Chemelot consortium provided can be found at the end of this appendix and in appendix F.

### 1 FIRMS & SERVICE PROVIDERS

In-cluster firms are those that can provide most relevant data on all topics. Namely the goals, activities, needs & expectations they have/perform regarding the cluster as (important) stakeholder and how they perceive the value the cluster provides (efficiency, complementarities, lock-in & novelty).

#### **Key Remarks:**

Firms that are not DSM units have troubles with organizing basic utilities (gas/water/electricity/data connection). DSM is not used to deal with other parties in this way (sharing utilities). The know-how is available but the service needs to professionalize!

Examples are:

- ‘Outside the gate’ data connections are very slow,
- Pricing of the various utilities is still under discussion (no bills are being received!?), and
- Firms are forced to use DSM servers (what happens with sensitive firm data?) & software (changes are time consuming, time smaller firms do not have).

An important aspect for the firms is that they need to (be able to) find partners, increasing the number of residents is only a first step. Stimulating this aspect can be done by structurally organizing meetings. Already available is a shared restaurant, but a more ‘professional’ option is to structurally organize ‘symposia’ or equal events. These meaningful informative events in combination with the possibility to find partners (afterwards) are believed to be a very efficient way to stimulate networking.

A very positive remark is that financing is well arranged at Chemelot, this should be maintained the way it is organized. Firms very much appreciate the way Chemelot assists in their need for financing. Service providers notice this can be further developed because they notice that approx. 50% of questions are on financing issues. Furthermore, the link with the regional government should enable access to funds/subsidies, which can be lobbied for, or at least some assistance towards the way to get access to these funds/subsidies can be provided.

#### **Differences between large/small & LS/MS & in-cluster/service providers**

LS are only small compared to MS and there are only a few LS firms at Chemelot.

There is a large difference between producing and R&D firms. Firms that produce/fabricate are more interested in focusing on their core business (which is fabricating their goods) compared to R&D firms. R&D firms are more eager to mix with the rest of the cluster in order to share/discuss know-how (however, both are interested in organized meetings with an interesting topics and 'networking' possibilities afterwards as previously indicated).

Service providers notice that being located in proximity works, especially for entrepreneurs this increases accessibility.

#### **Other results**

Firms settle at Chemelot because it is the only location in NL where Chemistry can be dealt with (think of environmental issues, licenses & know-how), and because the location has buildings that can be used (for some plug-and-play, others require significant investments but the space is available). Some other (less significant) reasons are:

- Chemelot offers an environment of suppliers, knowledge workers and buyers (however a value chain is not yet achieved, but may be interesting for the future),
- Chemelot is logistically well located in the Euregion, and
- Chemelot has an existing industry and facilities that are attached to this industry.

All firms have a focus on growth (business growth); some also consider recruiting as an important process and perceive the area (Chemelot) as capable to provide new employees (also in the longer term). However, the improving the position of Chemelot is possible:

- The attractiveness of the campus needs a boost in order to be able to attract personnel (old buildings are not perceived as a nice place to work).
  - Education at Chemelot location (make Chemelot a location where education and the working/professional environment meet), to attract education the park needs facilities such as public transport.

Regarding attracting knowledge workers, acquiring new (very) large firms is not necessarily desirable; for example, this will make it more difficult for smaller firms to attract quality

employees (this is of course not the case when it considers relabeling DSM units). To gather more firms of equal size (small and medium sized) is perceived more interesting.

- The really small firms however are less interesting for the larger firms because they do not have the means to get involved in significantly large collaborating activities,
- Important is that the firms that are attracted to Chemelot are open for the concept (sharing know-how etc.), and
- Sharing is expected to be easier between similar firms (size, market segment).

Several firms that reside at the campus do not fit the OI concept very well (mostly the producing/fabricating firms). The campus management should acknowledge this and should find ways to support these firms. This is specifically important because Chemelot is unique in comparison to other SPs in that it is a production location!

- Chemelot is a very expensive location to 'just' have an office, also services that are provided by 'Chemelot partners' are expensive (use of monopoly provided by Chemelot), and
- Chemelot and OI are a difficult mix, Chemelot is not an Open campus (more like a fortress). In addition, hampers business, customers from outside the gate are not really getting a warm welcome.

### **MasterPlan**

Firms believe that Chemelot can be the Euregional location for LS and MS:

- political policies are inconsistent (think of the high number of psychology students instead of beta students), but the Consortium is a step forwards (e.g. securing flow of employees by connecting with knowledge institutes),
- Internal infrastructure is by far not sufficiently developed to be competing with other park in the Euregion,
- Selection at the gate is necessary, firms that settle should be committed to the concept to create a 24/7 active environment of business creation / collaboration, and
- Overall, it is unclear what the aim of Chemelot is, what is their business plan?

### **Regional Development**

Connection with knowledge institutes:

- Improves the ability to maintain inflow of new employees,
- Change of university/school curricula improves education/business overlap, and
- What is a SP without access to Science? University/schools at location and a connection to science data (surfnet) should be self-evident.

There is a duality within the campus regarding what Chemelot should have to offer regarding services. Some firms see benefits to actively increase the availability of services in proximity,

but others argue that Chemelot should not offer any services that are offered by the 'yellow pages'. Overall, proximity can improve efficiency and makes these services more accessible:

- Operational services like couriers, cleaning, food etc., and
- Legal services (Arbo, IP protection).

Creating an attractive region does not only depend on jobs (attractive place to work). This includes the development of a city (Maastricht); people want to live in /near a city and thus this should be also focus of development.

### **Value drivers**

Overall, the park scores low on efficiency, especially regarded a weak point is infrastructure; the park does have potential! Chemelot scores somewhat better on complementarities, especially the potential that a connection with a knowledge institute offers. Less recognized are the benefits of the Chemelot brand (Chemelot brand is not recognized, this is a DSM park) and the cluster concept (what is the concept? / business plan?). An important remark considering complementarities is that not only partners settle at the campus, what use do these 'complementarities' have for non-partnering firms. Firms experience lock-in, but for different reasons, some firms have their knowledge workers and customers reside at location others made investments at this location. This does not seem to relate to the thrust firms experience towards other in-cluster firms. Firms experience novelty only through the high-tech environment offered by Chemelot; also, the outside of the campus can provide the basis for novelty, it does not necessarily come from within.

## **2 SHAREHOLDERS**

Regarding the shareholders of the consortium a major limitation is that there has not been performed an interview with the university (UM/MUMC+). This mean that the goals and expectations of this institute are based upon alternate information sources such as the MasterPlan and interviews with other parties (like other knowledge institutes).

**The local government** takes in the role of facilitator; the reason to be involved is mainly for regional development (creating a climate in which people enjoy living and working). The government has five main elements over which its involvement is determined to be successful / performing well:

- 1 Knowledge workers, which considers the attractiveness of the location and what is being done to realize an increase in employee inflow (increase with 1000 fte),
- 2 Housing / real estate, this is about the amount of real estate in use (percentage), why not all of the real estate is in use. Furthermore, what other real estate is needed (clean



- rooms, research facilities), what is the amount of rent money brought in, is the fund available for unused real estate sufficient (rate?),
- 3 Venturing fund, to what extent is the fund used, how much of the fund is used / time aspect (amount of € / year) and what causes the fund to be used this much/little?,
  - 4 Approx. 1,5 mln euros of funds for setting up the Chemelot Consortium Management, what is being done with it?, and
  - 5 Size of the campus: what is the size of, and what happens with unused areas? What is the business case? Is a business case being developed in order to attract future investors to take over the consortium (creating a modern, open and inviting atmosphere or something alike)? Lastly, what are growth expectations (the government can recover some money by selling land?)

Another item is that DSM has an image that is very useful to attract employees. It is not necessary to keep DSM at this location, but the employment is critical (this means Chemelot needs to build an image to take over this role). This image should be part of the Chemelot business plan, but the whole plan seems absent. If the government is presented with a strategy and some wishes are presented the government will do what is necessary to fulfill these wishes.

**The private partner in the consortium (DSM)** has two main reasons to develop Chemelot towards a SP with many other firms:

- 1 Defensive: it is not a core activity of DSM to possess and develop (a substantial amount) of real estate; Chemelot will be a new owner, and
- 2 Offensive: Chemelot can boost DSM R&D through OI, knowledge workers, mix between large and small firms: keeps research dynamic. Furthermore, this increases the ability to attract quality personnel to the region.

Chemelot is a success when DSM is no longer lead developer: they employ 860 fte at Chemelot; this should be 50% or less of total campus employment (thus total 2000 fte as DSM aims to grow towards 1000 fte).

- DSM desires relieve from responsibility with regard to park development. This also is an obstacle regarding subsidies; these are currently difficult to reach for DSM being a large firm.

A secondary success factor for DSM is their ability to enter into OI activities with in-cluster firms and knowledge institutes to accelerate DSM business development.

**The knowledge institute (UM/MUMC+)** has (as indicated) not been available for an interview. According to the MasterPlan the knowledge institute desires to start up new educational programs in the natural sciences to strengthen relations with businesses and to be able to valorize knowledge in biotechnology and materials. Achievements in this are:

**1 Educational**

- Recruitment of international talent towards UM/MUMC+,
- A broader educational program (setting up a science program),
- Practical and research based learning, and
- Involvement in business research projects in cooperation with other knowledge institutes.

**2 Scientific**

- (applied) Research towards material sciences, and
- (applied) Research in cooperation with Maastricht health campus towards life sciences.

**3 Cooperation**

- Connecting with other (inter)national educational- and knowledge institutes.

Several (non-UM) parties show some doubt about the intentions and the possible success of the cooperation with the university:

- University seems to be a slow, non-professional organization,
- University has no experience in the beta-field (except for clinical sciences; thus more overlap with the Maastricht health campus),
- A focus towards physical locating at Chemelot seems absent,
- University is too 'high-level' for smaller firms to initiate cooperation, and
- Some firms are redirected to clinical facilities in Venlo (e.g. new medicine tests).

These doubts clearly threaten a successful K2B cooperation at Chemelot!

**3 2<sup>ND</sup> TIER PARTIES (THE 'OTHER' STAKEHOLDERS)**

Eindhoven University of Technology is located outside of the direct proximity of Chemelot. However, there is a clear overlap in some fields of research (polymers and process technology) and K2B makes a university stronger. The university has the facilities to educate, thus no educational part will move to Chemelot (more likely student will move in the form of graduation projects and excursions); only in process technology Chemelot can offer practices TU/e cannot offer internally.

HsZuyd is in a different situation having already set-up a laboratory in which students and professionals can work together (Zuydlab); already a large number of projects is being performed in cooperation with regional and in-cluster firms. However, Zuydlab is not a successful facility, has to be proven a success but looks more promising than the 'inlooplab' now HsZuyd shapes its operations. Furthermore, Chemelot does not offer the facilities to

attract HsZuyd towards the campus, this hampers the triple helix cluster/culture to be established. HsZuyd aims to be given the possibilities:

- Physical location with high-end facilities (co-location with UM and firms),
- The 'place to be' for education in Chemistry is Chemelot,
- Organized continuous and dynamic meetings between professionals and students (organizing symposia makes these groups to meet naturally; both should show enthusiasm to meet),
- Small firms contact education for research (education is the link between small- and large firms, mediating the danger of unwanted knowledge spillovers), and
- Student office with economic students that assist firms (and vice versa) with tax and other business issues, ICT students can help with firm infrastructures, etc.

Next to the knowledge institutes there are several other organizations. These have been set-up to speed up economic development in the region (southeast Netherlands / Limburg) or at Chemelot in specific. Key elements of these organizations is Venture Capital, an element as earlier indicated which in-cluster residents are very satisfied with. These firms believe that a start has been made; start-ups are settling in, there is plenty of space available for new firms (also larger firms) and the location of Chemelot in the Euregion should help it to become a 'magnet' for Chemical industry. However, believed is that development will take +10 years to mature. To achieve a successful cluster:

- The basics need to be in order! (Utilities and infrastructure and critical mass in firms and services), not many firms are available to settle at Chemelot (business segment and size of market) thus Chemelot has to offer something more than just a cluster,
- Government must facilitate beyond funds: through licenses it has power to influence where firms settle (influencing firms desired to settle and vice versa). Furthermore it can make investments in foreign firms more flexible to create a larger pool of firms Chemelot can attract, and
- University can use Chemelot to climb in rank of universities worldwide, but it is difficult to create a beta faculty in NL without competing with other universities and also for a university to follow market needs; options should be considered.

Overall: all parties need to lose some of their identity in order to get to the common goal!

Considering the critical mass, checking the worthiness the firms important regarding the investment into the firm and regarding the value of the firm for the cluster (what will firm add for the benefit of the cluster?). Slowly the OI concept becomes relevant, for example the availability of facilities firms can use is a 'selling point'.

#### 4 CHEMELOT CONSORTIUM MANAGEMENT

The organization that has the task of developing Chemelot stresses the transition of the location (carbon mining towards science park). Chemelot needs to be like a Hotel that facilitates this transition (not the swimming pool that no one uses). Services Chemelot should offer are:

- Restaurant (everyone can choose to use it, to gather there, etc.), and
- Conference rooms.

For the rest: Chemelot is located in proximity of many services, thus these services need not necessarily provided at the Campus.

- Firms that settle pay a bonus to be settled in proximity of the other firms (thus firms pay for the cross overs),
- Utilities can be taken care of by a specialist, this specialist is not Chemelot (Firms cannot leave and thus should create the environment in which they operate best), and
- Office space / buildings need to be flexible:
  - Flexible contracts for large and small firms, and
  - Lab needs are mostly basic, thus that is sufficient to offer (if firms desire more they can take care of it, not Chemelot: customers want everything!).

Chemelot is a success at Euregional level

- No comparable other locations,
- Next steps are the transition to bio based and the link with Life Science.

APPENDIX I - REQUIREMENTS AND CONSTRAINTS

Q	Requirements		Side Constraints			Score	Remark
	Easy to obtain	User Friendly	Represents Campus Development	Allows for Policy Making/Adjustments	Data is easy to present		
1a	x	x	x	x	x	5	Q may be difficult
1b	x	x	x	x	x	5	
2	\	\*	x	\**	x	3.5	
3a-d	\	\	x	x	x	4	
4a	x	x	x	x	x	5	
4b	x	x	x	x	x	5	
4c	x	x	x	x	x	5	
4d	\	x	x	x	\	4	
5a-b	\	x	x	x	\*	4.5	
6	\	\	x	x	\*	3.5	
7	\	\	x	x	\*	3.5	
8a	\***	\	\	\	x	3	
8b	x	x	x	x	\	4.5	
9	\	\	x	x	\*	3.5	
10	x	x	x	x	\*	4.5	
11	x	x	x	x	x	5	
12a	\*	\	x	x	\*	3.5	
12b-g	\***	x	\	\	x	3.5	
13	\*	\	x	\	\*	3	
14	x	x	x	\	\*	4	
15	x	x	x	x	x	5	
16	x	x	x	x	x	5	

Q	Requirements		Side Constraints			Score	Remark
	Easy to obtain	User Friendly	Represents Campus Development	Allows for Policy Making/Adjustments	Data is easy to present		
17a	x	x	x	\	\	4	
17b	0	\	x	x	0	2.5	
17c	x	x	x	0	x	4	
17d	x	x	x	\	\	4	
17e	x	x	x	\	x	4.5	
17f	x	x	x	\	\	4	
17g	\***	\	\	\	\	2.5	
18	\	\	\	x	\	3	
19a	\	x	x	x	\	4	
19b	x	x	x	x	\	4.5	

\* Only quantitative part of the question adheres

\*\* Only qualitative part of the question adheres

\*\*\* Depends on firm internal data collection

APPENDIX J - DESIGN

To create a more coherent list of questions in the various questionnaires the questions may need to be reorganized when performing an interview. The numbers between brackets (###-#-#) indicate the identity of the indicators. The first numbers show the number of the indicator as given in chapters 5 & 6, for example (12d-#-#). The second number indicates whether the question belongs to cluster general performance (###-1-#), firm-level performance (###-2-#) or shareholder specific performance (###-3-#). The last number indicates to which value source the indicator belongs, thus complementarities (###-#-1), efficiency (###-#-2), lock-in (###-#-3), novelty (###-#-4) or none (###-#-0).

QUESTIONNAIRE: CHEMELOT MANAGEMENT

- |    |  |                |                        |   |   |   |   |   |   |         |
|----|--|----------------|------------------------|---|---|---|---|---|---|---------|
| 1a | (1a-1-1) Number of jobs (fte) the cluster provides for?                    | ...            | fte                    |   |   |   |   |   |   |         |
| 1b | (1b-1-0) Share of DSM at the Cluster?                                      | ...            | $\% (fte^{dsm} / fte)$ |   |   |   |   |   |   |         |
| 2  | (2-1-3) Chemelot is an attractive location to reside/settle?<br>Explain... | (do not agree) | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | (agree) |
| 3  | (3a-1-1) Chemelot improves visibility / observability?                     | (do not agree) | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | (agree) |
| 4  | (4a-1-1) Number of firms that reside at the cluster?                       | ...            | #                      |   |   |   |   |   |   |         |
| 5  | (4b-1-1) Number of firms settling & leaving the cluster?                   | ...            | # settling             |   |   |   |   |   |   |         |
|    |  | ...            | # leaving              |   |   |   |   |   |   |         |
|    |  | ...            | # change               |   |   |   |   |   |   |         |

- |    |   |  |     |                         |
|----|---|--|-----|-------------------------|
| 6  | (4c-1-1) Size of new settling & leaving firms?  | avg. size settling firms   | <=> | avg. size leaving firms |
| 7  | (4d-1-1) Specific value of settling & leaving firms?                                    | specific value of settling/leaving firm A for the Campus: ...<br>specific value of settling/leaving firm B for the Campus: ... |     |                         |
| 8  | (7-1-2) Chemelot has a clear strategy and focus in developing the Campus?<br>Explain... | (do not agree)    1   2   3   4   5   6   7            (agree)   |     |                         |
| 9  | (11-2-2) Number of start-ups generated and attracted by the cluster?                    | ...    # spin-offs   |     |                         |
|    |   | ...    # new firms   |     |                         |
| 10 | (15-3-0) To what extent is Chemelot a DSM cluster?                                      | ...    % (cultural)  |     |                         |
| 11 | (16-3-0) Total cluster turnover and growth compared to previous year?                   | ...    €   |     |                         |
| 12 | (17a-3-0) Amount of buildings in use? Change perspectives?                              | ...    % previous year(s)  |     |                         |
|    |   | ...    % in use this year (end) 2011   |     |                         |
|    |   | ...    % expected for (end) 2012   |     |                         |
| 13 | (17b-3-0) Cause of unused buildings / space?  | main reason: ...   |     |                         |



14	(17c-3-0) Amount of rent money brought in?	...	€							
15	(17d-3-0) Amount of funds used to cover losses?	...	€	...	%					
16	(17e-3-0) Amount of area in use? Change perspectives?	...	m <sup>2</sup> previous year	...	%	of total				
		...	m <sup>2</sup> in use (end) 2011	...	%	of total				
		...	m <sup>2</sup> expected (end) 2012	...	%	of total				
17	(17f-3-0) Amount of venturing fund used?	...	€	...	%					
18	(17g-3-0) Use of funds to set-up/organize Chemelot management?	Activity A	...	€						
		Activity B	...	€	etc.					
19	(18-3-1) The local government is effectively using its 'power' to assist Chemelot in park development?	(do not agree)	1	2	3	4	5	6	7	(agree)

QUESTIONNAIRE: IN-CLUSTER RESIDING FIRMS

- |    |  |                |       |   |     |       |   |   |   |         |
|----|--|----------------|-------|---|-----|-------|---|---|---|---------|
| 1  | (2-1-3) Chemelot is an attractive location to reside/settle?<br>Explain...   | (do not agree) | 1     | 2 | 3   | 4     | 5 | 6 | 7 | (agree) |
| 2  | (3b-1-1) Chemelot improves visibility / observability?<br>Explain...   | (do not agree) | 1     | 2 | 3   | 4     | 5 | 6 | 7 | (agree) |
| 3  | (5a-1-1) Chemelot increases the ability of my firm to maintain and/or<br>increase its knowledge base?<br>Explain...                              | (do not agree) | 1     | 2 | 3   | 4     | 5 | 6 | 7 | (agree) |
| 4  | (6-1-1) Chemelot offers the utilities, infrastructure and facilities &<br>services my firm needs to perform efficiently?<br>Explain why (not)... | (do not agree) | 1     | 2 | 3   | 4     | 5 | 6 | 7 | (agree) |
| 5  | (7-1-2) Chemelot has a clear strategy and focus in developing<br>the Campus?<br>Explain...   | (do not agree) | 1     | 2 | 3   | 4     | 5 | 6 | 7 | (agree) |
| 6a | (8a-2-2) Average project returns?  | ...            | % ROA |   | ... | % ROE |   |   |   |         |

6b	(8b-2-2) Chemelot enables my firm to achieve higher project returns? Explain...	(do not agree)	1	2	3	4	5	6	7	(agree)
7	(9-2-2) Chemelot improves the ability of my firm to acquire resources to support development projects? Explain...	(do not agree)	1	2	3	4	5	6	7	(agree)
8	(10-2-3) My firm invests its resources in products or projects of other in-cluster firms? Explain...	(do not agree)	1	2	3	4	5	6	7	(agree)
9a	(12a-2-4) Chemelot enables my firm to improve its innovativeness Explain...	(do not agree)	1	2	3	4	5	6	7	(agree)
9b	(12b-2-4) Percentage of sales/profit achieved with products/services Introduced last 5 years?	...								%
9c	(12c-2-4) Number of cost reductions achieved last year?	...								#
9d	(12d-2-4) Number of quality improvements achieved last year?	...								#
9e	(12e-2-4) Product capacity increased with?	...								%
9f	(12f-2-4) Delivery times reduces with?	...								%
9g	(12g-2-4) Number of innovation achieved last year, and percentage of Innovation covered with IP-rights?	...								#
		...								%

- 10 (13-2-3) Chemelot improves my firms' ability to set market standards? (do not agree) 1 2 3 4 5 6 7 (agree)  
Explain...
- 11 (14-2-2) Chemelot improves my firms' ability to reduce development cycle times? (do not agree) 1 2 3 4 5 6 7 (agree)  
Explain...
- 12 (15-3-0) To what extent is Chemelot a DSM cluster? ... % (cultural)
- 13 (19a-3-1) My firm has performed/performs projects in cooperation with The local/regional knowledge institute and will do so in the future? (do not agree) 1 2 3 4 5 6 7 (agree)  
Explain...

QUESTIONNAIRE: KNOWLEDGE INSTITUTES

- |   |   |                |   |   |   |   |   |   |   |              |
|---|---|----------------|---|---|---|---|---|---|---|--------------|
| 1 | (2-1-3) Chemelot is an attractive location to reside/settle?<br>Explain...  | (do not agree) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (agree)      |
| 2 | (3c-1-1) Chemelot improves visibility / observability<br>Explain...   | (do not agree) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (agree)      |
| 3 | (5b-1-1) Chemelot increases the ability of my institute to maintain<br>and/or increase its knowledge base?<br>Explain...                  | (do not agree) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (agree)      |
| 4 | (7-1-2) Chemelot has a clear strategy and focus in developing<br>the Campus?<br>Explain...  | (do not agree) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (agree)      |
| 5 | (15-3-0) To what extent is Chemelot a DSM cluster?  | ...            |   |   |   |   |   |   |   | % (cultural) |
| 6 | (19b-3-1) My institute is able to connect with firms to perform (applied)<br>research in cooperation with in-cluster firms?<br>Explain... | (do not agree) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (agree)      |

QUESTIONNAIRE: GOVERNMENT

- |   |  |                |   |   |   |   |   |   |   |              |
|---|--|----------------|---|---|---|---|---|---|---|--------------|
| 1 | (2-1-0) Chemelot is an attractive location to reside/settle?<br>Explain...                 | (do not agree) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (agree)      |
| 2 | (3d-1-1) Chemelot improves visibility / observability<br>Explain...                        | (do not agree) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (agree)      |
| 3 | (7-1-2) Chemelot has a clear strategy and focus in developing<br>the Campus?<br>Explain... | (do not agree) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (agree)      |
| 4 | (15-3-0) To what extent is Chemelot a DSM cluster?   | ...            |   |   |   |   |   |   |   | % (cultural) |

APPENDIX K - DESIGN IMPLEMENTATION

<b>Question (identity)</b>	1a (cluster performance – complementarities)	1b (cluster performance – 0)
	Number of jobs the cluster provides for?	Share of DSM at the cluster?
<b>Answered by</b>	Chemelot Management	Chemelot Management
<b>Specifics</b>	measured with: fte	measured with: ftedsm/fte
<b>Nature of Answer</b>	Quantitative (#)	Quantitative (%)
<b>Purpose of answer</b>	Goal in MasterPlan to reach employment growth	Goal DSM as shareholder to reduce cluster share
<b>Result specifically interesting for</b>	All Shareholders	DSM
<b>Future research</b>	Create a graph for long term overview	Create a graph for long term overview and compare with question 15 for discrepancies

<b>Question (identity)</b>	2 (cluster performance – lock-in)
	Chemelot is an attractive location to reside/settle? Why (not)?
<b>Answered by</b>	All
<b>Nature of Answer</b>	Quantitative (1 - 7) + Qualitative
<b>Purpose of answer</b>	Shows why Chemelot growth is achieved and how further growth may be stimulated
<b>Future research</b>	Create graph with long term overview and summary of qualitative answers

<b>Question</b>	3a-d (cluster performance – complementarities)			
	Chemelot improves visibility / observability?			
<b>Answered by</b>	Chemelot Management	Firms	Knowledge institutes	Government
<b>Specifics</b>	to attract new firms	to attract new employees	to attract (foreign) students	to attract people to live in the region
<b>Nature of Answer</b>	Quantitative (1 -7)			
<b>Purpose of answer</b>	Indication whether cluster brand needs to be stimulated above strengthening its underlying (functional) value.			
<b>Future research</b>	Create graph for long term overview and possibly differentiate between respondent groups			

Question	4a (cluster perf. – compl.)	4b (cluster perf. – compl.)	4c (cluster perf. – compl.)	4d (cluster perf. – compl.)
	Number of firms that reside at the cluster?	Number for firms settling & leaving the cluster?	Size of new settling and leaving firms?	Specific value of settling and leaving firms?
<b>Answered by</b>	Chemelot Management			
<b>Specifics</b>			measured with: fte	
<b>Nature of Answer</b>	Quantitative (1 - 7)			Qualitative
<b>Purpose of answer</b>	Indication whether the growth/change of the cluster has focus			
<b>Future Research</b>	Create graphs for long term overview, create summary of answers to question 4d			

Question	5a	5b
	Chemelot increases the ability of my firm to maintain and/or increase its knowledge base? Because...	Chemelot increases the ability of my institute to maintain and/or increase its knowledge base? Because...
<b>Answered by</b>	Firms	Knowledge institutes
<b>Specifics</b>	ability to attract quality employees and ability to complement internal know-how with external sources	ability to improve educational level of students and ability to perform (applied) research with business professionals
<b>Nature of Answer</b>	Quantitative (1 - 7) + Qualitative	Quantitative (1 - 7) + Qualitative
<b>Purpose of answer</b>	Indicates whether the cluster is able to retain and build up knowledge and whether the incorporation of a knowledge institute proves successful	
<b>Result specifically interesting for</b>	Knowledge institutes	
<b>Future research</b>	Knowledge base may need to be explained when confronting entrepreneurs (specifics)	Focus on UM/MUMC+, but also other institutes may be involved



<b>Question</b>	6 (cluster performance – complementarities)	7 (cluster performance – efficiency)
	Chemelot offers the utilities, infrastructure and facilities & services my firm needs to perform efficiently? Because...	Chemelot has a clear strategy and focus in developing the Campus? What displays this focus?
<b>Answered by</b>	Firms	All
<b>Specifics</b>	Chemelot concept success measure	link with questions 4a - d
<b>Nature of Answer</b>	Quantitative (1 - 7) + Qualitative	Quantitative (1 - 7) + Qualitative
<b>Purpose of answer</b>	Complementarities are the benefits that Chemelot offers, it indicates whether the concept is perceived fruitful and which element most or least developed	Measures whether the focus displayed by the cluster is achieved as such by stakeholders
<b>Future research</b>	Focus on whether ALL necessary/desired utilities, infrastructure, etc. are available, NOT on efficiency	Has the aim to stimulate the development of a clear business plan on park development, and is a measure for park openness

<b>Question</b>	8a (firm-level performance – efficiency)	8b (firm-level performance – efficiency)
	Average project returns (ROA and ROE)?	Chemelot enables my firm to achieve higher project returns? Why?
<b>Answered by</b>	Firms	Firms
<b>Specifics</b>	ROA + ROE because this give a more complete image of firm performance	
<b>Nature of Answer</b>	Quantitative (%)	Quantitative (1 - 7) + Qualitative
<b>Purpose of answer</b>	Indicates whether firms are performing well (cluster health) + whether firms are attracted to the cluster (complementary to question 2 - measure lock-in)	
<b>Future research</b>	Graph for long term overview	Graph + Summary of qualitative answers

<b>Question</b>	9 (firm-level performance – efficiency)	10 (firm-level performance – lock-in)
	Chemelot improves the ability of my firm to acquire resources to support development projects? explain...	My firm invests its resources in products or project of other in-cluster firms? example...
<b>Answered by</b>	Firms	Firms
<b>Specifics</b>		Link with question 9
<b>Nature of Answer</b>	Quantitative (1 - 7) + Qualitative	Quantitative (1 - 7) + Qualitative
<b>Purpose of answer</b>	Indicates whether the cluster has a (sufficiently) broad base of financial and content wise support	Indicates the financial and content wise involvement of firms
<b>Future research</b>	Consider resources in the broadest sense, thus including finances, knowledge or capacity.	Resources as in question 9

<b>Question</b>	11 (firm-level performance – novelty)
	Number of start-ups generated and attracted by the cluster?
<b>Answered by</b>	Chemelot management
<b>Nature of Answer</b>	Quantitative (#)
<b>Purpose of answer</b>	Indication of clusters innovative strength
<b>Result specifically interesting for</b>	DSM & Local Government
<b>Future research</b>	Possibly differentiate between cluster-internal (spin-offs), university (USOs) and external start-ups

Question	12a (firm-level – novelty)	12b (firm-level – novelty)	12c (firm-level – novelty)	12d (firm-level – novelty)
	Chemelot enables my firm to improve its innovativeness? Through...	Percentage of sales/profit achieved with products/services introduced last 5 years?	Number of cost reductions achieved last year?	Number of quality improvements achieved last year?
<b>Answered by</b>	Firms	Firms	Firms	Firms
<b>Nature of Answer</b>	Quantitative (1 - 7) + Qualitative	Quantitative (%)	Quantitative (#)	Quantitative (#)
<b>Purpose of answer</b>	Complementarities are the benefits that Chemelot offers, supposedly induces efficiency, lock-in and novelty. This indicator measures whether (novelty) innovativeness is achieved, and if complementarities were the cause of the innovativeness.			
<b>Future research</b>	Pilot measurement needs to determine which of indicators 12b-g are suitable for future use (focus on ease of use)			

Question	12e (firm-level – novelty)	12f (firm-level – novelty)	12g (firm-level – novelty)
	Production capacity increased with ... (%)?	Delivery times reduced with ... (%)?	Number of innovations achieved last year, and percentage of innovation covered with IP-rights?
<b>Answered by</b>	Firms	Firms	Firms
<b>Nature of Answer</b>	Quantitative (%)	Quantitative (%)	Quantitative (# + %)
<b>Purpose of answer</b>	Complementarities are the benefits that Chemelot offers, supposedly induces efficiency, lock-in and novelty. This indicator measures whether (novelty) innovativeness is achieved, and if complementarities were the cause of the innovativeness.		
<b>Future research</b>	Pilot measurement needs to determine which of indicators 12b-g are suitable for future use (focus on ease of use)		

<b>Question</b>	13 (firm-level performance – lock-in)	14 (firm-level performance – efficiency)
	Chemelot improves my firms ability to set market standards?	Chemelot improves my firms ability to reduce development cycle times? Why?
<b>Answered by</b>	Firms	Firms
<b>Nature of Answer</b>	Quantitative (1 - 7) + Qualitative	Quantitative (1 - 7) + Qualitative
<b>Purpose of answer</b>	Measures whether a certain amount of synergy is achieved between in-cluster residents (one cluster, using each other's technologies)	Measures whether firms use the cluster to improve internal performance (synergy), and whether firms notice they reduce cycle times through using shared (easily available) facilities
<b>Future research</b>	Most relevant for medium & large firms, possible relation with cluster size	May also lock-in because firms acknowledge they perform better at the cluster than out-cluster

<b>Question</b>	15 (shareholder specific – 0)	16 (shareholder specific – 0)
	To what extent is Chemelot a DSM cluster? (%)	Total cluster turnover and growth compared to previous year?
<b>Answered by</b>	All	Chemelot Management
<b>Specifics</b>	think of cluster organization & in-cluster activities	+ divide over jobs (fte) the cluster provides
<b>Nature of Answer</b>	Quantitative (%)	Quantitative (#)
<b>Purpose of answer</b>	Provides insight for DSM regarding their desire to lose their majority share in the cluster	Gives some insight in the cluster performance compared to regional and (inter)national performance
<b>Result specifically interesting for</b>	DSM	
<b>Future research</b>	Relates to culture, needs to be compared with question 1b	Compare change in growth with other clusters to determine relative cluster performance and compare with out-cluster firms

<b>Question</b>	17a (shareholder specific – 0)	17b (shareholder specific – 0)	17c (shareholder specific – 0)
	Amount of buildings in use? Change perspectives?	Cause of unused buildings / space?	Amount of rent money brought in?
<b>Answered by</b>	Chemelot Management	Chemelot Management	Chemelot Management
<b>Specifics</b>	multiple year projection		
<b>Nature of Answer</b>	Quantitative (graph)	Qualitative	Quantitative (graph)
<b>Purpose of answer</b>	Measures desired by government, indicate the performance of the investment made by government		
<b>Result specifically interesting for</b>	Local Government	Local Government	Local Government

<b>Question</b>	17d (shareholder specific – 0)	17e (shareholder specific – 0)	17f (shareholder specific – 0)
	Amount of funds used to cover losses? (leegstandfonds)	Amount of area in use? Change perspectives?	Amount Venturing funds used?
<b>Answered by</b>	Chemelot Management	Chemelot Management	Chemelot Management
<b>Specifics</b>	multiple year projection	multiple year projection (m2)	(€/year)
<b>Nature of Answer</b>	Quantitative (graph)	Quantitative (graph)	Quantitative (graph)
<b>Purpose of answer</b>	Measures desired by government, indicate the performance of the investment made by government		
<b>Result specifically interesting for</b>	Local Government	Local Government	Local Government

<b>Question</b>	17g (shareholder specific – 0)
	Use of funds to set-up/organize the Chemelot management?
<b>Answered by</b>	Chemelot Management
<b>Specifics</b>	(€1.5mIn/year)
<b>Nature of Answer</b>	Quantitative (list) + Qualitative
<b>Purpose of answer</b>	Measures desired by government, indicate the performance of the investment made by government
<b>Result specifically interesting for</b>	Local Government

<b>Question</b>	18 (shareholder specific – Complementarities)
	The local government is effectively using its ‘power’ to assist Chemelot with the development of the campus?
<b>Answered by</b>	Chemelot Management
<b>Specifics</b>	
<b>Nature of Answer</b>	Quantitative (1 - 7) + Qualitative
<b>Purpose of answer</b>	Shows whether synergy between cluster and government exists, and whether the government is performing well regarding the cluster
<b>Result specifically interesting for</b>	Local Government
<b>Future research</b>	Indicator has the aim to motivate Chemelot management to propose activities to local government, and also to stimulate local government in their ‘willingness’ to cooperate

<b>Question</b>	19a (shareholder specific – Complementarities)	19b (shareholder specific – Complementarities)
	My firm has performed/performs projects in corporation with the local/regional knowledge institutes and will do so in the future? How many and why?	My institute is able to connect with firms to perform (applied) research in cooperation with in-cluster firms?
<b>Answered by</b>	Firms	Knowledge institutes
<b>Specifics</b>		
<b>Nature of Answer</b>	Quantitative (1 - 7) + Qualitative	Quantitative (1 - 7) + Qualitative
<b>Purpose of answer</b>	Measures whether the incorporation of the knowledge institutes into the cluster has been successful	
<b>Result specifically interesting for</b>	Knowledge Institute	Knowledge Institute
<b>Future research</b>	Measures whether firms are positive considering the incorporation of the knowledge institutes	Measures whether firms are open to cooperating with knowledge institutes

APPENDIX L - DESIGN VALUE SOURCES

	Question	Value Sources
1a	Number of jobs the cluster provides for?	Complementarities
1b	Share of DSM at the cluster?	Shareholder Specific
2	Chemelot is an attractive location to reside/settle? Why (not)?	Lock-in
3a-d	Chemelot improves visibility / observability?	Complementarities
4a	Number of firms that reside at the cluster?	Complementarities
4b	Number for firms settling & leaving the cluster?	Complementarities
4c	Size of new settling and leaving firms?	Complementarities
4d	Specific value of settling and leaving firms?	Complementarities
5a	Chemelot increases the ability of my firm to maintain and/or increase its knowledge base? Because...	Complementarities
5b	Chemelot increases the ability of my institute to maintain and/or increase its knowledge base? Because...	Complementarities
6	Chemelot offers the utilities, infrastructure and facilities & services my firm needs to perform efficiently? Because...	Complementarities
7	Chemelot has a clear strategy and focus in developing the Campus? What displays this focus?	Efficiency
8a	Average project returns (ROA and ROE)?	Efficiency
8b	Chemelot enables my firm to achieve higher project returns? Why?	Efficiency
9	Chemelot improves the ability of my firm to acquire resources to support development projects? Explain...	Efficiency
10	My firm invests its resources (i.e. financial, knowledge or capacity) in products or project of other in-cluster firms? example...	Lock-in
11	Number of start-ups generated and attracted by the cluster?	Novelty
12a	Chemelot enables my firm to improve its innovativeness? Through...	Novelty

12b	Percentage of sales/profit achieved with products/services introduced last 5 years?	Novelty
12c	Number of cost reductions achieved last year?	Novelty
12d	Number of quality improvements achieved last year?	Novelty
12e	Production capacity increased with ... (%)?	Novelty
12f	Delivery times reduced with ... (%)?	Novelty
12g	Number of innovations achieved last year, and percentage of innovation covered with IP-rights?	Novelty
13	Chemelot improves my firms ability to set market standards?	Lock-in
14	Chemelot improves my firms ability to reduce development cycle times? Why?	Efficiency
15	To what extent is Chemelot a DSM cluster? (%)	Shareholder Specific
16	Total cluster turnover and growth compared to previous year?	Shareholder Specific
17a	Amount of buildings in use? Change perspectives?	Shareholder Specific
17b	Cause of unused buildings / space?	Shareholder Specific
17c	Amount of rent money brought in?	Shareholder Specific
17d	Amount of funds used to cover losses? (leegstandfonds)	Shareholder Specific
17e	Amount of area in use? Change perspectives?	Shareholder Specific
17f	Amount Venturing funds used?	Shareholder Specific
17g	Use of funds to set-up/organize the Chemelot management?	Shareholder Specific
18	The local government is effectively using its 'power' to assist Chemelot with the development of the campus?	Complementarities
19a	My firm has performed/performs projects in corporation with the local/regional knowledge institutes and will do so in the future? How many and why?	Complementarities
19b	My institute is able to connect with firms to perform (applied) research in cooperation with in-cluster firms?	Complementarities