How research & development adds value

- a business modelling method for R&D organisations -

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ABSTRACT

This research arose out of an interest in capturing the value of R&D. An interest which brought the two areas R&D and Business Models together and led to the following research question:

How to build a business model for a research and development organisation?

The quest for an answer did not only contribute by illuminating the shady grounds of value creation within R&D, it strengthened the fundaments where this research is built upon as well.

For this research, a generic method to build a business model in a structured and reproducible manner (Meertens et al, 20011) is tailored to be applicable for R&D organisations. The adjustments of the method based on typical R&D characteristics led to the solution design which then was demonstrated and validated via a case study. To ensure the quality of the validation an expert validation is done as well.

In section 2.1 the BMM is introduced based on the following business model definition: "A business model is a simplified representation that counts for the known and inferred properties of the business or industry as a whole..."

By a thorough literature study in section 2.2 the known and inferred properties of R&D were classified as project oriented, managing activities, risk management, cost management, value and external linkages. These characteristics were used in section 2.3 to research the suitable techniques within the BMM.

The solution design which is built upon the outcomes of 2.3 is presented in chapter 3. First the roles are identified using a stakeholder analysis which is especially designed for R&D projects. Second, the relations are recognised by mapping the value exchanges with e3-value modelling. Third, the activities are specified using Stage Gate Systems and the fourth step quantification of the model is covered by job costing. The fifth and the sixth step are general steps and outside the scope of this research. The solution design is based on two assumptions:

- a R&D organisation is project oriented
- the business model of R&D is a portfolio of innovation processes

In chapter 4 is demonstrated by at SE Blades Technology with a case study on New Product Development projects and a case study on Technology Projects.

In the expert validation in chapter 5 the strengths, weaknesses, opportunities and threads of the solution design were discussed. One of the strengths confirmed the results in chapter 4, that the method appeared well structured and useable in practice. The lack of an earning model was addressed as a weakness. However, the solution design is demonstrated at a R&D organisation which is seen as a cost centre. Therefore this is not a weakness but a limitation, as earning models are more useful for profit centres. This automatically leads to the opportunity of doing further research on how to shift from a cost centre to a profit centre. The threads of overlapping definitions which the experts warned for are taken into account during the revision of this thesis.

In this research a BMM method is tailored and the solution design turned out to be suitable for building the business model of a R&D organisation. It was not only suitable, it encouraged continuous improvement as well when working with the method. The solution design is validated by experts as well. Based on this validation the limitations of this research have been cleared.

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ABBREVIATIONS

A&L	Aero & Loads
ARN	Activity Release Note
BMM	Business Modelling Method
BSE	Bombay Stock Exchange
CBS	Centraal Bureau Statistiek
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CFT	Cross Functional Team
CMP	Composite Materials & Processes
COO	Chief Operations Officer
CTO	Chief Technology Officer
DCM	Design Change Management
DK	Denmark
DQ	Document Quality
GL	Germanischer Lloyd
HOD	Head of Departments
HR	Human Resource
HTV	High Temperature Version
IS	Information System
IT	Information Technology
KAM	Key Account Manager
LTV	Low Temperature Version
M&E	Moulds & Equipment
MDV	Material Design Values
ME	Manufacturing Engineering
MMU	Mould Manufacturing Unit
MW	Mega Watt
NL	Netherlands
NPD	New Product Development

NSE	National Stock Exchange of India
PB	Portfolio Board
PD	Product Development
PET	Polyethylene terephthalate
PM	Project Management
PMO	Project Management Office
PRF	Project Request Form
PS	Product Support
PSG	Product Strategy Group
QM	Quality Manager
R&D	Research and Development
SA	Stakeholder Analysis
SB xx	Suzlon Blades xx
SBT	SE Blades Technology
SBU	Strategic Business Unit
SCM	Supply Chain Management
SCS	Suzlon Composites Services
SD	Structural Design
SEG	Suzlon Energy GmbH
SEL	Suzlon Energy Limited
STV	Standard Temperature Version
SWOT	Strengths, Weaknesses, Opportunities, Threats

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Enschede, December 2012

Neill Sweet

Chapter 1. Introduction

1.1 Motivation for the research

According to figures of the Centraal Bureau Statistiek (CBS), the Netherlands are drifting further behind in research and development (R&D). In comparison to the nineties where the Dutch public sector spent 1.0 percent of the gross domestic product on R&D, in 2009 it was 0.88 percent (Kuipers, 2011). This is a huge gap with the EU 27[1] average of 1.25 percent (Figure 1-1) and an even bigger gap considering the agreement of Lissabon, which states that EU countries spend 2.5 percent of their gross domestic product on R&D by 2020.

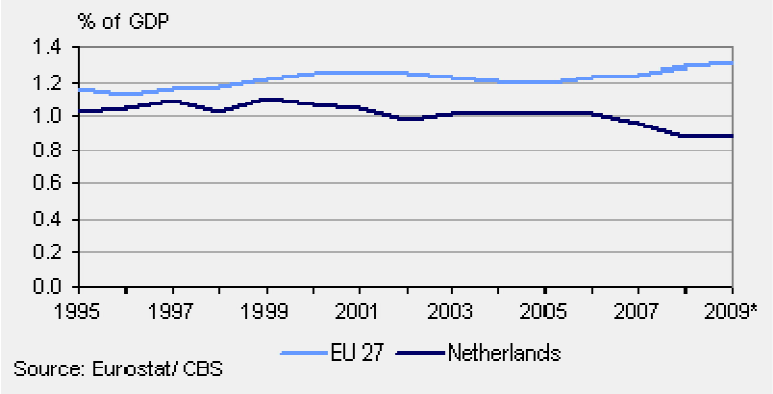


Figure 1-1: R&D expenditure public sector (Kuipers, 2011)

Jan Mengelers, head of the recognized Dutch institute TNO warns that with the Dutch economy slipping, the need for R&D and innovation is necessary (Icke, 2012). This is not in line with the cuts on innovation by the Ministry of Economic Affairs, Agriculture and Innovation. In 2011, Minister Verhagen announced a cut of 500 million euro on subsidies for innovation (Verhagen, 2011) and return these cuts by reducing the taxes for entrepreneurs. He defends his policy by stating that the current Dutch subsidy policy did not produce enough tangible results in the area of knowledge and innovation (Verhagen, 2011). This reasoning is interesting for multiple

[1] Belgium, Greece, Luxembourg, Denmark, Spain, Netherlands, Germany, France, Portugal, Ireland, Italy, United Kingdom, Austria, Finland, Sweden, Poland, Czech Republic, Cyprus, Latvia, Lithuania, Slovenia, Estonia, Slovakia, Hungary, Malta, Bulgaria, Romania

reasons. First question to answer is what are tangible results of innovation? This question relates closely to what is the value of innovation? Both questions are very hard to answer and it seems impossible to give an unambiguous answer. Even if an answer could be given, it still would be a lot of guesswork to determine '*enough*' tangible results.
The lacking R&D spending by the Netherlands (Kuipers, 2011) are even more painfully considering that foreign stakeholders in Dutch industry are accountable for 33% of all R&D spending (Icke, 2012). This is especially the case as the Netherlands like to present themselves as a knowledge intensive economy.

Why is innovation this important?

For a company to grow, it must keep ahead of competitors whenever possible. To do this, companies must innovate, which often depends on R&D. Following this reasoning, investing in R&D would give you a competitive advantage, which would be a boost for your economy. However, it is not that easy, a higher R&D spending does not automatically lead to more or better innovation. R&D is very difficult to manage, while the success of your results is not known in advance. In this light, the decision of Minister Verhagen can be argued.
Because the direct effect can hardly be measured, it is interesting to see how R&D does add value. This question remains unanswered from the beginning of the research on R&D.

Nevertheless, a relative young but turbulent research field is trying to grasp the value creation of organization, namely business model research. A business model is a simplified representation of reality which tries to show how a company does business or creates value. It would be very interesting to combine these two fields and expose the business model behind R&D.

1.2 Research aim and objectives

As mentioned at the end of the introduction, it would be interesting to expose the business model behind R&D. The translation of this interest to a scientific research leads to the main research question of this thesis:

How to build a business model for a research and development organisation?

The research question combines two scientific areas, the one of business model research and the one of R&D research. R&D research is closely related to innovation research and is intertwined with various fields of expertise, like knowledge management, marketing, production and so on. The business model research is a field with many changing factors in the last two decades. The upcoming of information technology, the introduction of a new distribution channel 'the internet', other new forms of communication and together with the rise of globalization, makes business model research an interesting topic.
Because of the developments and viewpoints in both fields, this research has to be positioned and delineated in order to find the area where the two areas overlap.

To tackle the main research question, it is separated in the following objectives and sub questions.

Objective 1: Describe the choice for the business modelling method for R&D

- What is the status of the current business model research?
- What is the business modelling method (BMM)?
- What is the influence of the R&D characteristics on the steps of the BMM?

Objective 2: Describe the R&D characteristics

Objective 3: Tailor the method for a business model of a R&D organisation

- How to design a method?
- Which steps to tailor?

Objective 4: Demonstrate and validate the designed method by a case study

- What is the unit of analysis?
- Which projects are suitable for the case study?

Objective 5: Validate the designed method by interviewing business model experts

- What are the strengths of the designed method?
- What are the weaknesses of the designed method?
- What are the opportunities of the designed method?
- What are the threats of the designed method?

In the remaining part of this chapter, the methodologies used will be introduced.

1.3 Methodology

The research objectives are assigned to the problem analysis, solution design, solution demonstration and validation (Figure 1-2).

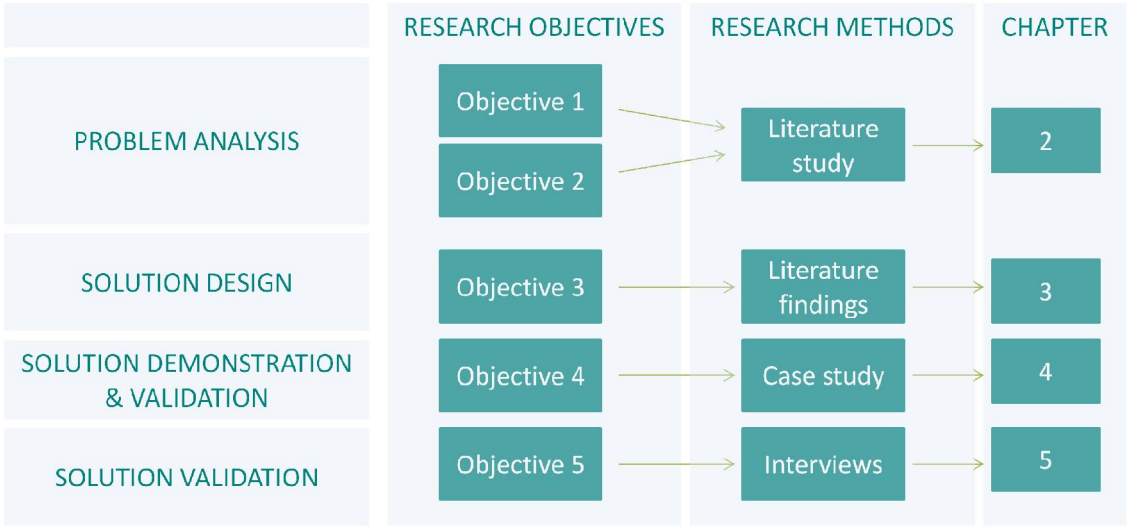


Figure 1-2: Research Model

To reach the objectives certain research methods are used. First of all, design science is used which largely determines the structure of this research (solution design and demonstration/validation). Section 1.3.1 provides the guidelines for the design and positions the research. But before a solution can be designed a problem analysis has to be performed. Section 1.3.2 shows how the literature search is build up, to ensure the literature is

reproducible. Finally in sections 1.3.3 and 1.3.4 the validation methods, case study and interview are described. These sections together represent the foundation of this research.

1.3.1 Design Science

The reach the objectives design science is used. Design science determines the structure of this research (solution design and demonstration/validation). On the role of design science in business model research, Osterwalder (2004) states in his introduction chapter:

"The reasoning behind business model research is not the understanding of a phenomenon, rather it is a problem-solution finding approach"

In design science he finds a suitable research method for an accepted problem solution method (Osterwalder, 2004). His understanding of design science research output follows March and Smith (1995), who define IT artefacts as constructs, models, methods and instantiations. However, Offermann, Blom, Levina, and Bub (2010) present in an overview, that this is not the only view on design science research output. The lack of consensus in this field is noticed by Gregor (2006) as well, where she discusses the terms design science and design theory.

This research follows the same approach as Meertens, Iacob, and Nieuwenhuis (2011), on which shoulders this research stands. The reasons for this will become clear in section 2.1.3. Meertens et al. (2011) follow the seven guidelines of Hevner, March, Park, and Ram (2004) to frame the methodology engineering approach from Kumar and Welke (1992). Furthermore they follow March and Smith (1995) by addressing a method as a design science artefact. Table 1-1 visualises the scope of Meertens et al. (2011) based on March and Smith (1995).

Table 1-1: Research framework according to March and Smith (1995)

		Research activities			
		Build/Tailor	Evaluate	Theorize	Justify
Research outputs	Constructs	-	-	-	-
	Model	-	-	-	-
	Method	●	●	-	-
	Instantiation	-	-	-	-

The scope of this research contains the same research output, a method, and the same research activities, Design (Tailor) and Evaluate. As mentioned, the seven design science research guidelines from (Hevner et al., 2004) are followed. Table 1-2 gives an overview of

these guidelines and how they are handled in this research. Most guidelines are interpreted the same way as Meertens et al. (2011).

Table 1-2: Design-Science Research Guidelines based on Hevner et al. (2004)

Design-Science Research Guidelines	
Guidelines	Output
Guideline 1: Design as an artefact	A method is tailored
Guideline 2: Problem Relevance	The solution is not yet technology-based. partial automation is left for future research
Guideline 3: Design Evaluation	The method is demonstrated via a case study and criticized by experts in interviews.
Guideline 4: Research Contributions	The methodology is specialized for R&D business models
Guideline 5: Research Rigor	Proven methods are used as foundation
Guideline 6: Design as a Search Process	The design is an iterative process within the literature, after the case study and experts interviews iterative adjustments are possible.
Guideline 7: Communication of Research	This master thesis is used to present the methodology

Within the guidelines of Hevner et al. (2004), the Methodology Engineering approach from Kumar and Welke (1992) is used. This approach is a proposal for the design and development of a meta-methodology for designing information systems development methodologies (Kumar & Welke, 1992). Meertens et al. (2011) describe the use of this approach as follows:

"The business modelling method has both aspects from the methodology engineering viewpoint: representational and procedural (Kumar & Welke, 1992). The representational aspect explains what artefacts a business modeller looks at. The artefacts[2] are the input and deliverables of steps in the method. The procedural aspect shows how these are created and used. This includes the activities in each step, tools or techniques, and the sequence of steps."

In light of cumulative progress, this research follows this reasoning.

[2] Something observed in a scientific investigation that is not naturally present but occurs as a result of the investigative procedure

1.3.2 Literature research strategy

To reach the goals of objective 1 and 2 a literature review is needed. To conduct the literature review an explicit and systematic methodology is followed. A well-defined methodology makes it less likely that results are biased. Furthermore, it guards the quality and the completeness of the review. And last, a search strategy allows replication and validation of the search process. Figure 1-3 is an overview of the followed methodology. Although the method is built up sequential, iterations within and between search and review occur.

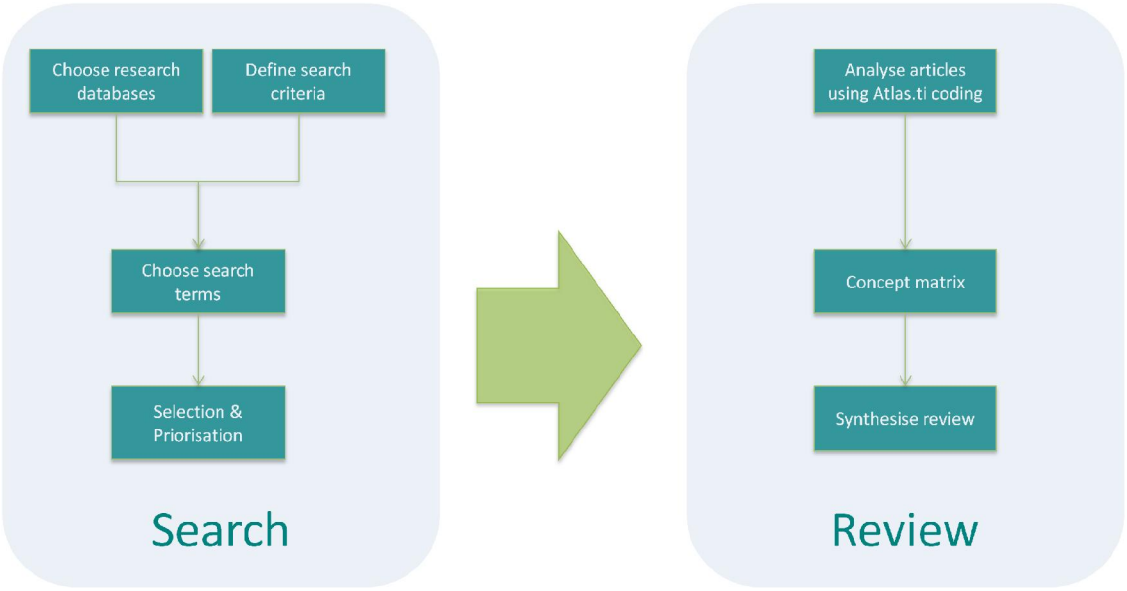


Figure 1-3: Overview literature search methodology

The steps of the methodology presented in Figure 1-3 are conducted as following:

Selection criteria

The selection criteria ensure the quality and relevance of the literature found. Furthermore they represent the limitations of search as well. The selection criteria are:

1. The sources have to be written in English, German or Dutch
2. The literature search is based on journals within the top 25 Information Systems (IS) Journals (Schwartz & Russo, 2004) or top 10 Innovation Management (TIM) Journals (Linton & Thongpapanl, 2004; update by Thongpapanl, 2012) or top 5 Accounting journals (Bonner, Hesford, Van der Stede, & Young, 2006) (forward/backward search is excluded).

3. The sources need to be available using the University of Twente library account
4. Search terms have to occur in the title, in the abstract or in the keywords of the articles
5. Date of search must be recorded for replication purposes

Choice of research databases

The choice of research databases determines the coverage and quality of the research. To ensure high quality of the literature review, only articles from top 25 IS journals according to Schwartz and Russo (2004) or from the top 5 accounting journals (Bonner et al., 2006) or from top 10 TIM Journals according to Linton and Thongpapanl (2004) and the update by Thongpapanl (2012) are used. The coverage of Scopus for these journals is more than sufficient (see Table 1-3) and therefore this search engine is used. For an overview of the journal rankings and the search queries used see Table 1-3.

Table 1-3: Coverage by database Scopus

Search engine Scopus				
Field	Coverage top 5	Coverage top 10	Coverage top 25	Missing Journals
Accounting	100%	-	-	-
Innovation	-	100%	-	-
IS	-	100%	96%	Data Base (#14)

The limited time available for this research in combination with the search limitation to high quality journals, legitimizes the choice of omitting a forward and backward search. However, the lack of a structured forward and backward search does not mean interesting references and citations are not used. By allowing only citations of papers from top journals, the quality is guaranteed. Secondary references by papers of quality journals are assessed as sufficient.

Search terms

Many different terms (synonyms) are often used to refer to the same thing and therefore many important papers are missed if only one specific term is used. At the start, multiple methods are used to generate initial keywords such as brainstorming, searching available literature reviews

and author search. The final search terms are then checked for spelling alternatives and queries are formed. This is an iterative process which has input from all the steps in the literature search methodology. The final search terms and queries for this research can be found in Chapter 2.

Selection and Prioritisation

The search based on titles, abstract or keywords of articles results in a pool of potentially relevant articles. For the sake of reproducibility, the search terms will be tagged with the date of search. The next step is a selection of relevance, based on the abstracts, followed by a selection based on the full text. The full texts are prioritised according to the following scale:

0 = not useful

1 = useful

2 = very useful

The quantitative reporting of the papers included and excluded at each stage of the selection process is presented in a flowchart. This explicit search methodology is presented in section 1.3.2.

Analysis and concept matrix

The useful papers are then analysed and to capture the chain of evidence, they are presented in a concept matrix. A concept matrix shows which concept(s) are described in the papers.

Synthesis

All above steps result in the synthesis of the literature review as presented in section 1.3.2.

In this section, the literature research methodology is presented using textual and visual content. Goal of this methodology is to deliver a transparent search process, which can be replicated and validated. Furthermore, the methodology ensures the quality and completeness of the literature review.

1.3.3 Case Study

To reach the goal of objective 4 a case study is used. The founder of the research strategy 'Case Study' is Yin (1987). He defines a research design plan as an action plan of getting from A to B. Table 1-4 describes the five components of a research design. The case study in Chapter 4 is built up according to these five components.

Table 1-4: Components of research design according to Yin (1987)

Component	Function
1. Study question	'How' and/or 'Why' question
2. Proposition(s) or purpose	Limiting scope, setting focus of the study's goals
3. Unit(s) of analysis	Defines the case, which case is going to be measured
4. The logic linking the data to the propositions	Matching pieces of information to rival patterns that can be derived from the propositions
5. Criteria for interpreting the findings	Iteration between propositions and data, matching sufficiently contrasting rival patterns to data; there is no precise way of setting the criteria

Yin (1987) provides four tests to judge the quality and case study tactics to deal with them. These tests are used to evaluate the case study. Table 1-5 consists of an overview of the four tests, case study tactics and the case study tactics which are used for this research.

Table 1-5: Tests for judging the quality of a case study (Yin, 1987)

Test	Case study tactics	Case study tactics used
Construct validity	Use multiple sources of evidence Establish chain of evidence Have key informants review draft case study report	Evidence is derived from interviews, internal documents from SharePoint, documents from the Knowledge Management Portal and data from information system (SAP) The chain of evidences is established using concept matrices. There is a weekly meeting with the quality manager and a monthly meeting with the department head of CMP, who function as key informants

Internal validity	Do pattern matching Do explanation building Do time-series analysis	With pattern matching the empirically collected data is compared with the predicted findings
External validity	Use replication logic in multiple-case studies	The scope of this research does not provide the time to multiple case studies
Reliability	Use case study protocol Develop case study data base	Research design of a case study protocol is set up

1.3.4 Interviews

During this research, multiple interviews are conducted. The basis of an interview is the interview scheme, which guides the interviewer as well with the design as during the interview (Emans, 1985). Figure 1-4 is an overview of the ten steps in the construction of an interview scheme.

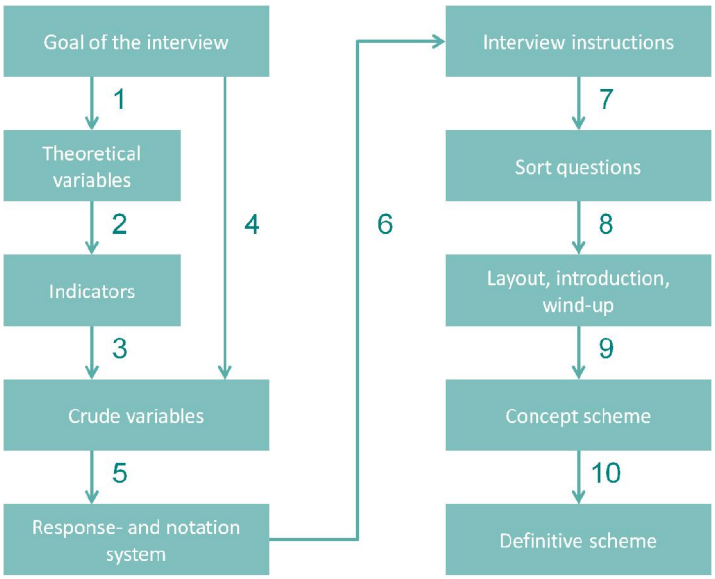


Figure 1-4: Interview scheme based on Emans (1985)

For every set of interviews, an interview scheme is constructed first. This interview scheme will then be the guide to collect the data.

Chapter 2. Literature Review

This chapter is roughly divided in three parts, business models, R&D characteristics and challenges. First, in the business model section (2.1) business modelling method is chosen and presented. Then, in the of the R&D section (2.2), the R&D characteristics are discussed. In the last section (2.3), the first two sections are combined. Based on literature reviews, the possible techniques for the business modelling method are assessed against R&D characteristics.

2.1 Business Model

This section is an introduction into business models and its importance. Furthermore, it gives a status on current business model research and the research gaps. Finally, it argues the choice for the business modeling method of Meertens et al. (2011) in this research.

2.1.1 What is a business model?

A business model is basically a simplified representation of how a company works. The simplified representation allows getting the grasp of an organisation instead of loosing yourself into the complexity of all its internal processes, external relations and environmental influences. Furthermore, a business model can be a supportive tool to act on possible influences of changing factors. A few examples of this to get some feeling with the relevance:

In the nineties, in almost every home you could find a magazine of the Wehkamp, from which you could order all kinds of products. The rise of the internet had a major influence on that business model, a new distribution channel arrived.

Another business model change which resulted from the rise of the internet is the music distribution industry. If you compare the business model behind CD's and nowadays, for example Spotify, a lot has changed.

Government regulations can be an influencing factor as well. What is, for example, the influence of more government regulations for Banks after the crisis in 2008?

These are some examples from practice to show where a business model can be helpful in times of change. Not only seems the importance of a business model intuitive logical, many authors recognize the importance of the business model concept as well (see for overview Vermolen, 2010). Nevertheless, no consensus concerning the definition of a business model (Pateli & Giaglis, 2004; Vermolen, 2010) from an academic perspective has been reached. In this research the definition given by Meertens et al. (2011) is followed:

"A business model is a simplified representation that counts for the known and inferred properties of the business or industry as a whole, which may be used to study its characteristics further..."

This definition will be the common denominator of this chapter.

In this section, the term business model is explained from a practical perspective as well as from academic perspective. The next section will dig deeper into the business model research from an academic point of view.

2.1.2 What is the status of business model research?

Business models traditionally belong to the field of organizational management (Pateli & Giaglis, 2004), but developments in the global economy changed the traditional balance between customer and supplier (Teece, 2010). The rise of information technology and its impact on business models, has lead to an increase of business model research in the Information System (IS) field (Pateli & Giaglis, 2004; Vermolen, 2010). Although this influence led to more research on eBusiness models (for overview see Pateli & Giaglis, 2004; Vermolen, 2010), Vermolen (2010) concludes that a distinction between eBusiness models and business models does not exist.

A literature review on business model research is already available in the existing literature. Pateli and Giaglis (2004) researched the status of business model research and this is redone six years later by Vermolen (2010). By summarising these papers a sufficient overview of the current status of business model research is given.

Pateli and Giaglis (2004) offer an extensive review of literature on eBusiness and propose an analytical framework that decomposes the area of business models into eight research sub-domains. Table 2-1 gives an overview of the eight sub-domains.

Table 2-1: Overview eight sub domains of business models (Pateli & Giaglis, 2004)

Sub domains	
Definitions	Design methods and tools
Components	Adoption factors
Taxonomies	Evaluation models
Conceptual models	Change methodologies

Pateli and Giaglis (2004) give for every sub-domain the research status and research suggestions. Furthermore they overall conclude that the business model field has matured in such way that it needs to move from the elementary definitional studies towards more in depth analysis. Another condition to reach maturity is for the research community to invent a common language. Only then research from various scientific disciplines can communicate and build upon each other's work.

Because of the lack of a recent business model research review, Vermolen (2010) jumped in to this by doing a structured review to identify the current status of research on business models. Based on the identified gaps and suggestions from literature, she came up with an agenda for future research on seven domains. Table 2-2 gives an overview of these seven domains.

Table 2-2: Domains for future research (Vermolen, 2010)

Domains for future research	
Definitions	Change
Components	Implementation and monitoring
Unit of analysis	Evaluation
Design	

Vermolen (2010) recognizes the similarity between the results and the results from (Pateli & Giaglis, 2004) and emphasises that the main future research suggestions remained the same. There is still a lack of cohesion in this field, which is needed for further developing the business model concept.

This summary does not aim at given a full overview of the available literature. For such an overview the two founding articles (Pateli & Giaglis, 2004; Vermolen, 2010) of this section are useful. The goal is to give some insight in the current status and especially in the domains of the research gaps. Based on Vermolen (2010) Meertens et al. (2011) concludes that there is no methodological approach in literature for the design and specification of business models. In an attempt to make business modelling a science instead of an art, Meertens et al. (2011) proposes a method which enables the development of business models in a structured and repeatable manner. Meertens et al. (2011) jump in one of the research gaps defined by Vermolen (2010), as '*Design*', and Pateli and Giaglis (2004), as '*Design tools*'.

In conclusion, the main research question of this research implies a method is needed to build a business model and for scientific purposes such a method needs to be reproducible. Based on the research of Vermolen (2010) Meertens et al. (2011) concludes that there is no such method available and proposes a method to build a business model which is structured and repeatable. Because there is no alternative, the decision to use the business modelling method of Meertens et al. (2011) to answer the main research question is considered valid. In the next section this method is described.

2.1.3 Business Modelling Method (BMM)

Meertens et al. (2011) proposes the Business Modelling Method, which from here on is referred to as BMM. The application of this method results in at least two business models. One business model which reflects the 'as-is' situation or the current situation of the business and the other one which reflects 'to-be' business model(s). This represents the potential impact on the business model after adoption of innovative technologies or more efficient business processes (Meertens et al., 2011). This is a direct representation of the definition of business models defined in section 2.1.1.

The BMM describes six steps using specific methods, techniques or tools. The first four steps concern the creation of the 'as-is' model:

1. Identify roles
2. Recognize relations

3. Specify activities
4. Quantify model

The remaining two steps concern developing the 'to-be' model:

1. Design alternatives
2. Analyse alternatives

Table 2-3 is an overview of the BMM, including for every step the inputs, possible techniques/tools and the deliverables.

Table 2-3: Business Modelling Method (Meertens et al., 2011)

Step	Inputs	Technique or tools	Deliverables
1. Roles	Documentation, domain literature, interviews, experience, previous research	Stakeholder analysis (Pouloudi & Whitley, 1997)	Roles list
2. Relations	Role list, stakeholder map, value exchanges	E3-value model (Gordijn & Akkermans, 2003)	Role-relation matrix
3. Activities	Role-relation matrix, role list, business process specification	BPM methods, languages and tools	List of activities
4. Quantification	Process specifications, accounting systems and annual reports	Activity based costing	Total cost of the business ('as-is')
5. Alternatives	As-is business model, ideas for innovations and changes	Business model method (step 1-4), brainstorming	One or more alternative business models
6. Analyse	Alternative business models	Sensitivity analysis, technology assessment, interpolation, best/worse case scenarios	Business case for each alternative

The BMM provides a way to create business models. Innovators can apply the steps to create business cases for their ideas systematically. This helps them to show the viability and get things implemented (Meertens et al., 2011). Furthermore Meertens et al. (2011) suggest that the BMM can be extended and/or tailored for specific situations.

Concluding, the BMM is a method to build a business model in a structured and repeatable manner and this method can be tailored to a specific situation. A R&D organisation is a specific

situation and therefore the BMM could be used in search of an answer to the research question.

2.2 Characteristics R&D

For an extensive literature review on the history of R&D and the various terminologies go to Appendix E). In the section 2.1.1 the following definition is given:

"A business model is a simplified representation that counts for the known and inferred properties of the business or industry as a whole, which may be used to study its characteristics further..."

The last section ended with the remark that the BMM can be used to answer the research question by tailoring the method to a specific situation. This specific situation is of course a R&D organisation which means that the known and inferred properties of R&D are needed to tailor the method. In this section is searched for the R&D characteristics by a literature study.

This section is based on a selection of articles which are obtained by the search process in Figure 2-1.

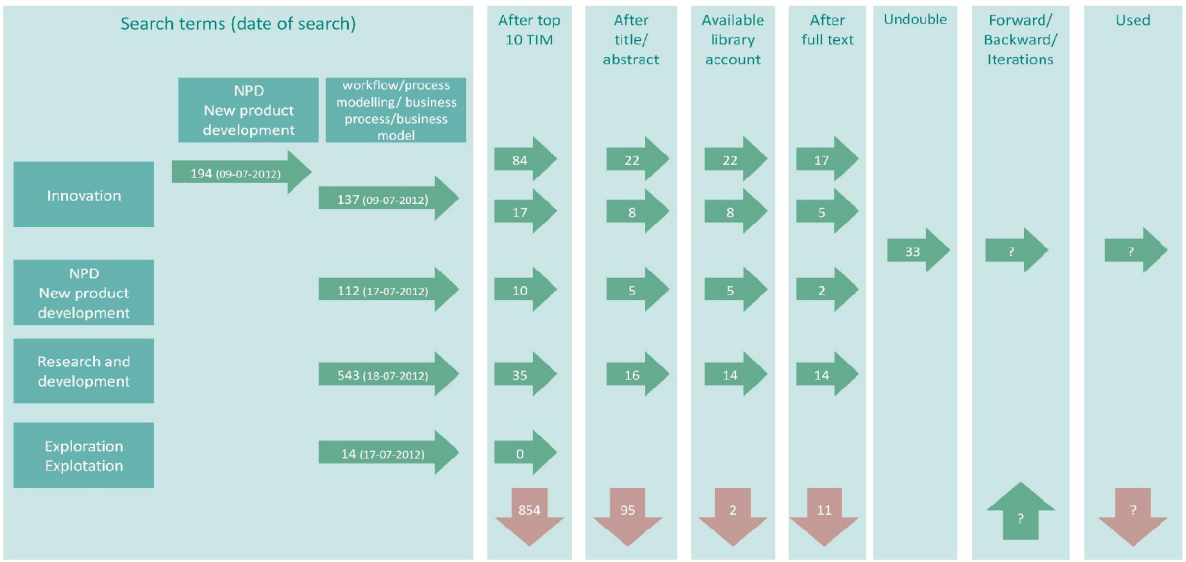


Figure 2-1: Search process chapter 2.1

Appendix D gives a deeper insight in the construction of the search terms. As mentioned in 1.3.2 an extended forward and backward search is left out. Nevertheless if an interesting article

is selected using citations it can be found in the right arrow in the block forward/backward/iteration in Figure 2-1. The arrow at the bottom of this block stands for articles conducted from iterations. These iterations are the result of the relevant articles which appeared during the literature research in section 2.3. Some terms are used from the business engineering field, this delineation is done, because of the great amount of articles in the innovation field which is not relevant for this research. Therefore, to ensure the literature review is manageable, the business engineering perspective is already taken into account. Again if articles from another field appear to be relevant they are taken into account. Table 2-4 consist the concept matrix.

Table 2-4: Concept matrix R&D

	Project management	Managing activities	Risk management	Cost management	Value	External linkages
(Ali, 1994)			●		●	
(Balachandra & Friar, 1997)	●		●			
(Brockhoff, Koch, & Pearson, 1997)	●	●	●			
(Chesbrough, 2003)						●
(Coombs, McMeekin, & Pybus, 1998)	●					
(Daniel Sherman & Olsen, 1996)			●			
(Healy, Myers, & Howe, 2002)				●		
(Kleinschmidt & Cooper, 1991)					●	
(Lev, Sarath, & Sougiannis, 2005)				●		
(Liberatore & Titus, 1983)	●			●		
(Morandi, 2011)		●				●
(Nobelius, 2004)						●
(Pinto & Covin, 1989)		●	●			

Liberatore and Titus (1983) notice that a lot of R&D management research has an emphasis on project management, which is in line with the conclusions of Coombs et al. (1998) and others (Balachandra & Friar, 1997; Brockhoff et al., 1997) that project management has an important role in R&D. Pinto and Covin (1989) suggest that projects usually have the following attributes:

1. a specified limited budget

2. a specified time frame or duration
3. a preordained performance goal or set of goals
4. a series of complex, interrelated activities

Based on these attributes R&D specific characteristics are exposed in the literature review. There may be overlap between the different characteristics because they are intertwined. Therefore the different classifications do not have hard boundaries and are only for clarification.

Risk management

Pinto and Covin (1989) notice the overt risks which are familiar to R&D projects. Ali (1994) mentions a lack or loss of project support and uncertain resource requirements. The duration of a R&D project can be very long (Brockhoff et al., 1997) especially for radical innovation (McDermott & O'Connor, 2002; Veryzer Jr, 1998), which makes it harder and more risky to determine the allocation of resources and set reasonable goals. The same goes for project support which is important for R&D, because R&D benefits are often only seen on the long term and success rates are often low (Daniel Sherman & Olsen, 1996; Pinto & Covin, 1989). The outcomes of R&D projects are difficult to predict (Balachandra & Friar, 1997; Brockhoff et al., 1997; Pinto & Covin, 1989) and together with the managerial aversion of taking risk, makes risk management an important R&D characteristic.

Managing activities

R&D activities are often considered as a black box, which is very hard to systematically manage and control. According to Brockhoff et al. (1997) R&D activities are more often none repetitive. Which is in line with Pinto and Covin (1989), who state that activities involved in R&D project execution are less amenable to scheduling. A project is a series of complex interrelated activities and the task uncertainty (Morandi, 2011) involving R&D processes makes it even more complex. However, because it is difficult to manage and control R&D activities, this does not mean it should be neglected. As mentioned before, there is a common understanding that the distinguished types of innovation need to be managed differently. Incremental innovation is more structured than radical innovation and therefore the same management and control techniques cannot always be used interchangeable. Section

Specify activities0 offers a deeper insight in the different management models for radical and incremental innovation.

Value

Value is hard to determine because the success of the outcome is not known. Even if the outcome will definitely lead to a patent, then the lifetime of that outcome or product cannot be predicted. The expected returns from incremental innovations are lower than from radical innovations (Kleinschmidt & Cooper, 1991). However, the risk associated with their development and commercialisation is lower than from radical innovations, incremental innovations are important for the firm's overall profitability (Kleinschmidt & Cooper, 1991).

Cost management

Liberatore and Titus (1983) address the existence of cost-effective techniques which can improve the R&D project management for. However, costing techniques may not directly apply because of availability of information, which is in line with earlier mentioned uncertainties. Uncertainty is why financial accounting rules treat R&D as an expense instead of the capitalisation of costs (Healy et al., 2002; Lev et al., 2005). Because the success of a R&D project is not known as well as the eventual life time of the R&D outcome, it is impossible to capitalise the R&D costs without the big risk of manipulation of earnings (Healy et al., 2002; Lev et al., 2005). The downside is the intangible assets are often undervalued.

External linkages

In Appendix E the five generations of R&D are mentioned and characteristic for the fifth generation is the emphasis on external linkages, in other words R&D as a network. The focus is on collaboration within a wider system, involving competitors, suppliers, distributors etc. (Nobelius, 2004). This is in line with open innovation proposed by Chesbrough (2003), which he defines as a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology.

2.3 Challenges

In this section the first four steps of the BMM are assessed against the R&D characteristics from section 2.3. Step 5 and 6 are steps who are based on the first four steps or use general techniques such as brainstorming. There is no need to assess them against the R&D characteristics. Meertens et al. (2011) proposed specific methods, techniques or tools that are suitable, but they remark that other techniques may be useful and applicable as well. Therefore, based on literature reviews for every step, a possible set of suitable techniques is presented. This section forms the basis for the solution design in the chapter 4, where a suitable technique is chosen, argued and presented.

2.3.1 Identify roles

Proposed technique – Stakeholder Analysis

The deliverable of this step is to create a role list. A stakeholder analysis (SA) is proposed as a technique to identify the different roles (Meertens et al., 2011). In the presented case study the SA method of Pouloudi and Whitley (1997) is used. This SA arose from the IS field and aims at inter-organisational information systems. From the perspective of 'External linkages' this SA is suitable for R&D, because of the focus on external stakeholders.

Literature review

Figure 2-2 forms the search process of the literature review.

Figure 2-2: Search process 2.3.1

The search process only results in one article (Elias, Cavana, & Jackson, 2002) which satisfies the selection criteria. In this article stakeholder management is verified as an important aspect of R&D management by various examples in literature (see for overview Elias et al., 2002). Furthermore a SA for R&D project management is presented. The proposed SA provides a systematic approach to identify and classify who the stakeholders are. It furthermore describes how to analyse the stakeholders' interests. These interests are used to map the changing role of a stakeholder throughout a project. The foundation of this SA is presented in Figure 2-3.

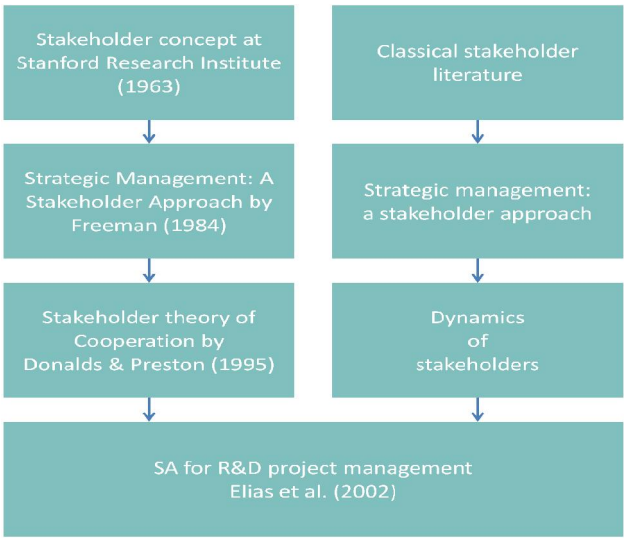


Figure 2-3: Stakeholder literature map based on Elias et al. (2002)

The SA is a combined version of Freeman (1984) and Mitchell, Agle, and Wood (1997). In the first part the stakeholder capability of an R&D project is determined and in the final part the dynamics of stakeholders are analysed.

Relevance to R&D characteristics

One of the difficulties in '*Risk management*' is the often long time frame of R&D projects. While time is passing by, the interests of stakeholders might change as well. The SA (Elias et al., 2002) focuses on the dynamics of stakeholders and their changing interests. In this way possible risks can be foreseen and acted on.

Another focus of this SA is the characteristic '*External linkages*', which is implicitly a part of every stakeholder analysis. This SA distinguishes itself by conducting an analysis on rational,

process and transactional level. This way a deeper insight is given in the management of relations as well as the transactions that take place. This information is supporting in the management of risks.

Table 2-5 contains an overview of the compatibility of the stakeholder analyses to R&D characteristics. According to the following scale these SA's are valued: 0=no focus, 1=focus, 2=strong focus.

Table 2-5: overview SA

R&D characteristic	SA (Pouloudi & Whitley, 1997)	SA (Elias et al., 2002)
Project management	1	2
Managing activities	0	0
Risk management	1	2
Cost management	0	0
Value	0	0
External linkages	2	2

2.3.2 Recognize relations

Proposed technique – e3-value model

The deliverable of this step is to create a role-relation matrix. In the BMM the e3-value model is proposed as a technique to facilitate the creation of that deliverable. However, Meertens et al. (2011) do not explicit argue why this technique fits this step. To decide if this technique is suitable for R&D, it needs to be clear why the choice for the e3-value model is valid. First the literature review is done to unlock the full potential of the e3-value model and is use. Second, is argued if the technique is applicable to R&D.

Literature review

The recognition of relations has a great deal of overlap with the identification of roles. The proposed deliverable by Meertens et al. (2011) can with some extra effort be derived from the input of step 1 without using the proposed technique (e3-value). Meertens et al. (2011) do not stress out the importance of the e3-value model to such an extent that its full potential for this step gets unlocked. Therefore, the focus of this literature review is based on the e3-value model.

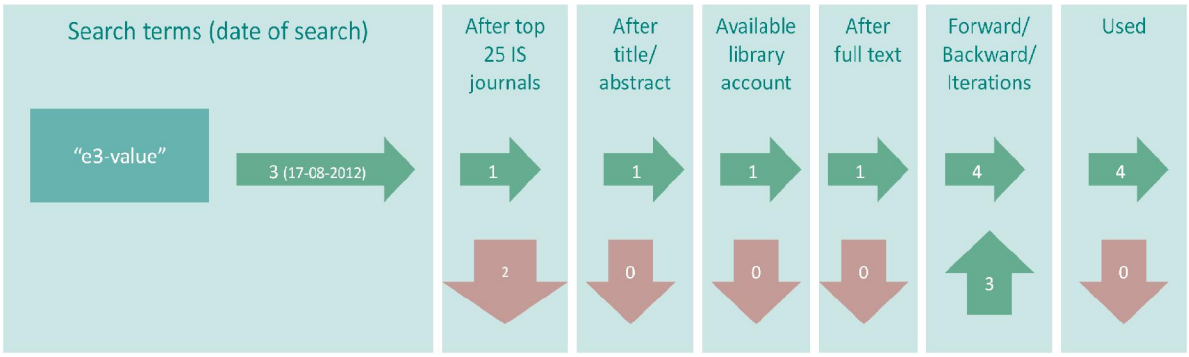


Figure 2-4: Search process 2.3.2

The search process only results in one article (Kartseva, Gordijn, & Tan, 2006) which satisfies the selection criteria. This article is used as a starting point for some forward and backward search. This search is no full forward/backward search, because of the limited amount of time within the scope of this assignment. These findings are the basis of this literature review.

The second step of the BMM aims to discover the relations among the roles. It may appear that relations are already captured in the SA of the first step and therefore this step is redundant. However, there are several reasons why the recognition of relations is a separate step in the BMM. First of all, a SA often follows a hub-and-spoke pattern, as the focus is on one of the roles (Meertens et al., 2011). Meertens et al. (2011) suggest a role-relation matrix as a deliverable, while this approach forces to specify and rethink all possible relations between the roles. Secondly, Meertens et al. (2011) note that relations always involve some interaction between two roles. Furthermore they assume that this interaction involves some kind of value exchange as well. This is in line with Gordijn, Akkermans, and Van Vliet (2001) who state that all roles in a business model can capture value from the business model. From this perspective the proposed technique for this step (Meertens et al., 2011), e3-value modelling, is a valid one. The e3-value model models the economic-value exchanges between actors (Andersson, Johannesson, & Bergholtz, 2009; Kartseva et al., 2006). This economic-value exchange can be tangible as well as intangible (Allee, 2008; Andersson et al., 2009). The initiators Gordijn and Akkermans (2003) present the e3-value model as being:

1. lightweight
2. a graphical, conceptual modelling approach

3. based on multiple viewpoints
4. exploits scenarios, both operational and evolutionary
5. recognising the importance of economic value creation and distribution

Property 3 and 5 are in line with the choice of this model in this step. The multiple view approach is the missing link between the SA and the role-relation matrix. Furthermore the focus on value exchange fits the property of a relation being an interaction between roles with some kind of value exchange. The remaining properties 1, 2 and 4 are useful in step 5 of the BMM. The light weighted and visual oriented approach facilitates the brainstorming and generating scenarios, which are important aspects of step 5.

Relevance to R&D characteristics

Now is clear why the e3-value model is suitable for this step. The next step is to decide if this technique is suitable according to R&D characteristics as well. Two R&D characteristics which are relevant for this step are '*Value*' and '*External linkages'*. The value exchange of intangible assets is an exchange occurs often while knowledge transfer goes hand in hand with R&D. By exposing the tangible value exchanges as well as the intangible ones, the e3-value model is from a '*Value*' perspective suitable for R&D. This automatically shows that this model is suitable from the perspective of '*External linkages*' as well. External linkages are the relations between different roles, for example a supplier, and the exchange of for example knowledge. The strength of the e3-value model lies in business network environments and an organisation together with their external linkages can be typed as a business network. Table 2-6 contains an overview of the compatibility of the e3-value model to R&D characteristics.

Table 2-6: Overview e3-value model[3]

R&D characteristic	e3-value model	R&D characteristic	e3-value model
Project management	0	Cost management	0
Managing activities	1	Value	2
Risk management	1	External linkages	2

[3] 0=no focus, 1=focus and 2=strong focus

2.3.3 Specify activities

Proposed technique(s) – BPM methods, languages and tools

The deliverable of this step is to create a list of business activities, which together form the qualitative model. This qualitative model reveals what must happen for the business to function properly (Meertens et al., 2011). The basis for this step forms the role-relation matrix, because a relation between two roles requires activities by both roles. To visualize this, think of the example of a hairdresser and his customer. The relation between these two roles is based on the payment of the customer and the coiffure from the hairdresser. The coiffure is designed by for example two activities washing and cutting. Meertens et al. (2011) propose techniques from business process management to create the attended output. However, in contrast to the example, R&D activities are considered as a black box, which makes them hard to specify. It is possible to cluster activities in groups, but the number of techniques offered by business process management is considerable, it is necessary to look deeper into the field of business processes in R&D.

Literature review

Process orientation and thinking has entered the engineering environment in the last two decades. The literature review for this step is based on a process perspective and uses the search process of section 2.1 as a basis.

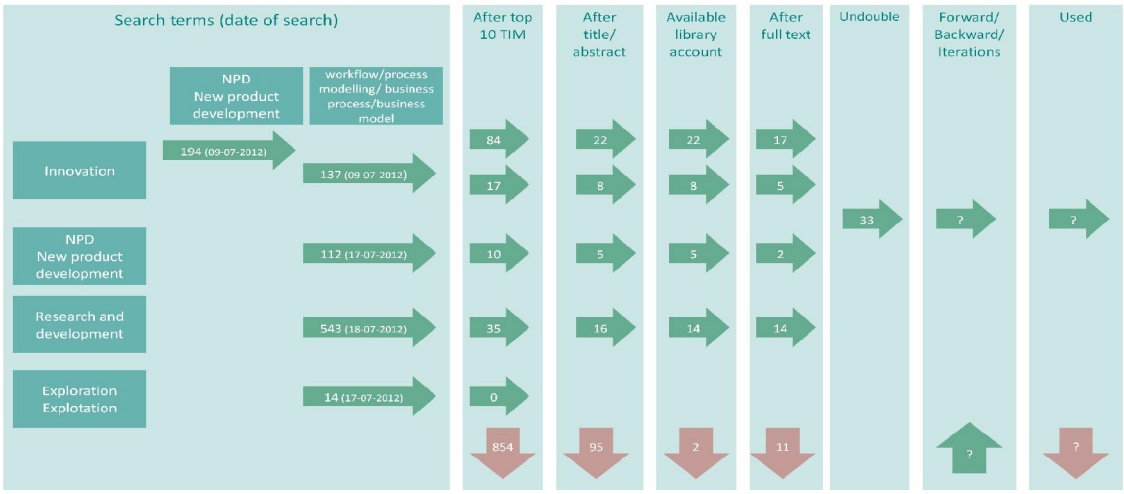


Figure 2-5: Search process 2.3.3

One of the main directions within innovation process management literature is the Stage-Gate process. Since its introduction (Cooper, 1990) it has been the basis of inspiration for a lot of research (in example Biazzo, 2009; Chao & Kavadias, 2008; Cooper, 2008; Kahn, Barczak, & Moss, 2006; Page & Schirr, 2008; Peters, 2006; Smeds, Haho, & Alvesalo, 2003). Cooper (1990) defines the Stage-Gate system as both a conceptual and an operational model for moving a new product from idea to launch. It can be used to manage the new product development process to improve effectiveness and efficiency (Cooper, 1990). The process from idea to launch is divided in stages of which each stage consists of a set of activities. This is then followed by a gate where a Go/Kill decision is made (see Figure 2-6 for example).

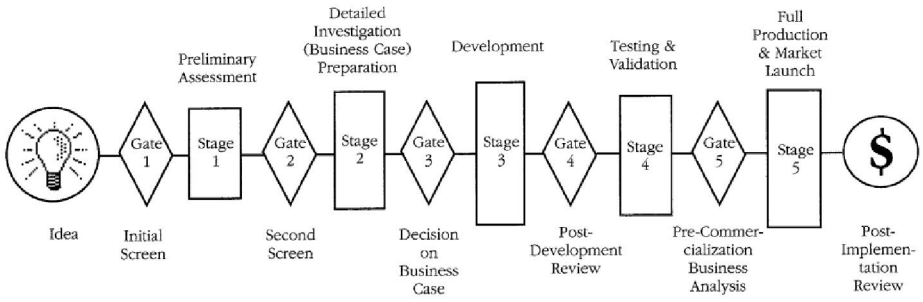


Figure 2-6: Example Stage-Gate system (Cooper, 1990)

The Stage-Gate system has been criticized for the lack of flexibility in uncertain environments (Iansiti, 1995) and as not being suitable for radical innovation (Brentani & Reid, 2012; Veryzer Jr, 1998). Iansiti (1995) proposes a flexible model as an alternative for the Stage-Gate system. His criticism is based on the assumption that a Stage-Gate system has an early concept freeze. In case of the flexible model, the concept freeze moves as close to the market introduction as possible and therefore can react to changes in a turbulent environment.

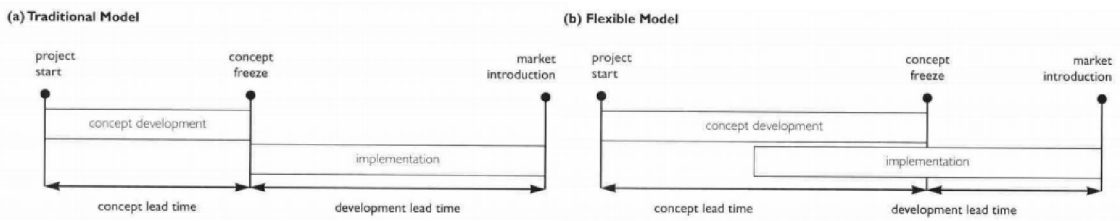


Figure 2-7: traditional model versus flexible model (Iansiti, 1995)

Figure 2-7 shows the differences between the Stage-Gate system (traditional model) and the flexible model. According to Iansiti (1995) in the flexible model the concept development and implementation are tightly linked set of activities and not sequential phases like in the traditional model. By overlapping these two stages and thereby moving the concept freeze, the flexible model allows being responsive to in a turbulent environment. This perspective is followed by other authors as well (in example Haque & Pawar, 2001; Kamoche & e Cunha, 2001).

Other authors (Brentani & Reid, 2012; McDermott & O'Connor, 2002; Veryzer Jr, 1998) argue that the development process of radical innovation is a distinct process than the Stage-gate system. Radical innovation requires a less structured process, while the structure contradicts with creativity. Coincidence and fortuitousness are recurrent aspects of this messy process (Veryzer Jr, 1998). Furthermore radical innovation is not that customer driven as incremental innovation (Veryzer Jr, 1998). Figure 2-8 shows the radical innovation process according to Veryzer Jr (1998).

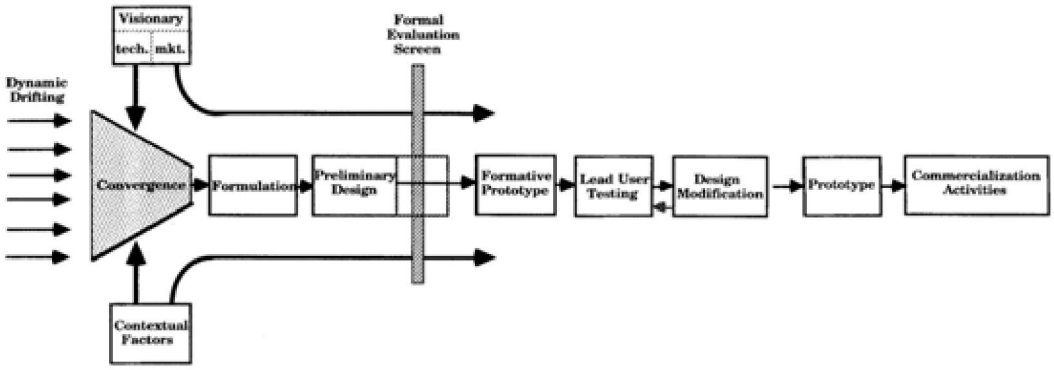


Figure 2-8: Radical innovation process (Veryzer Jr, 1998)

Biazzo (2009) has an interesting view on all the criticism and states that the various models are compared based on different dimensions. He distinguishes three dimensions for these kinds of models, the organisational dimension, the informational dimension and the transformational dimension. The organisation dimension refers to process structuration, the informational dimension refers to process flexibility and the transformational dimension refers to simultaneity in task execution. He concludes that the critique of Iansiti (1995) is misleading as it overlaps the organisational dimension with the informational dimension. Figure 2-9 visualises

this conclusion with the example of writing a scientific article. The two activities are problem formulation and problem solving and the two stages are planning and execution. Example (a) shows the organisational dimension as such the two stages and gates. Then, examples (b1, b2) give an example of how this relates to the two activities. In (b2), these activities follow a similar timeline as the gates and after a decision at the gate is taken, the activity is finished as well. In (b1), activities have shifted to another stage and thereby overlapping the stage gates.

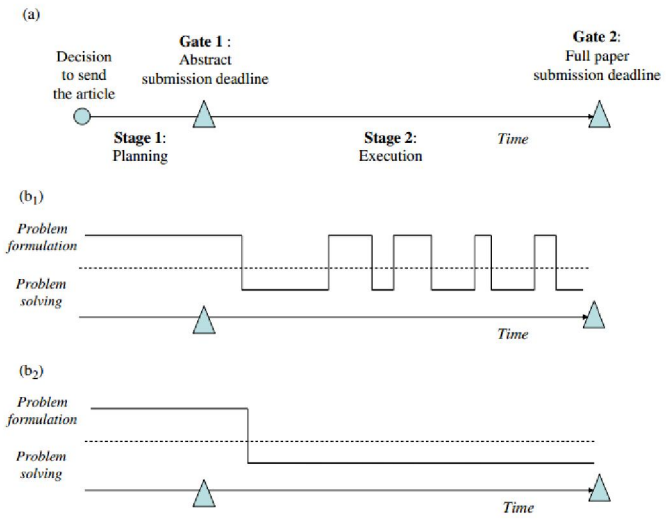


Figure 2-9: Example (Iansiti, 1995)

Notice that there is no difference between the stages on the organisational dimension, but there is a difference on the informational dimension. Another conclusion of (Biazzo, 2009) follows this reasoning and suggests that simultaneity in task execution does not influence the organisational dimension, only the informational one. Therefore he concludes that flexibility can occur in a form of Stage-gate system.

Cooper (2009) reacts on the criticism by pointing out that the original Stage-gate systems have evolved into the next-generation Stage-Gate systems by companies, who tweak the systems to their organisation. These Stage-Gate systems are proving more flexible by stating that not every activity or deliverable is mandatory. Furthermore, flexibility is achieved by allowing stage overlap through simultaneous execution. Another aspect of the next generation Stage-Gate systems is that they are scalable. Cooper (2009) presents three types of Stage-Gate systems suitable for different kinds of projects (Figure 2-10). 1) Stage-Gate Full is used for major NPD

projects 2) Stage-Gate Xpress is meant for medium risk projects and 3) Stage-Gate Lite for minor changes.

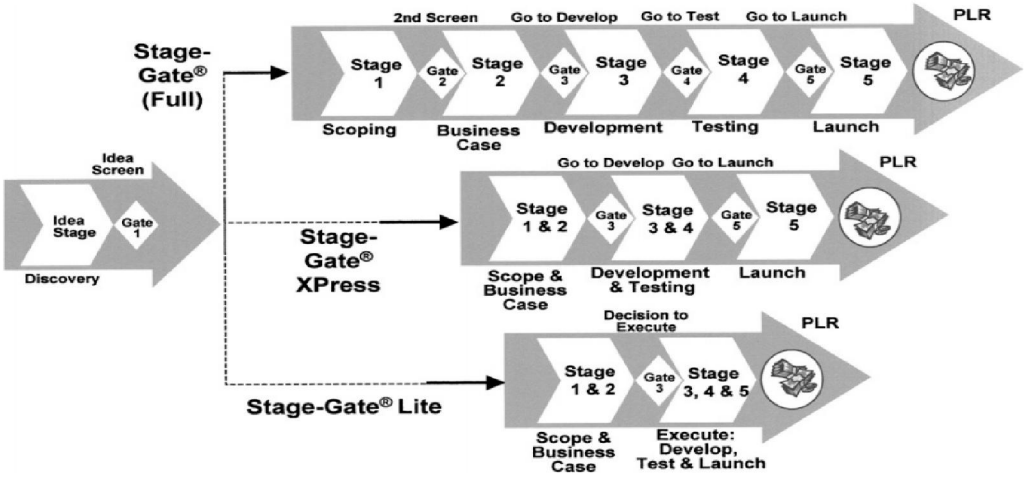


Figure 2-10: Scales of Stage-Gate Systems

Furthermore, Cooper (2009) addresses the need for adaption to radical innovation as well. Based on examples from practices from various organisations, he suggests modifications of the front-end of the Stage-Gate system and positions technology development as a feeder for new product developments (Figure 2-11).

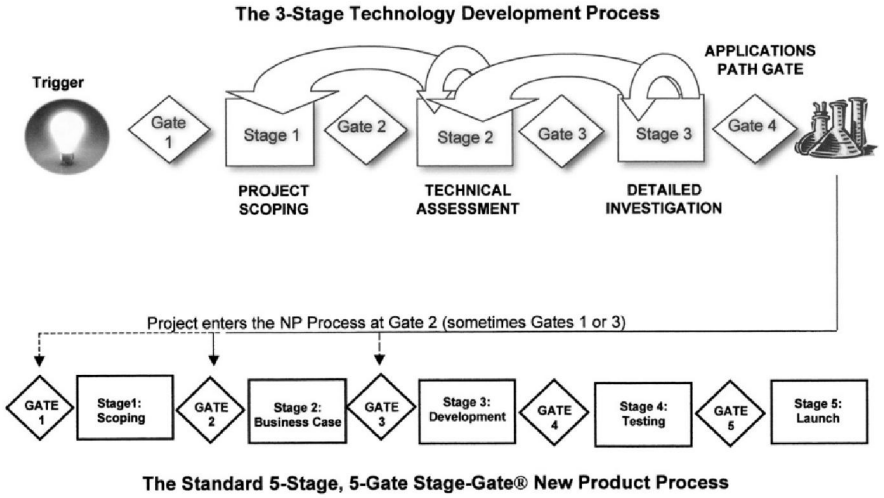


Figure 2-11: Technology Development Projects

So he suggests a 3-Stage Technology development process which can feed the Stage-Gate system at the different gates (Cooper, 2006).

Concluding remarks

Although some authors criticise the flexibility of the Stage-Gate system, others argue that the Stage-Gate system can be flexible as well. Furthermore it is important to understand that there is no one way NPD (Cooper, 2009), every company needs to adopt its own version. Finally, authors as well as organisations see the importance of a different process for technology development (or radical innovation).

R&D characteristics

A comparison based on the R&D characteristics does not seem relevant. The focus lies on the difference between incremental and radical innovation (managing activities). It is important to understand that radical innovation requires a different approach with less structure, but this does not mean any structure at all.

2.3.4 Quantify model

Proposed technique(s) – Activity Based Costing

As mentioned before R&D activities are considered as a black box. To be able to map these kinds of activities various kinds of models are introduced (see section 0). Basically, activities are clustered in stages and the output is monitored. In this research these kinds of models are used to create the qualitative model. The next step is to quantify the qualitative model. Meertens et al. (2011) propose Activity-Based Costing (ABC) for this step, but this is not suitable for R&D if the quantitative model is based on the clustering of activities. The clustered activities become too complex and costs cannot be allocated anymore.

Literature review

A literature research is done to search for other cost allocation techniques. The search process for this research is visualized in Figure 2-12.

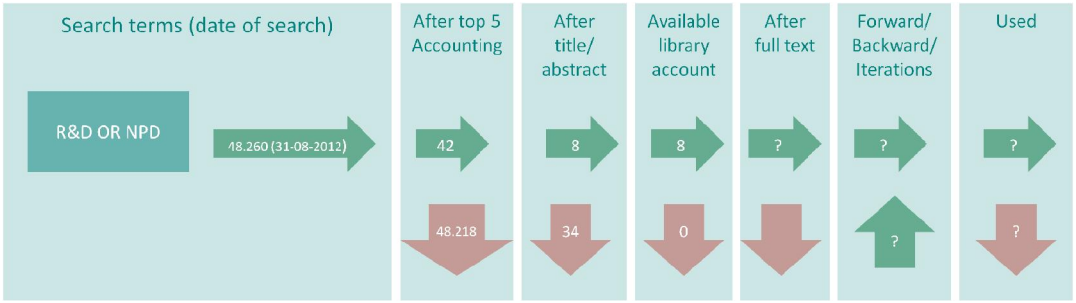


Figure 2-12: Search process section 2.3.4

Most of the literature focuses on the financial control for the process of R&D (Abernethy & Brownell, 1997; Lev et al., 2005; Rockness & Shields, 1984) or on treating R&D as expense or capital asset (Daley & Vigeland, 1983; Wyatt, 2005). There seems to be no literature on costing assignment for R&D in the top 5 accounting journals.

Nevertheless, there are systems available for an organisation to assign costs, which can be distinguished in traditional systems and more refined systems like Activity-Based Costing (ABC) (Drury, 2007). Process costing, job costing and a hybrid form of these two are considered as traditional systems. Process costing allocates costs to masses of identical or similar units of a product or service and job costing allocates costs to an individual unit, batch, or lot of a distinct product or service (Horngren, Foster, & Datar, 2006). Not only products or services can be cost objects, also a customer, product category, period, project (R&D/reorganisation), activity or a department may qualify as a cost object. ABC refines a costing system by assigning cost to individual activities.

R&D characteristics

ABC is not a suitable technique for R&D while activities are clustered and complex. Process costing is used to cost masses of identical or similar units. One of the characteristics of R&D is its non repetitive nature (Brockhoff et al., 1997) and therefore process costing is not suitable for R&D. Job costing on the other hand allocates cost to an individual unit, batch, or lot of a

distinct product or service. As mentioned, this research considers an R&D organisation as an organisation which is built on projects. Although project management techniques are used to create uniform structures like NPD processes, this does not mean that process costing can be used. These kinds of structures do not cluster uniform activities but try to support the process of delivering certain outputs. Each output is unique or has its unique features and therefore job costing is a suitable technique for R&D.

2.4 Conclusion

In this chapter, the BMM is introduced as a method to build a business model in a structured and reproducible manner. The BMM can be tailored to specific situations such as R&D. A literature study is done to uncover the characteristics of R&D. These characteristics are used to research possible suitable techniques within the BMM for the first four steps for R&D. The last two steps are of a general nature and build upon the first four. In the next chapter, techniques are chosen and presented for every step.

Chapter 3. Solution Design

In Chapter 2, the BMM is presented as a generic methodology to build a business model. This methodology consists of six steps and within every step a technique or method is used to produce the necessary deliverables. Therefore, the BMM can be described as a method of methods. Then, a literature search has been done to find out which methods are suitable within the first four steps ('as-is' situation) and how these methods meet R&D characteristics. Section 2.3 gives an overview of the suitable methods for each step.

In this chapter, the choice for which method to use in each step is made. By choosing for each step a method which is suitable for a R&D environment, the BMM is tailored from a generic method to a more specified method to build a business model for a R&D organisation. Step five and six ('to-be' situation) are not taken into account, as these steps stand re-use the first four steps and/or use non R&D specific techniques. The visualisation in Figure 3-1 on the next page is the common denominator of this chapter.

Before the tailored BMM is presented, it is important to understand that this method is based on the assumption that a R&D organisation is considered as a portfolio of projects. This assumption is in line with literature (Balachandra & Friar, 1997; Brockhoff et al., 1997; Coombs et al., 1998; Liberatore & Titus, 1983; Pinto & Covin, 1989), but from the logic that the projects create the value as well.

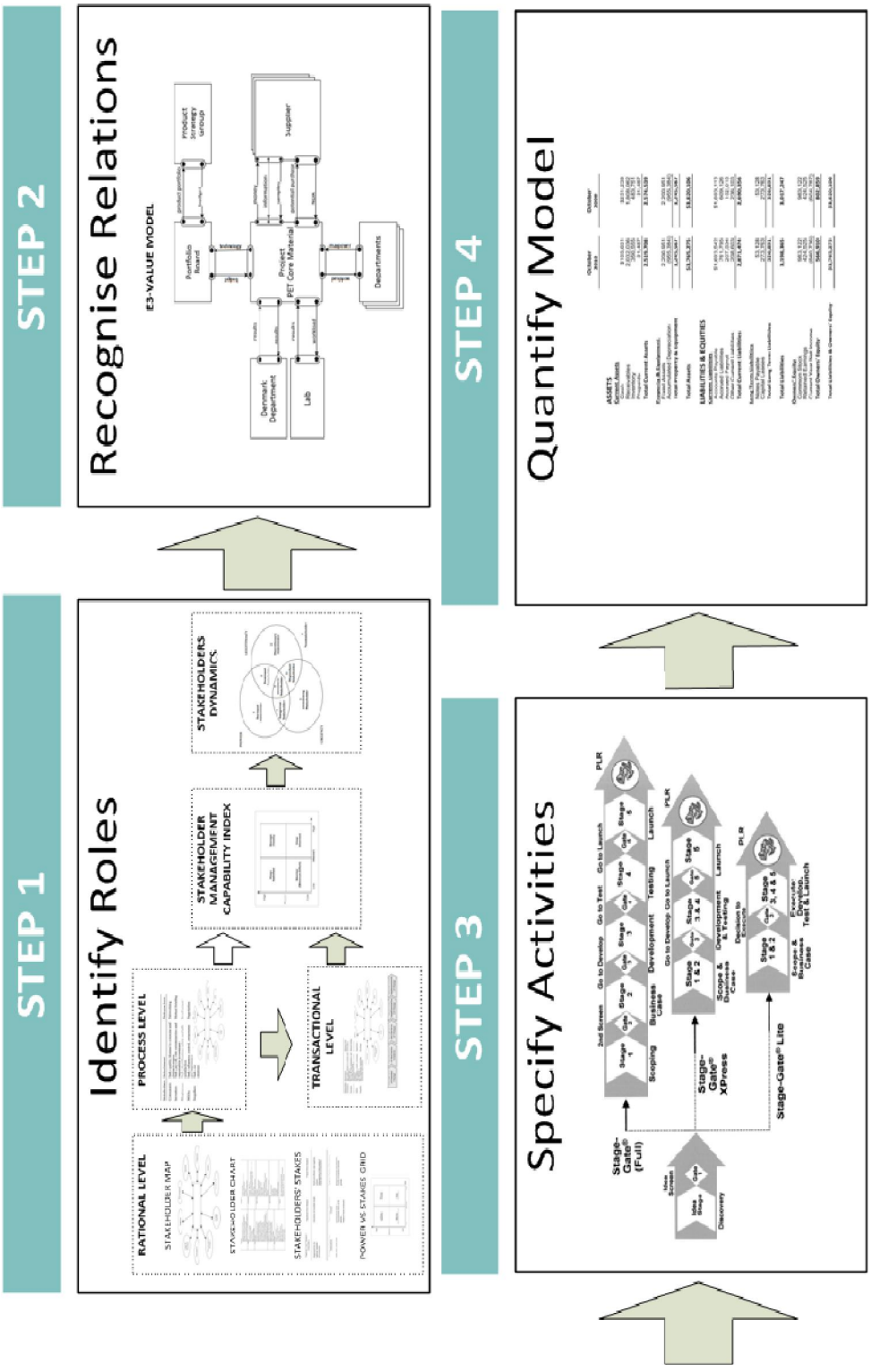


Figure 3-1: Overview steps BMM

3.1 Identify roles

First, the choice for the method is argued, followed by a presentation of the method. Finally, the position of the method within the business model is reviewed.

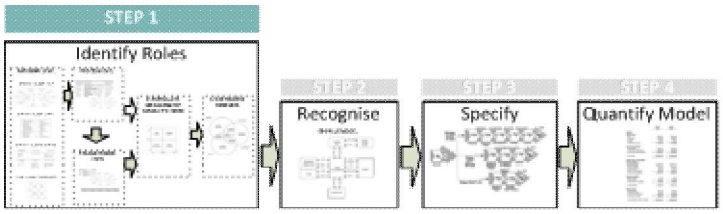


Figure 3-2: Step 1 BMM - Identify Roles

3.1.1 Choice

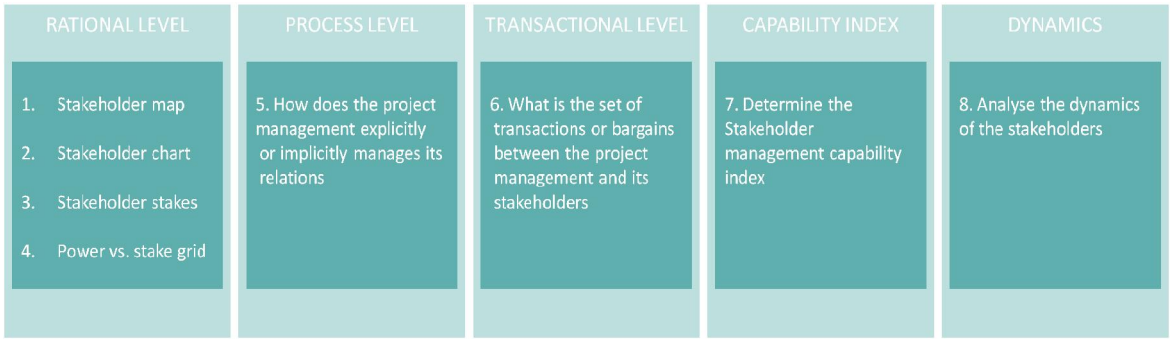
Although the proposed Stakeholder Analysis (Pouloudi & Whitley, 1997) is suitable for R&D, based on the perspective of the external linkages another technique is chosen. The Stakeholder Analysis (SA) of Elias et al. (2002) is more suitable, because it scores better on the R&D characteristics, project management and risk management.

The dynamics of the stakeholder is an important aspect of this SA, because the lifetime of a R&D project usually is longer than other projects. The changing interest of stakeholders is an important factor, especially for risk management, but for top management support as well. With this SA, the course of the stakeholder can be estimated and used during a project.

3.1.2 Presenting the Stakeholder Analysis

The first seven steps of the SA are based on (Freeman, 1984) and the last step is derived from (Mitchell et al., 1997). The combination of these two lead to the SA.

Table 3-1: Stakeholder Analysis based on (Elias et al., 2002)



Rational Level

In this level, the various stakeholders are identified together with their stakes. In the last step of this level, the stakeholders are placed in a two dimension grid (stakes and power). A stake is distinguished by equity, economic and influencers, and power is distinguished by formal/voting, economic and political power. The information needed can be obtained using the organisations' documentation and interviews. At the end of the first four steps, there is an understanding of who the stakeholders are and what their perceived stakes are.

Process Level

In this step is analysed how the project manager explicitly or implicitly manages the relations with the stakeholders. Are there any protocols or organisational processes for the management of these relations? This outcome then needs to be analysed if it is in line with the stakes and power of that stakeholder according to the rational level analysis. The information needed can be obtained using the organisations' documentation and interviews.

Transactional Level

The goal of this step is to have insight into the transactions with the stakeholders. This can then be compared to the status of a stakeholder according to the rational and process level analysis. Again, the information needed can be obtained using the organisations' documentation and interviews. This step helps to find out if transactions with stakeholders are built on understanding the legitimacy of the stakeholder.

Capability index

The capability index can be determined by placing the project within a two dimensional grid. This grid contains the axes process and transactional level (Figure 3-3). The visualisation allows to quickly overview how the stakeholders perform on process and transactional level.

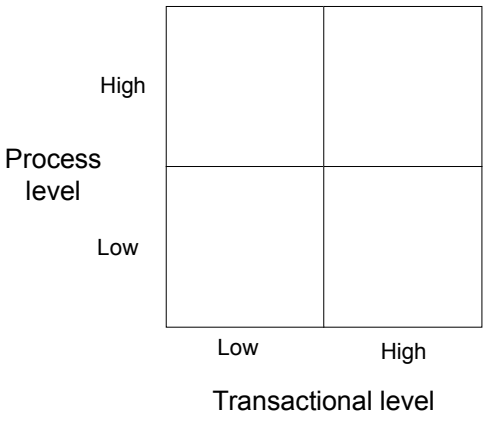


Figure 3-3: Stakeholder Management Capability

Dynamics of the stakeholders

Goal of this step is to capture the dynamics of a stakeholder. The stakeholders are classified according to eight types, which are identified by the possession or attributed possession of one or more of the relationship attributes: power, legitimacy, urgency. The stakeholder typology helps to estimate the influence of possible shifts of stakeholders and how to respond to that on process and transactional level.

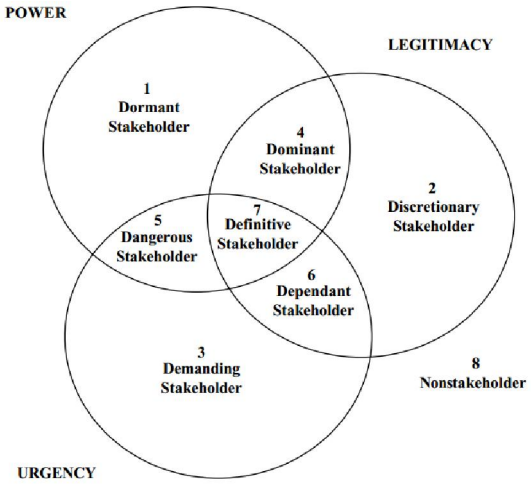


Figure 3-4: Dynamics Stakeholders

The deliverable of this step is a role list resulting from the rational level steps. However, the rest of the analysis gives valuable information on how stakeholders are managed and more important, it gives insight in the changing interests of stakeholders during a project. Not only enables this insight a project manager to foresee possible risks, it can result in pointers for improving or innovating the business model.

3.2 Recognise relations

First, the choice for the e3-value model is argued, followed by a presentation of the method. Finally, the position of the method within the business model is reviewed.

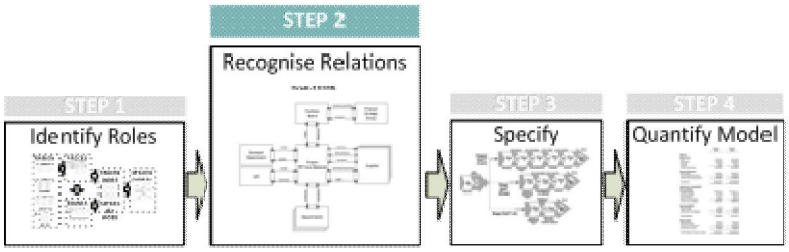


Figure 3-5: Step 2 - Recognise Relations

3.2.1 Choice

Although the e3-value model originated from the field of e-commerce, it appears suitable for the BMM for R&D as well. E3-value model it main focus lies on business networks, which is in line with the emphasis on external linkages of the fifth generation of R&D management. Furthermore, this technique offers a way to explicit the value exchange between stakeholders.

3.2.2 Presenting the e3-value model

For this technique, seven constructs can be used: actor, value object, value port, value offering, value interface, value exchange and market segment.

Actor	Graphic representation	ACTOR
Meaning	With whom do I collaborate to deliver my value proposition?	
Input	SA	

Value object	No graphic representation	-
Meaning	Is everything that has economic value for one of the actors	
Input	SA	

Value port	Graphic representation	ACTOR ⇄ ACTOR
Meaning	Models the act of provisioning or requesting value objects to or from actor. A value object that flows from an actor indicates a change of	

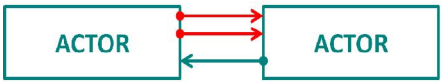
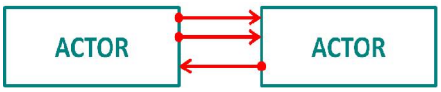
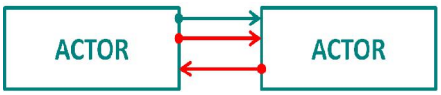
Input	ownership SA, business processes
Value offering	Graphic representation 
Meaning	What service or product bundling is offered or requested by an actor
Input	-
Value interface	Graphic representation 
Meaning	The value interface groups in-going and -going value offerings and models economic reciprocity
Input	-
Value exchange	Graphic representation 
Meaning	Connects two value ports of at least two actors with each other
Input	SA
Market segment	Graphic representation 
Meaning	What service or product bundling is offered or requested by an actor
Input	-

Figure 3-6 is an example of the use of this method.

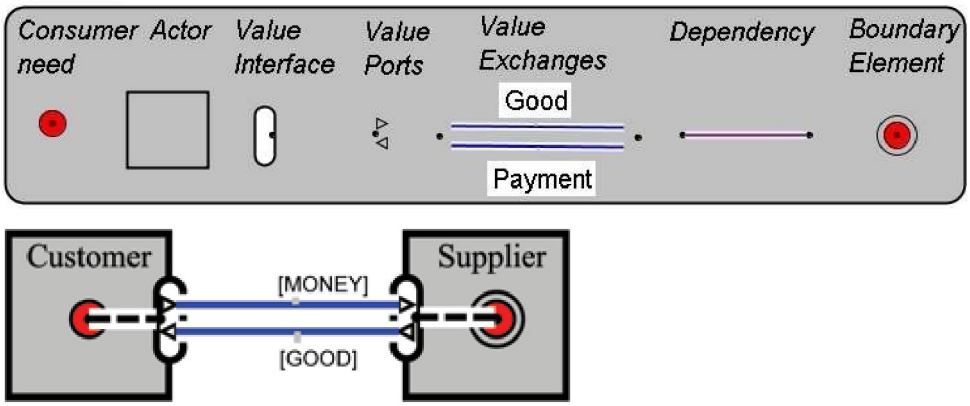


Figure 3-6: Example e3-value model (Gordijn 2001)

The explanation of the example of Figure 3-6 can be found in Table 3-2.

Table 3-2: Example e3-value model

Actor	Customer, Supplier
Value object	Money, Good
Value port	The arrow shows which way the interaction flows
Value offering	In case the supplier offers maintenance as well as the good, this would then be the value offering. Now it is only the good.
Value interface	The rounded squares from where the arrow starts, it groups the value offering
Value exchange	It shows which actors are willing to exchange value objects with each other (in this case the exchange between customer and supplier)
Market Segment	This example has no market segment construct, but customer can be replaced by the whole market

The e3-value model allows modelling the activities within actors as well. However, this is not suitable for this situation as R&D activities are often complex and not easily separated from each other.

The output of this method is a value-exchange model, and based on this the role-relation matrix can be build. Furthermore, this graphic representation can be used for the brainstorming purposes in step 5 of the BMM. For a discussion on this matter see section 2.3.2.

3.3 Specify activities

First, the choice for the Stage Gates is argued, followed by a presentation of the method. Finally, the position of the method within the business model is reviewed.

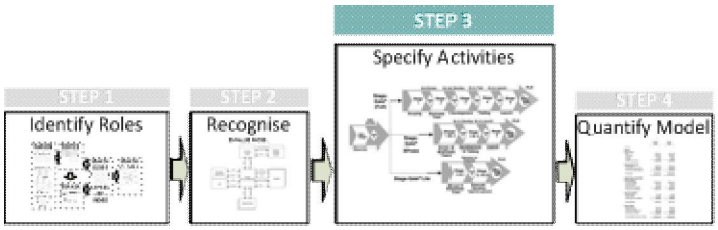


Figure 3-7: Step 3 - Specify Activities

3.3.1 Choice

In section 0, it became clear that to manage R&D activities for R&D projects, the new product development process is divided in stages, in the form of a Stage-Gate system. Criticism on the

lack of flexibility of this traditional model is refuted (Biazzo, 2009; Cooper, 2009) and criticism on suitability for radical innovations was countered (Cooper, 2009). Therefore this step uses this Stage-Gate system as a basis to model the R&D activities. As Cooper (2009) remarks, an organisation needs to adopt the Stage-Gate system according to its own needs. This allows the method to be applicable to various kinds of R&D organisation.

3.3.2 Presenting the Stage Gates

The Stage Gates are already presented in section 0. In this section an approach is created based on two scenarios:

1. An imbedded innovation process within the organisation is available
2. An imbedded innovation process within the organisation is not available

First, needs to be answered if the organisation has an imbedded innovation process. Based on this answer a certain approach needs to be followed. In case no imbedded innovation process is available, an innovations process needs to be created based on the clustering of activities. If an imbedded innovation process is available, this process needs to be reviewed. Figure 3-8 contains a flowchart of this overall approach.

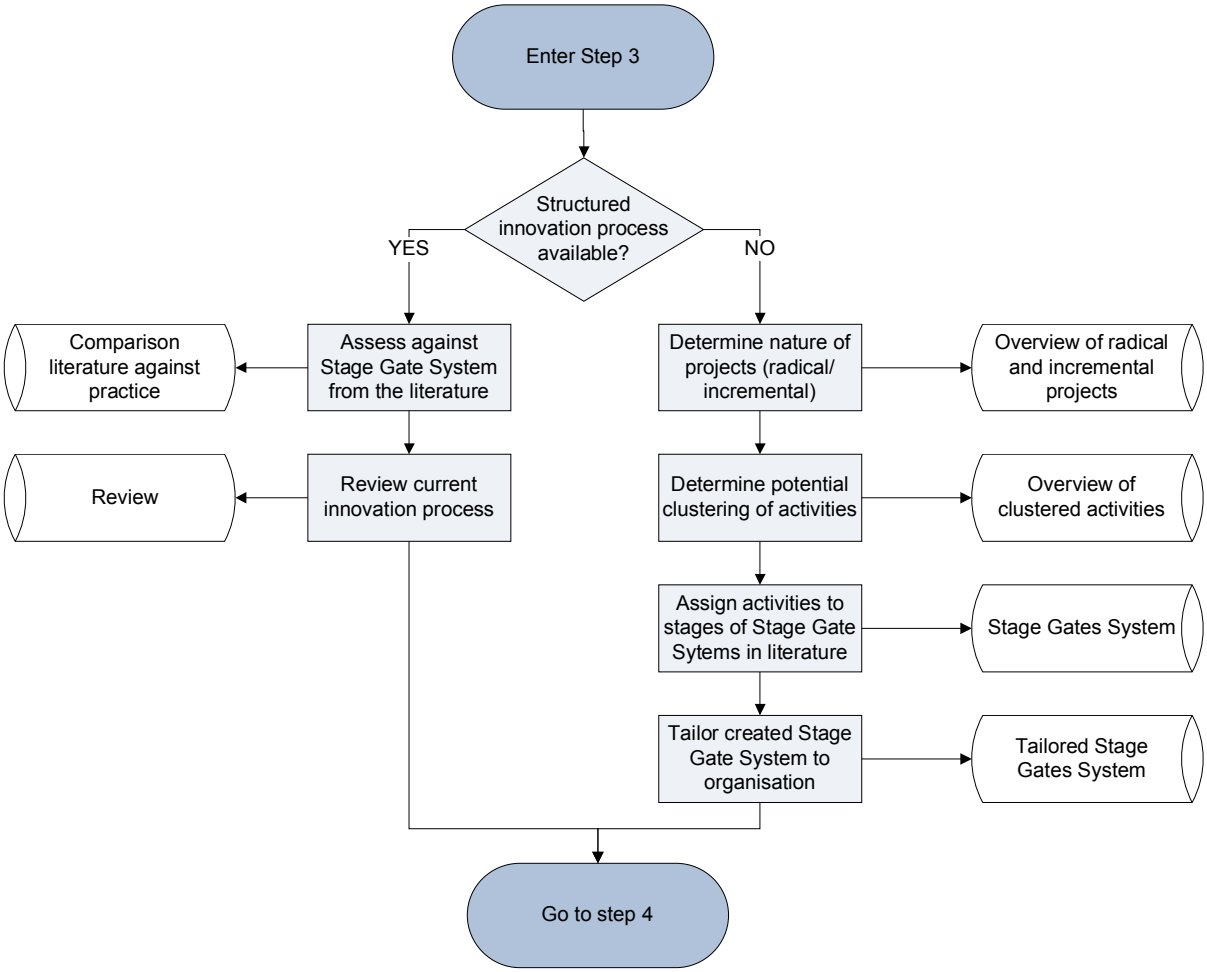


Figure 3-8: Workflow of Step 3

3.4 Quantify model

First the choice for the method is argued, followed by a presentation of the method. Finally the position of the method within the business model is reviewed.

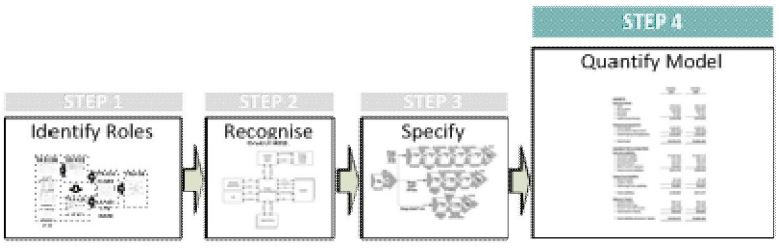


Figure 3-9: Step 4 - Quantify Model

3.4.1 Choice

According to the argument in section 2.3.4, job costing is the most suitable technique for allocating costs compared to process costing and ABC. With job costing, costs can be allocated to a project or even a project stage.

3.4.2 Presenting job-costing

The general procedure for job costing consists of seven steps to assigning costs to an individual job (Horngren et al., 2006):

1. **Identify the job that is the chosen cost object**

   In this model the cost object may be a project or a project stage.

2. **Identify the direct costs of the job**

   Direct costs like materials and labour are directly assigned as direct costs to the project or project stage.

3. **Select the cost-allocation bases to use for allocating indirect costs to the job**

   Indirect costs cannot be directly traced to a job and therefore need to be allocated. Different jobs require different quantities of indirect resources and therefore there needs to be some base to allocate. An example for a project can be hours spent.

4. **Identify the indirect costs associated with each cost-allocation base**

   All indirect costs can be summed up and assigned to a single cost pool (which needs to be allocated according to the choice in step 3). It is possible to create multiple overhead cost pools and even use different cost-allocation bases for these cost pools.

5. **Compute the rate per unit of each cost allocation base used to allocate indirect costs to the job**

   This step is an extension of step 3 and 4.

6. **Compute the indirect costs allocated to the job**

   This can be calculated by multiplying the outcome of step 5, by the actual quantity of the in step 3 chosen allocation base for that job.

7. **Compute the total cost of the job by adding all direct and indirect costs assigned to the job**

For this approach actual costing and normal costing can be used (Horngren et al., 2006). To allocate the actual overhead costs it is needed to wait until the end of the fiscal year, because only then all the actual costs can be taken into account. An advantage of actual costing is that possible season patterns are paved and the fixed indirect costs are spread over the monthly output. The disadvantage of course is that actual costs of jobs cannot be calculated until completed and at the end of the fiscal year. Normal costing makes it possible to allocate costs before all the overhead costs are known by calculating a budgeted indirect-cost rate for each cost pool at the beginning of the fiscal year. This costing system uses budgeted indirect-cost rates instead of actual indirect-cost rates (Horngren et al., 2006).

3.5 Conclusion

In this chapter the solution design based on chapter 2 is presented. The basis is the definition: "A business model is a simplified representation that counts for the known and inferred properties of the business or industry as a whole, which may be used to study its characteristics further..."

The known and inferred properties of the business have been identified as the characteristics of R&D. Furthermore, this method is based on the assumption that a R&D organisation is considered as a portfolio of projects. For this research a new definition for a R&D business model is defined which is derived from the above definition and the theory on Stage Gate Systems. **A R&D business model is a portfolio of innovation processes.** All projects are assigned to an innovation process and pools of projects are created. Those pools have some generic stakeholders, and generic cost structures. Of course projects are different from each other but certain similarities exist as well.

This is the foundation for the solution design. In this chapter the techniques used at every step have been presented. First roles are identified using a stakeholder analysis which is especially designed for R&D projects. Second, relations are recognised by mapping the value exchanges with e3-value modelling. Third, activities are specified using Stage Gate Systems and the fourth step of the model is covered by job costing. The fifth and the sixth step are general steps and outside the scope of this research.

Chapter 4. Solution Demonstration and Validation

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Chapter 5. Solution Validation

For a thorough validation of the solution design, multiple case studies are needed. However, this is not possible within the time frame of this research. Therefore, an expert validation by expert interviews is done as well. In section 5.1 the protocol is presented as well as the experts. In section 5.2 the results of the expert interviews are presented in the format of a SWOT analysis of the solution design. Then in section 5.3 a connection is made between the SWOT analysis and the results of the demonstration.

5.1 Protocol

Several experts on business models and/or innovation are interviewed in a one hour semi-structured interview. Each interview consists of an introduction, a presentation of the solution design and a discussion based on some high level questions. The document which worked as a guide during the interview can be found in Appendix E. Table 5-1 is an overview of the experts and their expertise.

Table 5-1: Overview Experts

	Function	Expertise
Expert 1	Research associate PhD candidate	Business modelling and innovation management
Expert 2	Senior advisor	Specialist on business models and business model innovation for ICT based services
Expert 3	Professor of Technology Management – Innovation of Operations	
Expert 4	Senior Research Consultant	Business model management, Business process management, Business innovation

5.2 SWOT

A SWOT analysis is a method to evaluate the Strengths, Weaknesses, Opportunities and Threads for in this case the solution design. The SWOT analysis is done based on the discussions with the experts.

5.2.1 Strengths

1. The solution design provides a well structured manner to map a R&D, which could be useful in practice in R&D environments. Often no structure exists at all in these environments which they could use (expert 2).
2. The SA and e3-value modelling are useful to get insight in the R&D project. It gives another perspective than the technology perspective of most people involved (expert 1, expert 2, expert 4)

5.2.2 Weaknesses

1. One of the things that are missing in the R&D characteristics is culture. The culture at a R&D organisation is different than in a production environment. Most of the employees are educated (expert 2).
2. Although the value exchanges are mapped the value model is lacking (expert 2).
3. In R&D projects the first step should be identify your network (expert 3).
4. The method may not be suitable for small organisations, where a Stage Gate System may be redundant (expert 4).

5.2.3 Opportunities

1. Interesting to implement within the method to show how to switch from cost centre to profit centre. The value model would be an important aspect then (expert 2)
2. Modelling value exchanges is valuable to the method, but it does not offer an earnings model and this is interesting to implement (expert 3).

5.2.4 Threats

1. Steps 3 and 4 can be time consuming, especially the quantification of the model (expert 1)
2. Business modelling has different definitions. Demarcate your definition to retain the potency of the solution design (expert 1)
3. Keep in mind that there is great overlap with portfolio management (expert 2)
4. Difficulties: what is the added value of a department instead (expert 2)

5. Using average indirect costs for job costing can be misleading, because in case a student works on a project it costs less than when a chief engineer works on a project. Therefore, using average costs the financial picture can be misleading (expert 3).

5.3 Conclusions

In this section the remarks of the experts are treated.

5.3.1 Strengths

1. The solution design provides a well structured manner to map a R&D, which could be useful in practice in R&D environments. There often no structure at all in these environments which they could use (expert 2).

   This is what the demonstration showed as well

2. The SA and e3-value modelling are useful to get insight in the R&D project. It gives another perspective then the technology perspective of most people involved (expert 1 and expert 2)

   The question "What is the value exchange" led to confusion. Making this explicit make people think differently

5.3.2 Weaknesses

1. One of the things that are missing in the R&D characteristics is culture. The culture at a R&D organisation is different than in a production environment. Most of the employees are educated (expert 2).

   True, however a part of it is within the characteristic managing activities. There is need for structure, but need as many as for a production environment. There is need for creativity.

2. Although the value exchanges are mapped the value model is lacking (expert 2).

   True, become more or less clear during demonstration. The demonstration was done in an organisation which is treated as a cost centre and not profit centre. In case of a profit

centre the value model would be more important. Maybe the scope needs to be adjusted to 'cost centres'.

3. In R&D projects the first step should be identify your network (expert 3).
   This can be of added value for step 5, for coming up with alternatives.
4. The method may not be suitable for small organisations, where a Stage Gate System may be redundant (expert 4).
   The solution design is tested on an organisation of 86 people. Probably, in a small organisation the need for structure is less than in a more mature organisation, because of the sake of monitoring and control.

5.3.3 Opportunities

1. Interesting to implement within the method how to switch from cost centre to profit centre. The value model would be an important aspect then (expert 2)
   This remark is the result of an interesting discussion on cost/profit centres and the value model
2. Modelling value exchanges is valuable to the method, but it does not offer an earnings model and this is interesting to implement (expert 3).
   This is indeed something for further research

5.3.4 Threats

1. Steps 3 and 4 can be time consuming, especially the quantification of the model (expert 1)
   Quantifying the model using job costing appeared an easy to use technique in the demonstration. When an innovation process needs to be developed it indeed is time consuming.
2. There are many different definitions for business modelling. Delineate your definition to retain the potency of the solution design (expert 1)
   Good point, this remark refined my view on my solution design
3. Keep in mind that there is great overlap with portfolio management (expert 2)
   True, but solution design is comprehensive and by step 5 and 6 the method distinguishes itself from portfolio management

4. Difficulties: what is the added value of a department instead (expert 2)

   Close to remark on value model, what is the value model of a department?

5. Using average indirect costs for job costing can be misleading, because in case a student works on a project it costs less than when a chief engineer works on a project. Therefore, using average costs the financial picture can be misleading (expert 3).

   If the financial data allows making this distinction, this needs to be taken into account. If not, the continuous improving character of the solution design should ensure that the job costing methodology is continuously refined.

Chapter 6. Conclusions, discussion and recommendations

This section contains the conclusions in section 6.1, the discussion in section 6.2 and the recommendations in section 6.3.

6.1 Conclusion

The research question of this thesis is:

How to build a business model for a research and development organisation?

To answer this question in section 2.1 is concluded that the Business Modelling Method is a method to build a business model in a structured and repeatable manner and this method can be tailored to a specific situation. A R&D organisation is such a specific situation and therefore the Business Modelling Method is used. In section 2.2, the known and inferred properties of R&D are classified as project oriented, managing activities, risk management, cost management, value and external linkages. These characteristics are used in section 2.3 to research the suitable techniques within the Business Modelling Method. Four steps of solution design are presented in chapter 3. First roles are identified using a stakeholder analysis which is especially designed for R&D projects. Second, relations are recognised by mapping the value exchanges with e3-value modelling. Third, activities are specified using Stage Gate Systems and the fourth step of the model is covered by job costing. The last two steps, design alternatives and analyse alternatives are not taken into account for this research. Both steps use the output derived from the first four steps in combination with general techniques which are not R&D specific.

Chapter 4 demonstrates the solution design for two scenarios. First it is demonstrated in case a Stage Gate system is already imbedded. All the four steps are performed and the solution design automatically resulted in ideas for improvements which can be implemented directly or can be feeders for step 5 and 6. Secondly, the solution design is demonstrated in case a Stage Gate System is not available. Only the first three steps have been performed, but it showed that the solution design works sufficient as a Stage Gate System is created. Furthermore, the only reason for not demonstrating step four is the lack of available financial data.

Based on expert interviews a SWOT analysis is performed for the solution design. One of the strengths confirmed by the results is that the method appeared well structured and useable in practice. The lack of an earning model was addressed as a limitation.
In conclusion, an answer is given to the research question in the form of a business modelling method tailored to be applicable in a R&D organisation.

6.2 Discussion

In section 6.2.1 the limitations of this research are presented as well as directions for further research in section 6.2.2. Finally, in section 6.2.3 the contribution of this research is described.

6.2.1 Limitations

The expert validation resulted in limiting the solution design to cost centres. Not because it cannot be used on a profit centre, but the discussion on earnings models led to the discovery that the solution design only is demonstrated at a R&D organisation which is seen as a cost centre.
The lack of an earnings model within the solution design to determine value creation was addressed by the experts as well. This limitation did not come to light during the demonstration because of the first described limitation in this section.
Quantifying the model for Technology projects could not been done, as the data was not sufficient. Unfortunately, the studied projects were still ongoing.

6.2.2 Further research

One of the aspects which came forward during the demonstration is Technology Readiness Levels. TRL's could be interesting to implement in Technology projects which are feeders for other projects. By monitoring the maturation of technology, the organisation has more insight in its current technological capabilities, more insight in foreseeing potential costs to improve a technology and the organisation can measure technology.
One of the limitations is that the model is demonstrated on a cost centre and not on a profit centre. It would be interesting to connect this solution design to the known theory of the shift from cost centre to profit centre.

6.2.3 Contribution of research

Meertens et al. (2011) encouraged to extend, improve or tailor the BMM to specific situations. This research picked this up and developed and validated a structured way to build a business model for a R&D organisation. The demonstration of the method showed that the solution design is applicable in practice and not only in theory.

By tailoring the BMM for a specific situation this research contributed to the validation of the original BMM as well.

6.3 Recommendations

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Appendix A: Top TIM Journals

Table 6-1: Overview top 10 TIM journals

Top 10 TIM Journals (Linton & Thongpapanl, 2004)	Top 10 TIM Journals (Thongpapanl, 2012)
Journal of Product Innovation Management	Research Policy
Research Policy	Journal of Product Innovation Management
Research Technology Management	Research Technology Management
R&D Management	Technovation
IEEE Transactions on Engineering Management	R&D Management
Technological Forecasting and Social Change	Industrial and Corporate Change
International Journal of Technology Management	IEEE Transactions on Engineering Management
Technovation	Journal of Technology Transfer
Technology Analysis and Strategic Management	Technological Forecasting and Social Change
Journal of Engineering and Technology Management	Journal of Engineering and Technology Management

Top innovation journals (100% coverage scopus)

AND (LIMIT-TO(EXACTSRCTITLE, "**Journal of Product Innovation Management**") OR LIMIT-TO(EXACTSRCTITLE, "**Research Policy**") OR LIMIT-TO(EXACTSRCTITLE, "**Research Technology Management**") OR LIMIT-TO(EXACTSRCTITLE,"**R and D Management ")** OR LIMIT-TO(EXACTSRCTITLE, "**IEEE Transactions on Engineering Management")** OR LIMIT-TO(EXACTSRCTITLE, "**Technological Forecasting and Social Change**") OR LIMIT-TO(EXACTSRCTITLE, "**International Journal of Technology Management**") OR LIMIT-TO(EXACTSRCTITLE, "**Technovation")** OR LIMIT-TO(EXACTSRCTITLE, "**Technology Analysis and Strategic Management**") OR LIMIT-TO(EXACTSRCTITLE, "**Journal of Engineering and Technology Management")** OR LIMIT-TO(EXACTSRCTITLE, "**Industrial and Corporate Change")** OR LIMIT-TO(EXACTSRCTITLE, "**Journal of Technology Transfer"))**

Appendix B: Top IS Journals

WORLD RANK	TITLE	WORLD RANK	TITLE	WORLD RANK	TITLE
1	MIS Quarterly	18	Communications of the AIS	35	Journal of Information Systems
2	Communications of the ACM	19	IEEE Computer	36	The Information Society
3	IS Research	20	Journal of Strategic IS	37	Journal E-U Computing
4	Journal of MIS	21	Admin. Science Quarterly	38	Info Resources Mgmt Journal
5	Management Science	22	Academy of Mgmt Review	39	Interfaces
6	IEEE Transactions (various)	23	Int'l Journal of E-Commerce	40	EM - Electronic Markets
7	Harvard Business Review	24	ACM Computing Surveys	41	Journal of CIS
8	Decision Sciences	25	Accounting, Management & IT	42	European Journal of OR
9	Decision Support Systems	26	ACM SIG Publications	43	Operations Research
10	Information and Management	27	IT and People	44	Int'l Journal of H-C Studies
11	European Journal of IS	28	IBM Systems Journal	45	Journal of the ACM
12	Sloan Management Review	29	OMEGA	46	Australian Journal of IS
13	ACM Transactions (various)	30	Journal of the AIS	47	Org. Behavior and Human Dec.
14	Data Base	31	Journal of Org., Comp. and EC	48	Behavior and IT
15	Organization Science	32	Human-Computer Interaction	49	Scandinavian Journal of IS
16	Information Systems Journal	33	Information Systems Management	50	Computer Journal
17	Academy of Management Journal	34	Int'l Journal of Man-Machine Studies		

Top 10 IS journals according to Schwartz and Russo (2004) SYNTAX (100% coverage scopus)

AND (LIMIT-TO(EXACTSRCTITLE, **"MIS Quarterly: Management Information Systems "**) OR LIMIT-TO(EXACTSRCTITLE, **"Communications of the ACM"**) OR LIMIT-TO(EXACTSRCTITLE, **"Information system research"**) OR LIMIT-TO(EXACTSRCTITLE, **" Journal of Management information systems "**) OR LIMIT-TO(EXACTSRCTITLE, **"Management Science")** OR LIMIT-TO(EXACTSRCTITLE, **"Harvard Business Review"**) OR LIMIT-TO(EXACTSRCTITLE, **"Decision Sciences"**) OR LIMIT-TO(EXACTSRCTITLE, **"Decision support systems")** OR LIMIT-TO(EXACTSRCTITLE, **"information and Management"**) OR LIMIT-TO(EXACTSRCTITLE, **"IEEE transactions on *"))**

Top 25 IS journals according to Schwartz and Russo (2004) SYNTAX (96% coverage scopus)

AND (LIMIT-TO(EXACTSRCTITLE, **"MIS Quarterly: Management Information Systems "**) OR LIMIT-TO(EXACTSRCTITLE, **"Communications of the ACM"**) OR LIMIT-TO(EXACTSRCTITLE, **"Information system research"**) OR LIMIT-TO(EXACTSRCTITLE, **" Journal of Management information systems "**) OR LIMIT-TO(EXACTSRCTITLE, **"Management Science")** OR LIMIT-TO(EXACTSRCTITLE, **"Harvard Business Review"**) OR LIMIT-TO(EXACTSRCTITLE, **"Decision Sciences"**) OR LIMIT-TO(EXACTSRCTITLE, **"Decision support systems")** OR LIMIT-TO(EXACTSRCTITLE, **"information and Management"**) OR LIMIT-TO(EXACTSRCTITLE, "IEEE

transactions on *") OR LIMIT-TO(EXACTSRCTITLE, **"European Journal of Information Systems"**) OR LIMIT-TO(EXACTSRCTITLE, **"MIT Sloan Management Review"**) OR LIMIT-TO(EXACTSRCTITLE, **"ACM Transactions on *"**) OR LIMIT-TO(EXACTSRCTITLE, **"Organization Science"**) OR LIMIT-TO(EXACTSRCTITLE, **"information systems journal"**) OR LIMIT-TO(EXACTSRCTITLE, **"Academy of management journal"**) OR LIMIT-TO(EXACTSRCTITLE, "Communications of the Association for Information Systems") OR LIMIT-TO(EXACTSRCTITLE, **"Computer"**) OR LIMIT-TO(EXACTSRCTITLE, **"Journal of Strategic Information Systems"**) OR LIMIT-TO(EXACTSRCTITLE, **"Administrative Science Quarterly"**) OR LIMIT-TO(EXACTSRCTITLE, **"Academy of Management Review"**) OR LIMIT-TO(EXACTSRCTITLE, " International Journal of Electronic Commerce") OR LIMIT-TO(EXACTSRCTITLE, **"ACM Computing Surveys"**) OR LIMIT-TO(EXACTSRCTITLE, **"Information and Organization"**))

Scopus doesn't cover Data Base (#14). Furthermore Scopus uses the name Computer instead of IEEE Computer (#19) and Accounting, Management & IT (#25) is now called Information and Organization. So using Scopus has a 96% coverage of the top 25 journals is possible.

Remark:
IEEE Transactions (#6) and ACM Transactions (#13) consist of various journals. Because it isn't clear which journals it covers, I used the search terms:
"**IEEE** Transactions on *" and "ACM Transactions on *" which basically means that all journals within are taken into the search.

Data Base (14)

non-available in scopus http://portal.acm.org/browse_dl.cfm?idx=J219

Appendix C: Top Accounting Journals

Top 5 Journals (Bonner et al., 2006)

1. Accounting Review
2. Journal of Accounting Research
3. Journal of Accounting and Economics
4. Contemporary Accounting Research
5. Accounting, Organizations and Society

Top 5 accounting journals (100% coverage scopus)

AND (LIMIT-TO(EXACTSRCTITLE, "**Accounting Review**") OR LIMIT-TO(EXACTSRCTITLE, "**Journal of Accounting Research**") OR LIMIT-TO(EXACTSRCTITLE, "**Journal of Accounting and Economics**") OR LIMIT-TO(EXACTSRCTITLE,"**Contemporary Accounting Research**") OR LIMIT-TO(EXACTSRCTITLE, "**Accounting, Organizations and Society**"))

Appendix D: Search terms chapter 2.1

TITLE-ABS-KEY("innovation management" AND ("workflow" OR "process modelling" OR "business process" OR "business process model*" OR "BPM"))	
Date	09-07-2012
All journals	67
Top 10 TIM	8
Title / Abstract	5
Available utwente account	5
Full Text	4
TITLE-ABS-KEY("innovation management" AND "business model")	
Date	09-07-2012
All journals	47
Top 10 TIM	8
Title / Abstract	2
Available utwente account	2
Full Text	0
TITLE-ABS-KEY(("continuous innovation" OR "evolutionary innovation" OR "incremental innovation") AND ("workflow" OR "process modelling" OR "business process" OR "business process model*" OR "BPM"))	
Date	09-07-2012
All journals	47
Top 10 TIM	8
Title / Abstract	2
Available utwente account	2
Full Text	0
TITLE-ABS-KEY(("discontinuous innovation" OR "revolutionary innovation" OR "radical innovation" OR "transformational innovation") AND ("workflow" OR "process modelling" OR "business process" OR "business process model*" OR "BPM"))	
Date	09-07-2012
All journals	11
Top 10 TIM	0
Title / Abstract	0
Available utwente account	0
Full Text	0
TITLE-ABS-KEY(("disruptive innovation") AND ("workflow" OR "process modelling" OR "business process" OR "business process model*" OR "BPM"))	
Date	09-07-2012
All journals	0
Top 10 TIM	0
Title / Abstract	0
Available utwente account	0
Full Text	0
TITLE-ABS-KEY(("npd" OR "new product development") AND ("workflow" OR "process modelling" OR "business process" OR "business process model*" OR "BPM"))	
Date	17-07-2012
All journals	112
Top 10 TIM	10
Title / Abstract	5
Available utwente account	5
Full Text	2

TITLE-ABS-KEY(("innovation management" OR "continuous innovation" OR "evolutionary innovation" OR "incremental innovation" OR "discontinuous innovation" OR "revolutionary innovation" OR "radical innovation" OR "transformational innovation" OR "disruptive innovation") AND ("npd" OR "new product development"))	
Date	09-07-2012
All journals	194
Top 10 TIM	84
Title / Abstract	22
Available utwente account	22
Full Text	17
TITLE-ABS-KEY(("exploration" AND exploitation) AND (bmp OR "business process model*" OR "activity model*"OR workflow OR "business process" OR "process model?ing"))	
Date	09-07-2012
All journals	14
Top 10 TIM	0
Title / Abstract	0
Available utwente account	0
Full Text	0
TITLE-ABS-KEY(("research and development") AND ("workflow" OR "process modelling" OR "business process" OR "business process model*" OR "BPM" OR "business model"))	
Date	18-07-2012
All journals	194
Top 10 TIM	84
Title / Abstract	22
Available utwente account	22
Full Text	17

Appendix E: A peek into innovation

History

At the beginning of the 20th century the first research laboratories were founded. WOI and WOII gave a boost to the interest in the use of scientist in industrials started (Brockhoff et al., 1997; Trott, 2005). But it wasn't until the late 1960s that researchers looked into the management of R&D (Rosenberg, 1982). This interest increased when the importance of R&D for competitive advantage was recognized (Brockhoff et al., 1997). Since then the perspective on R&D has changed throughout the years (Nobelius, 2004). Rothwell (1994) represented these developments into five generations of R&D management. Table 6-2 gives an overview of these generations.

Table 6-2: Generations of R&D management based on (Bullinger, 2008; Nobelius, 2004; Rothwell, 1994; Trott, 2005)

R&D generation	Period	Type of model	Characteristics
First generation	1950 – mid 1960s	Technology push	Simple linear sequential processes, emphasis on R&D
Second generation	mid 1960 – early 1970s	Market pull	Simple linear sequential processes, emphasis on marketing
Third generation	mid 1970s – mid 1980s	Coupling model	Sequential but with feedback loops, combination of push-pull
Fourth generation	early 1980s – mid 1990s	Interactive model	Emphasis on integrating R&D and marketing
Fifth generation	mid 1990s onward	Network model	Emphasis on external linkages

Meanwhile a sixth generation with a re-focus on research is proposed by Nobelius (2004). Although to some the classification did not reach general validity (Brockhoff et al., 1997) , the generations give a structured overview of developments during the last period.

The importance of R&D is recognised as an enabler of competitive advantage (Brockhoff et al., 1997), nevertheless, in times of crisis R&D are often the first to suffer from cutbacks on resources (Brockhoff & Pearson, 1998). A short term solution is the chosen instead of a long

term. One of the reasons for this is the difficulty to determine the value creation of R&D. Only a few of all the initiated projects become successful.

Research & Development (R&D), Technology management, innovation, (new) product development (NPD)

In literature a lot of terms are coined on this topic (Gaynor, 1996). The boundaries between terms like technology management, R&D management, innovation management and (new) product development are hazy. Although there is a lot of overlap Verloop (2006) states that these are different activities with different objectives and purposes. In this section these different terms are described and their relations are explained. This allows the reader to position this research within the existing research on R&D and provides a mutual understanding.

Research and Development

Roussel, Saad, and Erickson (1991) define R&D as the development of new knowledge and the application of scientific or engineering knowledge to connect the knowledge in one field to that in others. The definition reflects the complexity of scientific knowledge and that it is difficult for a company to be the technology leader of all the technology used in its products (Sushandoyo & Magnusson, 2012; Trott, 2005). A recent and pungent example of this is the outsourcing of screens to Samsung by Apple for multiple products.

To provide a better understanding of R&D instead of only a definition, an explanation of the operations that build up R&D is more sufficient. Common R&D operations are basic research, applied research, development and technical service (Trott, 2005)[4]. Trott (2005) describes these R&D operations as following. Basic research involves work of general nature intended to apply to a broad range of users or to new knowledge about an area. Applied research uses basic research for the solution of a problem. Development is the application of known facts and theory to solve a particular problem through exploratory study. And technical service focuses

[4] A similar classification is offered by Pappas and Remer (1985), who classify R&D operations as basic research, exploratory research, applied research, development and product improvement.

on costs and performance improvements to existing products, processes or systems. Figure 6-1 gives an indication of the place of these R&D operations.

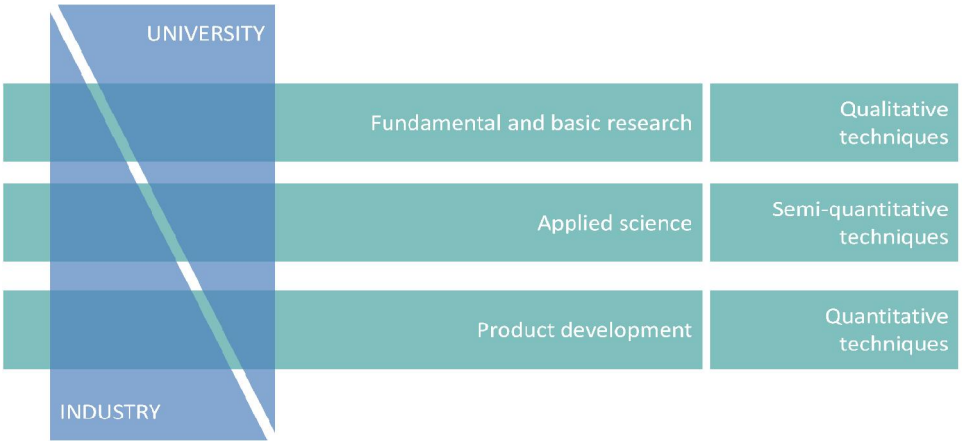


Figure 6-1: Classification, place of R&D, measuring R&D (based on Pappas & Remer, 1985; Trott, 2005)

Figure 6-1 shows that the emphasis of industrial R&D has a stronger focus on the development side then on the research side. This is in line with the industry's purpose to grow and make profit, which can be achieved through the development of new products and new businesses (Trott, 2005). Figure 6-1 shows which measuring techniques for R&D productivity are used as well in the different stages. However, according to Pappas and Remer (1985) this must be interpreted as a general trend and that exceptions are possible.

Technology management

There is an overlap between technology- and innovation management (Brockhoff, 1992), which often gives a confused view of these terms. It appears that within the literature there is no clear divided line between the two disciplines. Bullinger (2008) offers a overview of references which states that technology management covers decisions on the strategic and operational selection, procurement, maintenance and exploitation of novel and existing technological competences of the firm, covering their entire lifecycle. In other words, technology management is about an organization's interaction with its external and internal technological environment. Examples as such are licensing, acquisition of external knowledge and R&D.

Innovation (management)

While technology management has a strong focus on technology, innovation management has a more organization wide focus. Trott (2005) sees innovation as a management process by defining innovation as the management of all the activities involved in the process of idea generation, technology development, manufacturing and marketing of a new (or improved) product or manufacturing process or equipment. Examples of innovation management are processes such as new product development and new process development. By managing innovation, the right conditions are set to ensure that the company as a whole is given the opportunity to develop new products (Trott, 2005).

Before (new) product development is described, the different degrees of innovation should be explained. In this research the terms incremental and radical innovation are used, but there is no consensus in literature on this terminology. Incremental innovation is interchangeably used with continuous (Veryzer Jr, 1998) and evolutionary innovation (Verloop, 2006). Radical innovation is used as well as discontinuous (Veryzer Jr, 1998) revolutionary (Verloop, 2006) and breakthrough (McLaughlin, Bessant, & Smart, 2008) innovation, which again is interchangeable. The distinction between incremental and radical change can be traced back to 1942 when Schumpeter (1994) states:

"We have seen that the function of entrepreneurs is to reform or revolutionize the pattern of production by exploiting an invention or, more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way…"

In which he basically describes the fundament of radical innovation. Later on in that paragraph he distinguishes incremental innovation as:

"…down to such things as making a success of a particular kind of sausage or toothbrush"

Ali (1994) defines incremental products as product line extensions or modifications of existing products and radical products as technical breakthroughs. Radical products often are unfamiliar to the market which results in a high level of uncertainty concerning their technological and market feasibility (Ali, 1994; Verloop, 2006; Veryzer Jr, 1998). In incremental innovation one knows the customer and in radical innovation one does not (Verloop, 2006). An example as such for radical innovation is the first Apple Iphone, where following generations

can be seen as incremental innovations. Verloop (2006) provides an overview of the characteristics between inside-the-box and outside-the-box innovations, which he links to incremental and radical innovation (Table 6-3).

Table 6-3: Overview innovation characteristics

Inside-the-box	Outside-the-box
Improving existing value chains	Creating new value chains
Incremental innovation	Radical innovation
Operates at product strategy level	Operates at company strategy level
Managed and funded by business unit	Steered and funded corporately
A 'must-do' activity	Strategic option
Significant, but identifiable risks	High and unknown risks
Done for growth and profit	Aims at robustness and continuity
In-house development	Developed with partners

As a consequence of this distinction Verloop (2006) concludes that these innovations need to have separate business processes. This is in line with literature, where there is consensus that the new product development (NPD) process for incremental innovation needs to be managed differently than the NPD of radical innovation (McDermott & O'Connor, 2002; Rice, O'CONNOR, Peters, & Morone, 1998; Veryzer Jr, 1998). Table 6-3 offers some insight in the competitive advantage for a company as well. Inside-the-box mainly focuses on the short term and outside-the-box to the long term. To keep an organization running, incremental innovation is needed, but to stay ahead of competitors, radical activities should be there as well (McLaughlin et al., 2008).

(New) product development (NPD)

The process that takes product development activities from idea generation to market launch is an important factor influencing a firm's innovative performances (Griffin, 1997). As mentioned before, the NPD process for incremental innovation needs to be managed differently than the NPD process for radical innovation (McDermott & O'Connor, 2002; Verloop, 2006; Veryzer Jr, 1998). Some authors state that these processes cannot exist together within an organisation and suggest that radical innovation needs to be stalled at spin-offs (Birkinshaw & Gibson, 2004). However, most authors recognise the distinction but do adhere that these processes can exist

side by side (McLaughlin et al., 2008). The NPD process for radical innovation is nonlinear, stochastic, highly explorative and experimental, involving probing and learning rather than developing (Rice et al., 1998). In literature there are various process models that describe how firms develop products (Cooper & Kleinschmidt, 1986), but the basic progression of activities are similar (Veryzer Jr, 1998). Most of research on NPD is focused on incremental innovation (McDermott & O'Connor, 2002; Veryzer Jr, 1998), but in the last decade the focus shifted towards radical innovation as well.

Relationships and boundaries

In this section the terminology is explained. The mutual relationships have become clear within lines, but for the sake of clarity an overview is given. Figure 6-2 illustrates the relationship and boundaries of R&D management, technology management and innovation management according to Brockhoff (1992).

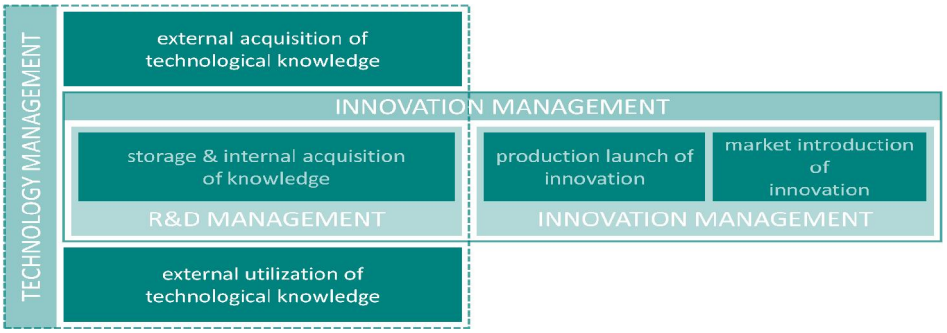


Figure 6-2 Boundaries of technology-, innovation-, and R&D management (based on Brockhoff, 1992; Bullinger, 2008)

Brockhoff (1992) defines R&D management as a part of technology management, concerning the storage and internal acquisition of knowledge where technology management concerns the procurement of external knowledge as well, which is in line with Bullinger (2008). Brockhoff (1992) defines R&D as a part of innovation management as well, allthough innovation management can exist without the existence of R&D. Brockhoff (1992) offers a clear view on the relationships between technology-, R&D- and innovation management, but does not take NPD into account in this representation. Following the earlier writings on NPD, this is part of the innovation process and may or may not involve R&D.

Appendix F: Interview Guide

Introduction

- To record or not to record:
  - Personal evaluation expert interview
  - Transcription, Atlas.TI
  - No direct quotations
  - Privacy
- Any Questions upfront?
- Can you give short introduction /

1

Structure

- *Introduction (~5 minutes)*
- Presenting research (~15 minutes)
- Questions semi-structured (~30 minutes)
- Evaluation of interview (~5 minutes)
- *Extra time (~5 minutes)*

2

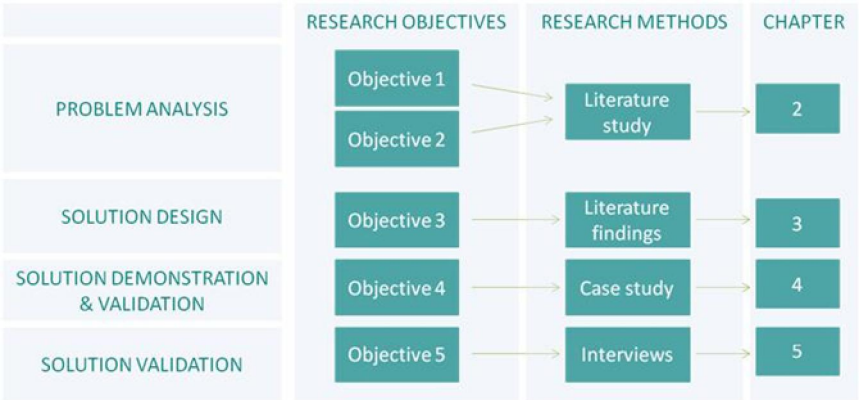
Goal Thesis

Research question:

How to build a business model for a research and development organisation?

- Goal from scientific perspective
  - Design/tailor the business modelling method for R&D
  - Demonstrate and validate this method by case study
  - Validate by expert interviews
- Goal from business perspective
  - Give insight in the cost structure of Technology and NPD on stage level.

1



4

Definition

*"**A business model is a simplified representation that counts for the known and inferred properties of the business or industry as a whole**, which may be used to study its characteristics further..."*

*"A business model is a simplified representation that counts for the known and inferred properties of the business or industry as a whole, **which may be used to study its characteristics further..."***

5

Business Modelling Method

Meertens et al. (2011) proposes a method which enables the development of business models in a structured and repeatable manner.

Step	Inputs	Techniques or Tools	Deliverables
Identify Roles	Documentation, domain literature, interviews, experience, previous research	Stakeholder analysis (Pouloudi & Whitley 1997)	Role list
Recognize Relations	Role list, Stakeholder map, value exchanges	e3-value (Gordijn 2002)	Role-relation matrix
Specify Activities	Role-relation matrix, Role list, business process specifications	BPM methods, languages and tools	List of activities
Quantify Model	Process specifications, accounting systems and annual reports	Activity based costing	Total cost of the business "as-is"
Design Alternatives	As-is business model, Ideas for innovations and changes	Business modelling method (steps 1 to 4), Brainstorming	One or more alternative business models
Analyse Alternatives	Alternative business models	Sensitivity analysis, technology assessment, interpolation, best/worst case scenarios	Business case for each alternative

6

R&D Characteristics

- Project Oriented
- Managing Activities (Radical vs Incremental Innovation)
- Risk Management
- Cost Management
- Value
- External Linkages

7

Business Modelling Method R&D

1. Identify Roles
   - Stakeholder analysis (Elias, 2002)
   - Stakeholders' dynamics
2. Recognise Relations
   - e3-value model
   - Value exchange
3. Specify Activities
   - Stage Gates System (Cooper, 2008)
   - Managing activities
4. Quantify Model
   - Job costing

8

Heeft u vragen naar aanleiding van deze uitleg?

9

Wat zijn de sterke punten van deze methode?

10

Wat zijn de zwakke punten van deze methode?

11

Denkt u dat deze methode toepasbaar is bij R&D organisaties?

12

SE BLADES

Bedankt!

SE BLADES

Back-up vraag:

Wat vindt u van de gekozen technieken?

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