MASTER

From idea to investment
how to organize the sustainable campus of tomorrow?

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FROM IDEA TO INVESTMENT:
HOW TO ORGANIZE THE SUSTAINABLE CAMPUS OF TOMORROW?

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SUMMARY

Energy-efficiency of higher education institutes is an international problem, pronounced in different levels of governance. On European level the Directive 2006/32/EC, on national level the Dutch Long-term Agreement MJA3 and on university level the Energy Policy Statement of the TU/e Board. However, despite the implementation of new policy at the TU/e, consultancies, as well as internal actors, have been critical on the organizational execution of it. Thus, even though the TU/e possesses aspects traditionally required for innovation in the field of energy-efficiency (ambition, capital access, scale, long-term strategy & knowledge) and is internationally leading in technologic research, they struggle to live up to their potential. Therefore the research question is formulated as:

“What are the critical points within University organizations that limit investments in energy-efficiency, and how can they be solved?”

Policy of the Dutch government is solely based on top-down research. Top-down research can only be used to illustrate the need of governmental intervention, by estimating attainable economic value through investment in energy efficiency. As a result the current policy, the MJA-3 focusses on awareness and monitoring and has been proven costly, without achieving a significant result.

In order to develop a specific policy design that is efficient and effective, knowledge on the internal behavior of organizations is necessary. This knowledge is best acquired with bottom-up research in the form of case-studies. Unfortunately the current scientific field is lacking in these types of researches. It appears most universities have only just formulated their sustainability goals, and therefore the scientific field is equally behind. In addition, a gap exists between experts on energy efficiency and organizational science.

The existing case-studies do not provide a structured methodology to repeat and compare with other cases. Therefore, the current state of the art can best be improved by developing a standard methodology for improving the development process of innovative investment proposals in campus estate energy-efficiency.

The methodology developed in this research is founded on the field of Business Process Management, New Product Development, Strategic Decision Making, Case-Study Research Methodologies, Case-study research on Sustainability in Higher Education.

Assuming a clear problem description and case selection, the methodology is centered on:

- **Identification of the process steps**, with data gathered from interviews and policy documents.
- **An added-value assessment**, according to the process performance criteria.
- **A risk assessment**, according to the probability and impact of expected risks.

The output of the analysis will be used for a redesign of the low-value steps and reduction of risks during the whole process; followed by the implementation, monitoring and optimization of the solution.
The key to standardization is developing a default protocol for the Definition, Added-Value Assessment and Risk Assessment (shown in TABLE 3.3, 3.4 and 3.5). During the definition the process will be broken down in standard behavioral routines. The routines will be rated according to a standard list of performance criteria and risks during the assessments. The case can then be compared to other studies using the same building blocks.

The development of investment proposals starts with the recognition of a problem and the opportunity to act on it, followed by a diagnosis of the problem, the development of the proposal and ending with an authorizing decision. There are likely additional routines to support the process; such as a quality control/rework cycle, validations and additional authorizations. During the case-study it appeared that a Hand-over routine, not mentioned in literature, plays also an important role. This routine describes the hand-over from responsibility at the end of a process step from one actor to the next.

Traditional performance criteria of a process are cycle time, process cost, quality and risk sensitivity. The quality of a process can be divided in internal and external quality. Internal quality is related to the satisfaction of the process participants. External quality is related to the satisfaction of the client, which is in this case the Executive Board of the University.

Organizational risks have their roots in the flaws of individuals. Individuals are limited by Personal Values, Limited Cognitive Capacity and Inertia. A certain amount of inefficiency is to be expected. Individuals try to overcome their limits by forming organizations. Organizations are then structured by the principal-agent relations of individuals. In these relations, risks occur on the aspects of:

- Information Distribution
- Quality Management
- Decision-Authority Allocation
- Strategy Management
- The budgeting structure

These risks increase the chance that the best option according to the employed decision criteria is not chosen, leading to loss in performance or total process failure.

In abstraction, the process at the TU/e is determined by the Project Team, the Department Management and Top-Management. The development of ideas can be considered as ‘emergent’. Plans are started locally at project teams and work their way to the top.

Two factors stand out. First, the existing process structure is still in its grassroots stage. Organizational relations are informal and formed when the need occurs. As no predetermined plan exists, actors had different expectations on the process structure and decision criteria when they collaborated. Especially the process phases where the project team and department management needed to collaborate where nominated for improvement. The existing ambiguity severely increases the organizational risks, which can have severe impact on the development of the proposal.

Second, likely unique to the TU/e, is competition among investment proposals. The university employs a maximum of 14% of the turnover in campus estate investment. As for
the upcoming years budget is mostly spend in the current redevelopment, only a few proposals will be accepted. Therefore there is a high risk a proposal is dismissed even though it is a valid option. The development costs are then lost without returning profit.

The objective is to reduce both problems mentioned above, ideally with a re-design of the collaboration moments, as those were rated as weakest. The measures are designed to reduce the ambiguity during decision making and secondly to move the proposal competition to the start of the process such that unnecessary development is avoided.

It is proposed to:

**IMPLEMENT A STRATEGY DATABASE**, containing the goals, decision criteria, process plan, legal & finance rules and a “Hand-over Form”. The hand-over form is a quick overview of the proposal and makes them easy to compare. The database ensures all staff strives for the same objectives.

**IMPROVE THE CASE ADMINISTRATION.** In innovative processes there is a constant flow of new information. To prevent decision making with outdated or missing information an effective administration is necessary. The administration could be centered on the hand-over form.

**REACH AGREEMENT** on the strategic documents and process plan before the actual process starts. Ultimately it is the decision of the client how the process is structured. But the case-study has proven that clarity and agreement between actors is essential.

**IMPLEMENT ANNUAL DEVELOPMENT SCHEDULING.** Currently, there are far more ideas being developed than there is budget for. It is proposed to hold a meeting at the beginning of the year in which all ideas are contributed. In the meeting will be decided which ideas are most eligible considering the university strategy. This reduces competition at the end of the process and prevents unnecessary development costs.

It is not recommended to just copy the conclusions to other cases. Cases are unique and the solution is custom-made. Risks to the TU/e might not occur at other cases. Rather, it is recommended to obtain the knowledge presented. The principal objective of this research has been to develop a methodology that is re-usable for other cases. The methodology can be used to quickly improve the implementation capacity of other organizations.

As for the governmental policy, it is recommended to reduce the administrative burden of the MJA3 program and instead focus on education on “how to implement technology”. Additionally, it is contradictory to spend money on policy, while the universities are still in the lowest energy-tax class.

The research has been a major step to promote the importance of organizational design and strategy in the path to an energy-efficient nation. This thesis has been a means to convince the reader that:

> “**BY DESIGNING A BETTER ORGANIZATIONAL STRUCTURE, COMPANIES CAN INCREASE THEIR ABILITY TO ADAPT ENERGY-EFFICIENT INNOVATIONS AVAILABLE ON THE MARKET; AND THEREBY INCREASE THEIR OWN AND NATIONAL ECONOMIC VALUE.”**
# Contents

1. Research Outline ........................................................................................................... 1
   1.1. Introduction ............................................................................................................. 1
   1.2. Problem Description .............................................................................................. 1
       1.2.1. Problem Statement .......................................................................................... 2
       1.2.2. Problem Owner ............................................................................................... 2
   1.3. Research Question .................................................................................................. 2
       1.3.1. Sub-Questions ................................................................................................. 2
   1.4. Relevance ................................................................................................................ 3
   1.5. Research Design ..................................................................................................... 3
       1.5.1. Objectives ......................................................................................................... 3
       1.5.2. Boundaries ....................................................................................................... 3
       1.5.3. Design ............................................................................................................... 4

2. The Current State of the Art & Society ......................................................................... 7
   2.1. Top-down Science .................................................................................................... 7
       2.1.1. Deficiencies ...................................................................................................... 7
   2.2. Bottom-up Science .................................................................................................. 9
       2.2.1. Deficiencies ...................................................................................................... 9
   2.3. Application in Dutch Society ................................................................................... 10
   2.4. Conclusion ............................................................................................................... 11

3. Design for a new standardized Methodology ............................................................... 13
   3.1. Organizational Science .......................................................................................... 13
       3.1.2. New Product Development .......................................................................... 13
       3.1.3. Strategic Decision Making .......................................................................... 14
   3.2. Methodology Design .............................................................................................. 14
   3.3. Case Study Selection .............................................................................................. 16
       3.3.1. Definition ......................................................................................................... 16
       3.3.2. Selection .......................................................................................................... 16
   3.4. Process Performance Criteria ............................................................................... 17
   3.5. Data Gathering ....................................................................................................... 18
       3.5.1. Multiple sources of evidence ...................................................................... 18
       3.5.2. Data Review ................................................................................................... 18
       3.5.3. Chain of evidence ........................................................................................ 18
       3.5.4. Data-Base / Research Administration .......................................................... 18
       3.5.5. Interview protocol ......................................................................................... 18
   3.6. Process Identification ............................................................................................. 18
       3.6.1. Designation ..................................................................................................... 19
       3.6.2. Prioritization .................................................................................................. 20
       3.6.3. Protocol .......................................................................................................... 20
10.2. Valorization options ........................................................................................................75
10.2.1. Consultancy & Presentations.................................................................................75
10.2.2. MJA3 platform .........................................................................................................75
10.2.3. publication ................................................................................................................75
10.3. Further Research .........................................................................................................76
1. RESEARCH OUTLINE

1.1. INTRODUCTION

It is a paradox; the world smartest region fails to implement what they promote: sustainability and energy-efficiency through innovation. The Technical University of Eindhoven struggles with the use of PV-Panels, which are continuously innovated by their professors. But what is maybe most strangely is that, with exception of the responsible department, many of the professors, students, PhD’s and other staff do not recognize it as a scientific problem.

It seems that it is commonly accepted as a characteristic of a governmental institute. Arguments heard during my research are: “Universities do not have the financial means”, “The board lacks vision”, “There is too much bureaucracy to make innovation possible”, “Governmental workers only care about their own task”, “Professors should fix problems that matter, not internal problems of the university”.

This research is the first attempt at this university, to look past the easy assumptions, and to scientifically dissect the problem. I invite you to read on, because as a university we can only change the world if we know how to change ourselves.

1.2. PROBLEM DESCRIPTION

Energy-efficiency of higher education institutes can be indicated as an international problem, given the number of knowledge centers, governmental policy programs, scientific publications and journals regarding this theme. Most importantly, the European directive (THE EUROPEAN UNION 2006) requires member states to take action. Likewise, the energy-efficiency of the Technologic University of Eindhoven (TU/e) is not on the level socially desired, apparent by the necessity to participate with the Dutch governmental Long-term Agreement Program, MJA3, (AGENTSCHAP NL 2008) and the outspoken ambition of TU/e Board (COLLEGE VAN BESTUUR 2011).

However, despite the implementation of new policy, two consultancies are both critical on the execution of the policy. Lloyd’s Register noticed the motivated employees, but states the improvement potential is not fully accomplished due to structural flaws in the organizational design (LLOYD’S REGISTER 2013). Similarly, Urgenda praises the ambition and motivation of the university, but concludes structure and coherence is missing on the organizational level. In addition, proposed measures have a limited energetic impact and seem to be mainly driven by esthetic and financial arguments (URGENDA 2011). From data provided by internal reports can be deducted that the university did not achieve the interim targets of 2006 (DIENST HUISVESTING 2009) and will struggle to complete the final target of 30% efficiency over the period 2005-2020 (DIENST HUISVESTING 2012). This is confirmed by the university’s responsible energy manager, stating that after the quick gains in the early years, the transition to a long-term approach is found to be difficult.
The external and internal reports as well as conversations with actors give reason to believe organizational problems reduce the effectiveness of the TU/e to implement energy efficiency measures. Thus, even though the TU/e possesses aspects traditionally required for innovation in the field of energy-efficiency (ambition, capital access, scale, long-term strategy & knowledge) and is internationally leading in technologic research, they struggle to live up to their potential.

Furthermore, the governmental program, MJA3, established to help organizations in this struggle, seems to fail as well. The latest review on the effectiveness of the MJA3 program concludes that the program has had only limited effect to the improvement of energy-efficiency among participants. Moreover, the overall costs-to-effect ratio of the MJA3 is relatively high for participants and government due to high operating costs and administrative burden (ECORYS 2013).

1.2.1. PROBLEM STATEMENT
- The Technical University of Eindhoven struggles to implement energy-efficiency.
- The Government is incapable of providing help.

1.2.2. PROBLEM OWNER
- SOCIETY, represented by the government, has need for an energy-efficient nation. In addition, society benefits from economic profit for the university as it is a public institute.
- THE TECHNICAL UNIVERSITY OF EINDHOVEN, profits directly from energy-efficiency and indirectly by reputation.

1.3. RESEARCH QUESTION
Following the problem description, the research question is formulated as:

“WHAT ARE THE CRITICAL POINTS WITHIN UNIVERSITY ORGANIZATIONS THAT LIMIT INVESTMENTS IN ENERGY-EFFICIENCY, AND HOW CAN THEY BE SOLVED?”

1.3.1. SUB-QUESTIONS
- “HOW DOES THE STATE OF THE ART AFFECT SOCIETY AND HOW SHOULD IT BE IMPROVED?”
- “HOW CAN ORGANIZATIONAL PROCESSES BE ANALYZED?”
- “HOW CAN THE METHODOLOGY BE STANDARDIZED FOR REPEATABLE USE?”
  - “How does the standard development process of an investment proposal look like?”
  - “What are the performance criteria of a process?”
  - “What are organizational risks to the process, according to theory?”
- “HOW IS THE PROCESS ORGANIZED AT THE TU/E AND WHAT ARE ITS CRITICAL POINTS?”
- “HOW CAN THE PROBLEMS BE SOLVED?”
- “CAN CONCLUSIONS BE GENERALIZED?”
  - “Can the conclusions be used to improve the governmental policy?”
1.4. RELEVANCE

Energy and sustainability are most known by their link with climate change. Global climate conferences have been held on climate change with some limited results in the form of non-binding agreements. Recent legislations of the European Union on sustainability and environment have had more impact, as member states monitor each-other and the European court of justice has power to overrule national legislation. Although the latest EU directive 2006/32/EC is still of voluntary nature, member states recognize energy will become an issue on the short term. The major concern of the directive is the security of supply (The European Union 2006).

Indeed, events in the recent years have increased the pressure to gain energy independence and security; The growing number of people incapable of paying the energy bill, earthquakes in Groningen, the nuclear disaster in Japan and the consecutive decision of Germany to close nuclear power plants, the Arabic Spring and the currently most defining: the incapability of the EU to force economic sanctions on to Russia in response to the Ukrainian crisis, due to gas dependency.

Thus energy is a key subject in environmental, economic, social and diplomatic political issues on national and international level.

1.5. RESEARCH DESIGN

1.5.1. OBJECTIVES

The TU/e pursues research that contributes to society, industry and science (Technical University Eindhoven 2013). Accordingly, the objective of this research is to contribute to the same fields. This is ensured by choosing a topic, energy-efficiency, which is relevant to society. Secondly, with the research design and analytic tools is strived for a pragmatic quality, such that the TU/e Real-Estate Department is able to implement the new knowledge. Lastly, by developing a standard theoretic model, the case is generalizable and can be compared to similar cases. This makes new knowledge accessible to colleague scientists, who could implement it in to new further research.

1.5.2. BOUNDARIES

The scope of this research is limited to organizational theory and uses the Technical University of Eindhoven as case. The unit of analysis is “Investment proposals for campus estate improvements” and considers the process form idea to the decision to implement the proposal.

The research is done from the perspective of the TU/e Real-Estate Department. Furthermore, energy-efficiency is considered from an economic perspective, not environmental. Lastly, this research only deals with energy efficiency gains through investment projects, not user behavior or chain-efficiency.
1.5.3. **Design**

The aim of the research design is to provide the strategic plan on how to solve the research question and reach the research objectives.

In chapter 2 a review has been done on existing literature on Energy-Efficiency to establish the necessary field of expertise. Chapter 3 presents the tools for analysis, based on Business Process Modelling techniques. In chapter 4 a theoretic standard model for energy-efficient investment processes is developed. The aim of this standard model is to make this research generalizable, such that without much effort the obtained knowledge can be implemented in other cases. Chapter 5 describes the currently known risks to the process. Chapter 6 describes the case at the TU/e, which will be assessed in chapter 7. Eventually the analysis will give us the knowledge to redesign the organization at the TU/e in chapter 8. Then, a conclusion will be made in which the research question will be answered, chapter 9. Lastly, chapter 10 will discuss how to continue in this field of research.

Finally, I would like to emphasize that knowledge is worth very little if it is not implemented.
Research Design

Problem Description & Research Question

The Use of EE Science in Society

Methodology

Theoretic Standardization of EE Investment Processes

Known Barriers to Organizational Efficiency

Case Study: The Investment Process of PV Panels at the TU/e

Added-Value & Risk Assessment

Proposed Solutions

Conclusion (Discussion)

Implementation?
2. THE CURRENT STATE OF THE ART & SOCIETY

In this chapter the state of the art of the scientific field of energy efficiency and its role in Dutch society is established. Its purpose is two-fold. First, literature research is necessary to ask better research questions and to focus the objective (Yin 2009). Second, science should serve society. It is therefore important to know which knowledge is still missing to form effective policy, on company and governmental level.

The field of energy-efficiency can be divided into top-down research, which examines global and national economics, and bottom-up research, which examines behavior of individual companies. Both are examined and compared.

2.1. TOP-DOWN SCIENCE

Ever since society attaches importance to energy-efficiency, scientists, managers and politicians have tried to find ways to estimate the current efficiency and the potential efficiency. The difference between both statistics is known as the “energy-efficiency Gap” first coined by Hirst & Brown 1990. Hirst & Brown used the term after assessing a comparison between projections on energy use in the US, based on a current-trends scenario versus the potential cost-effective scenario (Figure 2.1). From the graph can be deducted that the American economy fails to take full advantage of cost-effective, energy-conserving opportunities resulting in the “Energy-efficiency gap” (Hirst & Brown 1990).

The “energy-efficiency gap” brings two important arguments to politics. First, the graph visualizes explicitly how much economic value is lost by doing nothing. Second, such graphs lie at the basis for the hypothesis that the market on its own is incapable of achieving the most efficient state of economy. Therefore the research of Hirst & Brown breaks with the traditional American philosophy of the liberal market as the ideal economy. It opens up the question if the gap is caused by inefficient markets or inefficient market-actors, such as a university.

But opponents of the research results are skeptical that systematic unexploited opportunities exists, because it represents a case in which business firms, which are often presumed to be economically efficient, make decisions that do not maximize profits. Moreover, they argue that the market has self-healing capabilities as efficient companies will outcompete inefficiency (DeCanio 1998). In other words, they doubt the validity of such scenarios. Several weak points increase those doubts.

2.1.1. DEFICIENCIES

The existence of an energy-efficiency gap is not accepted as an objective fact. Deficiencies in the research methods give room for political discussion and subjectivity. It is therefore necessary to investigate the arguments and counter-arguments to the Energy-Efficiency Gap. The quantitative model introduces accuracy problems and functional problems.
2.1.1.1. ACCURACY PROBLEMS

The Energy-Efficiency Gap is build up from two scientific models: a model to measure the current performance of the economy and a model to predict the potential the economy has. The current national performance can be calculated using energy consumption and manufacturing figures of economic databases. (KOOPMANS & TE VEORLE 2001)

Although data on energy and economic figures are available, the unit of measure and the calculation method can vary. For example, in 2014 the calculation method of the Gross Domestic Product will change due to a revision in the European System of Accounts resulting in an estimated change of 4% GDP figures of the Netherlands, without a change in the real-world situation (CENTRAAL BUREAU VOOR DE STATISTIEK 2014). Such a change has effect on the predicted size of the problem. This example shows the subjectivity of the choice for methodology.

The economic efficiency potential is based on the costs and returns of individual energy saving techniques and a discount rate based on market rates for loans. The use of these data give accuracy problems with “hidden costs” and “heterogeneity” (HIRST & BROWN 1990) (DECANIO 1993) (JAFFE & STAVINS 1994) (KOOPMANS & TE VEORLE 2001). Hidden costs are the extra costs which are not explicitly accounted for in investment proposals, such as transaction, development and information costs, as well as additional risks. Heterogeneity of the...
research population is caused by the fact that not every company is positioned in the same circumstances, such as market access and facility characteristics. Therefore business economists generally use higher discount rates then scientists and thus predict a much smaller efficiency gap (Jaffe & Stavins 1994) (Koopmans & Te Velde 2001). The choice for methodology and the generalization of the research population introduce subjectivity.

2.1.1.2. Functional Problems

Functional problems arise because it is difficult to allocate the data to specific aspects of society. Industries, services and individuals are linked to each-other. The efficiency potential of the sum of single activities is different than the potential of the total chain. Thus, while the model can indicate there is improvement potential in the Dutch economy, the model is of limited use to policy makers if it is unknown where the problems exactly lie in Dutch society.

The purpose of top-down research is to illustrate the size of the economic problem. But the accuracy and functional problems impose serious limits to the usefulness of large scale quantitative research. Moreover, without knowing the causes of the problem political discussion about whether the gap is a socially acceptable level of technology diffusion or if it requires governmental intervention, will stall action. I reason that in order to be able to make effective policy, quantitative market analysis should be complemented by investigation of the workings in day to day business-activities, such as case-studies.

2.2. Bottom-up Science

Bottom-up science is formed by individual or multiple similar case-studies. The need for a case-study arises out of the desire to understand complex social phenomena (Yin 2009). Similar is the need for case-studies in the field of energy-efficiency. Business case-studies can provide an excellent addition as they examine relations between cause and problem (Sorrell & Scott 2000).

2.2.1. Deficiencies

A common concern about case studies is that they provide little basis for scientific generalization. Case studies are generalizable to theoretic propositions and not to populations. Multiple case-studies with the same theoretic propositions are necessary to generalize the conclusions. (Yin 2009)

Case-study methodology in general has backlog in its development compared to other methodologies. A structured methodology is necessary to ensure the reliability of the research and the validity of the conclusion. More over the methodology should be applicable to similar cases so that conclusions can be made generalizable. (Yin 2009) But the existing case-studies do not provide a structured methodology to repeat with other cases.

A problem occurring in case studies in the field of energy efficiency particularly is the cultural regime in science. Top-down research is mostly done by economists. Energy-efficiency investments are examined by engineers and real-estate experts. While the cause
of the problem lies for a significant part in organizational science. For example, in Sorrell & Scott 2000, an extensive number of case-studies is done, but the authors admit the research is limited in treating the organizational aspects, because their team lacked the expertise in the specific field. In turn, organizational scientists have a harder time estimating the potential and need for energy-efficiency. A gap exists between experts on energy efficiency and organizational science. It appears most universities have only just formulated their sustainability goals, and therefore the scientific field is equally behind.

2.3. APPLICATION IN DUTCH SOCIETY

Science already plays an active role in Dutch policy. The Central Bureau of Statistics (CBS) continuously monitors the Dutch economic and environmental situation. With these data the Bureau for Economic Policy Analysis (CPB) builds scientific models to predict the effects of national policy. The Dutch CBS is internationally renowned, but the prediction models suffer from the same problems as mentioned in §2.1.1.

The Dutch government is apparently aware of the limits of top-down prediction models, and has started in 1992 the Long Term Agreement (MJA) with industry and service sector. The MJA is aimed at stimulating a bottom-up culture shift in energy-use. The MJA organization provides a knowledgebase and management tools to businesses to help them implement economical viable energy efficient measures. In addition, the MJA collaboration functions as an experimental ground for the government to analyze the impact of potential new policy. The effects on participant behavior are actively monitored. The advantage of such an experiment is that it creates response from the target group such that weak and strong points of the policy can be discovered. Success creates public support to implement the policy on national level. (AGENTSCHAP NL 2008); (AGENTSCHAP NL 2012)

The latest review on the effectiveness of the MJA3 concludes that the program has had only limited effect to the improvement of energy-efficiency among participants. Moreover, the overall costs-to-effect ratio of the MJA3 is relatively high for both participants and government due to high operating costs and administrative burden (ECORYS 2013). This is a setback for the MJA3 program itself, but it does prove the usefulness of such an experiment. It has prevented costly and inefficient policy to be implemented on national scale. Unfortunately, it is still unclear why the MJA has had such a low success. The review refers to international research on similar covenants and concludes that the workings and effects on businesses are still unclear. The main effect is creating ‘awareness’, but this has been hard to validate. In addition, the participants are unsatisfied about the supplied support tools (ECORYS 2013).

It is unknown how the MJA3 has had effect on the decision-making of participants and how the MJA3 should have effect on their decision-making. Although, the top-down analytics are of good quality in the Netherlands, case-studies are necessary to investigate the why and how of the decision-making of organizations.
2.4. CONCLUSION

Top-down research with national economic figures, can only be used to estimate the national size of the problem. It can be used to illustrate the need of governmental intervention, but not as justification for specific policy design. Although the efforts of the Dutch government are admirable, their policy focusses on monitoring and awareness resulting in high costs with limited effect for both government and business. Effective policy should not only stimulate action among businesses, but focus on removing the causes that limit a business to take action.

Bottom-up research in the form of case-studies to the behavior of organizations is necessary to design an effective and efficient policy. Unfortunately a structured methodology is virtually non-existent, making it impossible to compare the studies and establish founded conclusions. In addition, a gap exists between experts on energy efficiency and organizational science. The objective of this thesis is therefore to make a first leap towards organizational science. A second objective is to provide a standard methodology and model structure, which is reusable for other universities and campus-organizations.
3. DESIGN FOR A NEW STANDARDIZED METHODOLOGY

The next three chapters will provide the scientific base on which the case-study is founded. A new methodology is developed and standardized so that it can be re-used for other case-studies. Case-studies can then easily be compared and conclusions generalized. Chapter 3 will describe the methodology, Chapter 4 will provide a theoretic framework for process structures and Chapter 5 will review common risks to organizational efficiency.

The theoretic fundament will be constructed from leading work in the field of Business Process Management (Dumas et al. 2013), New Product Development (Ford & Sterman 1998); (Cooper 1994), Strategic Decision Making (Mintzberg 1976), Case-study Research Methodologies (Yin 2009), and Case-study Research on Sustainability in Higher Education (Sorrell & Scott 2000).

3.1. ORGANIZATIONAL SCIENCE

In this section the specific organizational theories will be described and why they have been chosen. During the delineation of the methodology references will be made where applicable. But for a deeper understanding it is recommended to read the articles to which is referred.

3.1.1. BUSINESS PROCESS MANAGEMENT

Business Process Management (BPM) is the science of working. It is an efficiency science. The goal is not to change the output of a process but to make it easier, faster and cheaper to achieve it. Organizations that seek to improve processes as a basis for gaining efficiency and customer satisfaction have a significant advantage above non-process oriented organizations (Dumas et al. 2013). Business Process management finds its origin in the manufacturing industry, and therefore the main body of the theory is developed for that area. This is not surprising as the manufacturing can profit greatly from BPM due to the large numbers of similar products. (Cooper 1994) (Dumas et al. 2013)

3.1.2. NEW PRODUCT DEVELOPMENT

‘Regular’ BPM is not suitable for this topic as investment proposals are not standardized manufacturing product, but projects. A project is the development of a one-off product with specific requirements, start and end dates and a budget limit. Project management is the activity of managing and moving the development forward (Lyneis & Ford 2007).

But process management meets project management when multiple projects with similar characteristics are executed in quick succession. This is the case at the TU/e. The campus has such a significant size that the TU/e Real-Estate department is continuously busy with projects for the maintenance and improvement of the real estate. And recently, projects to improve the energy efficiency have been added. The search and development of investment proposals of technologies foreign to the company can be considered as innovation processes. New Product Development (NPD) is an excellent addition to BPM as it is used to design the process that drives the development of ideas towards new products. (Cooper 1994); (Ford & Sterman 1998)
3.1.3. STRATEGIC DECISION MAKING

The TU/e is currently still busy with the change management towards the new sustainable strategy. More over the university is characterized as an informal organization. The result is that there is no pre-determined process structure and past processes are often not administrated. BPM requires a certain basic structure to improve on. The field of Strategic Decision Making (SDM) is therefore used to bring structure in the description by actors of the process.

During a product development process, decision makers meet situational and unprecedented decisions (COOPER 1994). SDM assumes that when faced with a complex, unprogrammed situation, the decision maker seeks to reduce the decision into general purpose routines. I.E. he factors them into familiar, structurable elements (MINTZBERG 1976). The design of the routines should ideally be the same as their typology, such that the process can be constructed from familiar elements. Dependent on the needs of the process routines can be easily added or removed. The routines are cross-referenced with BPM and BNP (See also §x)

3.2. METHODOLOGY DESIGN

Process Management is a process itself. To ensure maximum effectivity a standard workflow is necessary. A workflow of Dumas et al. 2013 is used as basis, but a new improved design is presented in this thesis incorporating the principles of case study research of Yin 2009 and that of BNP and SDM. A quick overview is presented in Table 3.1.
SUMMARY OF METHODOLOGY STRUCTURE

DEFINITION

PROBLEM DESCRIPTION - Process management starts with a problem description and an objective for improvement, (which has been done in chapter 1).

CASE SELECTION - The problem description, describes which process is perceived to be problematic. A past development should be selected as case to examine and base the analysis on. Of course, multiple cases increase the reliability.

DEFINITION OF PROCESS PERFORMANCE CRITERIA - The problem description should be operationalized with performance criteria to define what is desired from the processes.

ASSESSMENT

DATA GATHERING - In order to do the assessment information is necessary from actors and documents. The data gathering should conform certain requirements to ensure reliability of the study.

PROCESS IDENTIFICATION - The processes relevant to the case should be identified and structured such that they can be assessed. The identification phase consists of two steps. The designation of the several present processes and a prioritization of them, to determine on which processes to focus.

ANALYSIS - The processes found in the identification phase are analyzed with an Added-Value Assessment and a Risk Assessment. The assessments are done in collaboration with the client.

IMPROVEMENT

(RE)DESIGN - The process is redesigned to resolve the problematic points found in the analysis. The objective is to optimize the process according to the performance criteria.

IMPLEMENTATION - The next step is to implement the new design. Change management is necessary to minimize the negative impact during the implementation. This will not be discussed in this research.

MONITORING - After implementation the process should be monitored and readjusted. When circumstances change the cycle starts anew. Monitoring will also not be discussed.

Table 3-1: Summary of Methodology Structure. Designed by the author, based on: (Dumas et al. 2013) (Yin 2009)
3.3. CASE STUDY SELECTION

3.3.1. DEFINITION
A case-study has a distinctive advantage to quantitative research when examining a set of events over which the investigator has little or no control, especially when the boundaries between phenomenon and context are not clearly evident. Case studies are generalizable to theoretical propositions and not to populations. This is because case-studies deal with operational links needing to be traced over time, rather than frequencies. The essence of a case study is that it tries to illuminate decisions: Why they were taken and how they were implemented. (Yin 2009)

3.3.2. SELECTION
A preliminary examination of the TU/e organization showed that there are three different areas of sustainability: user behavior, product chain and building sustainability. The TU/e also wields different approaches to investments in existing buildings and the development of completely new buildings. The types of processes are very distinctive between areas and conclusions found in one area are not generalizable to the others. The case of this research is therefore: “Sustainability investments in the redevelopment and maintenance of existing buildings at the TU/e”. Even though there is a technologic difference between energy generation investments and energy efficiency investments, the projects follow the same processes.

Due to time and resource constraints of the research an embedded case is used. The case concerns the development of a proposal for PV-panels at the TU/e from early 2010 to June

---

Figure 3-1 Case Selection
2014. The development of the proposal was not yet finished at the time of writing. (FIGURE 3-1) The strength of an embedded case is that allows for detailed examination, but the conclusions are only generalizable to the case. Ideally multiple cases should be investigated to increase the reliability of the conclusions. However this can only be done if someone is willing to invest in further research.

3.4. PROCESS PERFORMANCE CRITERIA

Traditional performance measures of a process are cycle time, process cost, quality and risk sensitivity. (DUMAS ET AL. 2013);(FORD & STERMAN 1998);(COOPER 1994)

The quality of a process can be divided in internal and external quality. Internal quality is related to the satisfaction of the process participants. External quality is, in commercial production processes, related to the satisfaction of the customer(DUMAS ET AL. 2013). As the research does not concern industrial products, external quality is formulated as the measure to which the output unit, in this case the investment proposal, satisfies the criteria of the decision maker(FORD & STERMAN 1998); (COOPER 1994). Cycle time is defined as the time it takes to handle one case from start to end. Time can be distinguished in processing time and waiting time. Waiting time occurs when process steps have to wait on other process steps. Process costs are the cost involved to complete the process cycle, such as resources, labor costs and consultancy costs.

Risk is equal to probability times impact. There is always a chance an exception to the process occurs. Exceptions are events occurring by internal or external effects, which deviate the process from its regular path. Dependent on the event, a recovery trajectory can be started. (DUMAS ET AL. 2013)

<table>
<thead>
<tr>
<th>Process Performance Criteria</th>
<th>Unit of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Quality</td>
<td>Client Satisfaction</td>
</tr>
<tr>
<td>Internal Quality</td>
<td>Staff Satisfaction</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>Time</td>
</tr>
<tr>
<td>Processing Time</td>
<td>Time</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>Time</td>
</tr>
<tr>
<td>Process Costs</td>
<td>Euro</td>
</tr>
<tr>
<td>Risks</td>
<td></td>
</tr>
<tr>
<td>Probability</td>
<td>Probability factor (1/Time)</td>
</tr>
<tr>
<td>Impact</td>
<td>Client Satisfaction, Staff Satisfaction, Euro or Time</td>
</tr>
</tbody>
</table>

Table 3-2 Process Performance Criteria
3.5. DATA GATHERING

Data is collected during the process identification, Added-Value Assessment and Risk Assessment. The validity of the data is of utmost importance. Misinformation leads to false conclusion. Five important measures should be taken to ensure the validity of the data collection. (YIN 2009)

3.5.1. MULTIPLE SOURCES OF EVIDENCE

Multiple sources of evidence with overlapping areas are necessary to reduce the chance individual perceptions of the source cloud the actual data. The evidence used in this thesis can be sorted in across three types; internal policy documents, external consultancy reports and actor interviews. Three actors with different key positions have been interviewed: The team captain of the project team, a member of the financial department and the secretary of the GC 2020 top-management group.

3.5.2. DATA REVIEW

A review of the data is necessary as the researcher could have interpreted differently than the interviewees intended. Therefore all actors have had the chance to review the outcomes.

3.5.3. CHAIN OF EVIDENCE

The chain of evidence is aimed at allowing the reader and colleague scientists to trace the arguments on which the conclusions are build. For the review of existing knowledge this means of course a reference list, scientists can then trace back to the original articles. For the data-collection it is import that scientists can trace where, when and how the data was collected. Other scientists should be able to replicate the study.

3.5.4. DATA-BASE / RESEARCH ADMINISTRATION

Research administration is the execution of the chain of evidence. The ‘raw’ data should be administrated in a single data-base and it should be accessible to other scientists on request.

3.5.5. INTERVIEW PROTOCOL

An interview protocol ensures the reliability and that no relevant information is accidentally omitted by the interviewer or interviewee. The protocol is the key to the replicability and generalizability of conclusions. A good protocol can be used on multiple cases and can thus be used to compare the data. For this research, and following studies, three interview protocols have been designed; for the Process Identification, the Added-Value Assessment and the Risk Assessment. They are presented and explained at their respective sections.

3.6. PROCESS IDENTIFICATION

The problem described by the researcher or given by the customer is often a symptom of several sub-problems. The aim of the identification phase is to find where these sub-problems are located among the organization’s processes. The identification phase
comprises two activities: The *Designation* of the existing process and a *prioritization* of the processes most important to the analysis (Dumas et al. 2013).

### 3.6.1. Designation

Designation is used to create an understanding of the organization, its processes and the links between them. Designation can be a complex activity as many strands of processes interlink and flow naturally into other processes. (Dumas et al. 2013)

A complete description of every process within the organization surpasses the function of an identification. The analysis should be a trade-off between effort and effect. Therefore three levels of abstraction are used. The analysis starts with a description of the *process landscape* to designate the existing processes. The next step is to zoom in on a particular process and create an *abstract Process Model* and then the *Detailed Process Model*. With each step a decision is made on which processes to prioritize. Thus the identification phase is essentially done three times. (Dumas et al. 2013)

![Figure 3-2: Two approaches to the identification phase.](image)

Left the traditional by (Dumas et al. 2013); right the alternative designed by the author.

As described in §3.1.1, BPM is developed for industrial manufacturing, where a basic process structure is often already in place. Moreover quality detailed process models are attainable to make, because the machinery requires explicit action. However this is quite different at the TU/e. The TU/e has only just started with the first efforts for real-estate innovations and a process structure is not yet in place. In addition, the organization is characterized as horizontal. Colleagues know each other well and use quick-links to bypass the formal structure. In such a case a detailed process model is hard to make as actions are based on intuition and experience rather than a formal structure.

The level of ‘Process Choreography’ is therefore better suitable for analysis. Nonetheless the choreography should be based on actual actions to be reliable. But due to the informal structure and long time horizon of 4 years, actors had a hard time to recall the structure and
reasoning of detailed actions. Therefore an alternative approach was necessary (Figure 3-2). In §4.2, a theoretic fundament of behavioral routines is created to found the Process Choreography on. The theoretic fundament greatly improves the reliability of the research and makes the approach easily repeatable and comparable to other cases.

3.6.2. Prioritization

Prioritization is necessary such that the effort of process management is spend on the processes that most need it. Prioritization is done after the designation of each level. Criteria for prioritization are Importance, Dysfunction and Feasibility. (DUMAS ET AL. 2013)

Importance is related to how essential the process is in achieving the strategic goals of the company. It is represented by the external quality and internal quality. But also by the relative size of the process costs and duration compared to others. Processes with a higher degree of dysfunction profit more from attention. Indicators for dysfunction are a high risk sensitivity and a low value to costs ratio. Lastly an estimation should be made on how susceptible the processes are to changes to determine the feasibility of process management. The prioritization can be seen as an estimate of where the analysis phase will net the best results.

3.6.3. Protocol

The interviewee is likely to tell an unstructured story when asked about his experience on the process. The purpose of the identification protocol is be able to structure the process story in behavioral routines as explained in §4.1.3. In addition the protocol ensures that essential information will not accidentally omitted.

<table>
<thead>
<tr>
<th>Process Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client: Contractor: Interviewer: Interviewee (code or name): Research Code: Interview Code:</td>
</tr>
<tr>
<td>ID</td>
</tr>
</tbody>
</table>
| 1 ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ...
| 2 ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ...
| Etc. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ...

Figure 3-3: Process Identification Protocol (developed by Author)
The top-bar in the protocol is for the purpose of administration. The most left bar will be used to assign a code to individual process steps. A tag-name can be used to make it easier for the interviewee. The codes will be assigned during the interview, as of course the process is not completely known beforehand. Start- and end-conditions denote the borders of a process step and should be named by the interviewee before assigning an ID-code. Decisions, outputs, and exception occurring in the middle of a process step could indicate that the step should be split-up.

A process-step is defined by its input, purpose, decisions, output and exceptions, as will be explained in §4.1.3. The data acquired, during the identification will be used to construct the existing process structure.

3.7. ANALYSIS

3.7.1. ADDED-VALUE ASSESSMENT

An added-value assessment is a technique aimed at identifying unnecessary steps in a process in view of eliminating them. A step should either add value directly to the product or indirectly by facilitating the process (DUMAS ET AL. 2013). If it doesn’t add significant value relative to the cost of the step, it should be removed or changed. As changing process structures is often intrusive and costly, the objective is to change the steps with the highest priority.

To determine the value of each step an interview is done with the client according to the protocol presented in FIGURE 3.4. In the left column the process steps, identified with the protocol in FIGURE 3.3, are listed. The client will rate each step according to the performance criteria listed in §3.4. Ideally, the rating will be done with quantitative numbers. However, acquisition of quantitative numbers is often not possible or very costly. Therefore the steps will be rated according to the measure of desired change.

<table>
<thead>
<tr>
<th>Added Value Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client:</td>
</tr>
<tr>
<td>Contractor:</td>
</tr>
<tr>
<td>Interviewer:</td>
</tr>
<tr>
<td>Interviewee (code or name):</td>
</tr>
<tr>
<td>Research Code:</td>
</tr>
<tr>
<td>Interview Code:</td>
</tr>
<tr>
<td>ID</td>
</tr>
<tr>
<td>Quality</td>
</tr>
<tr>
<td>Cycle Time</td>
</tr>
<tr>
<td>Costs</td>
</tr>
<tr>
<td>Id-code</td>
</tr>
<tr>
<td>Tag-name</td>
</tr>
<tr>
<td>Client Satisfaction</td>
</tr>
<tr>
<td>Staff Satisfaction</td>
</tr>
<tr>
<td>Processing Time</td>
</tr>
<tr>
<td>Waiting Time</td>
</tr>
<tr>
<td>Finance</td>
</tr>
<tr>
<td>1 ...</td>
</tr>
<tr>
<td>... ...</td>
</tr>
<tr>
<td>2 ...</td>
</tr>
<tr>
<td>... ...</td>
</tr>
<tr>
<td>Etc.</td>
</tr>
<tr>
<td>... ...</td>
</tr>
</tbody>
</table>

Figure 3-4: Added Value Assessment (developed by the author)
3.7.2. Risk Assessment

Even in highly structured processes there is always a chance on exceptions. Exceptions are events occurring by internal or external effects, which deviate the process from its regular path. Dependent on the event, a recovery trajectory can be started (Dumas et al. 2013).

Risk can be defined as the combination of the probability of an event and its consequences. There is the potential for events and consequences that constitute opportunities for benefit or threats to success (AIRMIC/ALARM/IRM 2002). In this research the focus will be on threats only.

A list will be established by the author based on common known organizational risks (§5.3) and case-specific risks occurred in the past (§7.2.1). The list should be customized dependent on the research and/or case. The risks will be assessed by the client according to impact and probability, as shown in the protocol (Figure 3.5). Again, the process steps discovered in the process identification phase are listed in the left column. In the other columns the risks are listed.

<table>
<thead>
<tr>
<th>Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client:</td>
</tr>
<tr>
<td>Contractor:</td>
</tr>
<tr>
<td>Interviewer:</td>
</tr>
<tr>
<td>Interviewee (code or name):</td>
</tr>
<tr>
<td>Research Code:</td>
</tr>
<tr>
<td>Interview Code:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>I/P</td>
</tr>
<tr>
<td>2</td>
<td>.</td>
</tr>
<tr>
<td>etc.</td>
<td>.</td>
</tr>
</tbody>
</table>

Legend

P • I represents Risk = Probability • Impact
P " Probability value between 1-5
I " Impact Value between 1-5

Figure 3-5: Risk Assessment Protocol (developed by the author)
3.8. (RE)DESIGN
It is the objective of the process engineer to design a process which maxes out on the performance criteria. However, an optimum is often not possible, as increasing the performance of one can lead to the decrease of the other. The process engineer should therefore listen to the preference of his client. Furthermore he should take into account the feasibility of the changes within the existing situation. Ultimately, the assessment is based on science, but the design is mainly based on the experience of the engineer.

3.9. IMPLEMENTATION & MONITORING
It is up to the client if the proposed design will be implemented. Implementation involves change management and system monitoring. Both fall outside the scope of this research and will therefore not be discussed. It will of course be an excellent topic for further research.
4. THEORETIC PROCESS TEMPLATE

As delineated in the previous chapter, a process template based on scientific theory is necessary, because a basic structure is lacking at the TU/e and actors have a hard time recollecting events because of the long time horizon.

This chapter is build up in three parts; §4.1 explains the basic BPM notation, §4.2 shows the basic behavioral routines, which have been developed by the author based on theory, and lastly in §4.3 an example is given how a process structure could look like if the routines are connected.

4.1. BPM NOTATION

The purpose of the analytic tools is to support the analytic process. It is of importance to use a standardized toolset. Basing the tool design on an existing toolset has as advantage that the existing set has already been extensively tested, it allows the easy comparing and it prevents that the reader needs to spend effort to learn a new toolset. In this research the toolset of (DUMAS ET AL. 2013) is used.

4.1.1. SYNTAX

BPM uses Information Technology syntax to describe the structures. BPM is often used in automation technology. Using the same syntax allows IT specialists to implement and monitor IT systems in a way that is aligned with the vision that business stakeholders have of the organization (DUMAS ET AL. 2013). Moreover it paves the way for using software modelling in further research, such as agent-based modelling for example. The legend is shown in FIGURE 4.1. Except for the exclusive split, the gateways signs can mainly be ignored as they are mainly a necessary syntax when programming (in other studies).

4.1.2. RELIABILITY

The tools are used to create an abstract representation of the real world. To ensure the reliability there are three guidelines for quality. (DUMAS ET AL. 2013)

4.1.2.1. SYNTACTIC QUALITY

The content of the model should comply with the syntax and rules as defined by the process modeling language in use to ensure structural correctness. Behavioral correctness relates to the system simulation. A correct model should in general never be able to deadlock or livelock. Following these rules helps to make sure that a process can always be interpreted.

4.1.2.2. SEMANTIC QUALITY

Semantic quality is the ability of the model of producing true statements within the considered domain. Moreover the model should contain all processes relevant to the domain. A clear process border is therefore very important for the semantic quality. Validation is used to confirm the trueness of the statements.

4.1.2.3. PRAGMATIC QUALITY

Pragmatic quality is necessary to make the model usable. It focuses on the interaction between model, model-user and the client.
Business Process Modeling Syntax (1 of 2)

Start and End Nodes

| INPUT | Output | Input & Output | The input and output denote the borders of the process. |

Activity

| ACTIVITY | Activity | An activity requires an input, output, actor, production unit, information, resources and tools to be functional |

Actor pool

| ACTOR | Actor | Activities always fall within the responsibility of an actor, denoted by an actor pool |

Data Artifacts

| Document | Contains information. The information cannot change without an activity. A document is dated. |
| Decision criteria | Same as a document. But contains decision criteria necessary for decision making. |
| Case File | Contains documents related to the case. Used in this research as the production unit. |
| Database | Contains documents and files. A database is part of the organizational structure. Actors can 'store' and 'pull' information from the database to ease their activities. |

Links

| Action Path | Denotes the sequences of actions. Implies decision-making on a sub-level. |
| Data Path | Shows the interaction of activities with data artifacts. A data path starting from activities represents the creation of new information. A data path ending at an activity represents the ‘pulling’ of existing information with the purpose of using it during the activity. |

Figure 4-1: BPM syntax, based on (Dumas et al. 2013)
Business Process Modeling Syntax (2 of 2)

**Event Nodes**

- **Message event**: Notification events are used to notify another actor an activity has ended and the receiving actor can start their relating activity.

- **Exception event**: Events causing the deviation of the regular process are called exceptions. Depending on the process design recovery activities can be started.

- **Timer event**: Holds the next activity until a certain time has been passed.

**Gateways**

- **Exclusive split**: Depending on certain conditions the process will follow only one of the action paths. (This split is used for decisions and for pragmatic reasons the symbol defers from that of the other gateways)

- **Exclusive join**: Starts the next activity if an input is received from either input paths.

- **Parallel split**: Splits the unit into two units each following a different path.

- **Parallel join**: Merges two different units into one. The next activity can only be started when all paths have delivered an input.

- **Inclusive Split**: Is used as a parallel split when the number of outputs is not known beforehand.

- **Inclusive Join**: Can merge units, but is not conditional such as parallel join.
4.1.3. Basic Structures

(Figure 4.2)

4.1.3.1. Basic Activity Structure
An input causes an actor to do an activity, leading to an output. It needs an actor to do or oversee the activity. The production unit is the part that has changed during the activity. In addition, the actor needs resources, tools and information to be able to do the activity (Dumas et al. 2013)(Ford & Sterman 1998). Information can be explicit in documents or be knowledge in the mind of the actor. Depending on the pragmatic function of the model, the unit, resources, tools and information can be visually in- or excluded. Resources and tools fall outside the scope of this research and are therefore not displayed.

4.1.3.2. Decision Structure
A decision needs to comply with all rules of the activity structure presented earlier. A decision consists of determination of choice criteria, evaluation in terms of the criteria and the making of the choice (Mintzberg 1976). The choice criteria are represented with the criteria document. The input brings that which will be evaluated. The question represents the ‘formula’ which turns the input into one of the outputs. A decision can only yield one output.

4.1.3.3. Communication Structure
The activity need to comply all rules of the activity structure presented above. Communication is used to start activities under responsibility of other actors. A request activity and a message are used to represent the communication of information and possibly the transfer of the production unit (Dumas et al. 2013). Such an event can be called a “hand-over”. Mintzberg suggests hand-overs represent a certain meta-decision making by one or both the actors. The
structures presented in (Ford & Sterman 1998) and (Cooper 1994) suggests this occurs in development routines (§4.2.3), but it is not known if it happens in other routines too. It is recommended to do further research on this topic.

4.2. BASIC ROUTINES
When faced with a complex, unprogrammed situation, the decision maker seeks to reduce the decision into general purpose routines. In other words he factors them into familiar, structurable elements (MINTZBERG 1976). The several types of routines are presented below and delineated in to BPM syntax by the author. For each routine, first a detailed structure is developed and then an abstraction is made, as the assessment takes place on the choreography level (see also FIGURE 3.2).

4.2.1. RECOGNITION
The need for action is identified by Mintzberg as a difference between information on the actual situation and the expected standard (MINTZBERG 1976). This matches the mathematical expression of goal-seeking behavior of Sterman, which is driven by the (perceived) current situation and the desired situation (STERMAN 2000).

Starting a process is a discrete action. If the accumulation of stimuli reaches an action threshold, the actor will initiate the process. The threshold is determined by the availability of opportunity. A decision maker may be reluctant to act on a problem for which he sees no apparent action, but when an opportunity is matched with a problem, a manager is more likely to take action (MINTZBERG 1976). Thus in the recognition routine (FIGURE 4.3) the actor recognizes he has a need to act and the opportunity to do so.

![Recognition Routine](image)

Figure 4-3: Recognition Routine (developed by author)
4.2.2. Diagnosis

The first step following the recognition is the tapping of existing information channels and the opening of new ones. The issues are clarified and defined. Similarly the opportunities are evaluated. The diagnosis (Figure 4.4) serves as a justification for action and it produces a strategic action plan on how to match opportunities to the problem. (Mintzberg 1976)

To evaluate the opportunities, technologic information is necessary, which can be acquired from internal specialists or from the market by selling parties or consultants. Information on the organization is necessary to develop the action plan. Part of the action plan is a process structure such as developed in this thesis. The process structure should be tested according to the demands of the problem.

In other words, the diagnosis encompasses two feasibility tests; a technologic feasibility test and an organizational feasibility test.

Figure 4-4: Diagnosis routine (developed by the author)

4.2.3. Development

The development (Figure 4.5) is the core of the process. Here the solution to the problem is developed. According to (Mintzberg 1976) development consist of search and/or design activities dependent on the problem. A problem which can be solved with a turn-key solution will only involve a search routine. On the other end of the spectrum is the design of a home-made solution, started when alternatives on the market are not fulfilling.

The type of development activity has effect on choice behavior within the development phase. During the search activity, market alternatives can be compared quite easily, while designing multiple alternatives is costly. Organizations are thus likely to use a smaller set of alternatives in proportion to design activity (Mintzberg 1976). In design activities the symptom of ‘satisficing’ is thus more likely to pop-up. Satisficing means settling for the first
alternative that complies the criteria, rather than continue searching for the best alternative (DeCani 1993).

Throughout the development, actors are conscious or sub-conscious scanning found alternatives and reduce them to the ones most appropriate. Search and design criteria play an active role in the development quality. (Mintzberg 1976)

Figure 4-5: Development Routine (developed by the author)

Figure 4-6: Quality Control Routine (developed by the author)
4.2.4. **QUALITY CONTROL**

Although not mentioned in (Mintzberg 1976), quality control and the rework cycle are the essential structure behind the modelling of Project Management and New Product Development (Cooper 1994); (Ford & Sterman 1998); (Rahmandad & Hu 2010). The quality control is a routine, which can be added to an activity that produces a certain product (Figure 4.6).

In NPD the product is often divided in a number of abstract task units, which are required to complete the product. In the most basic rework cycle a task can have one of three possible statuses: task to be completed, task completed or task approved. An actor completes tasks, but possibly with certain errors. A second actor checks to quality and either approves the task or disapproves it in which case the completed task will be put back in the “tasks to be completed group”. (Ford 1995); (Ford & Sterman 1998)

In this research the quality routine is represented by a decision structure. Generally, a quality control decision has the output paths ‘rework’ and ‘approve’. Ending the process during development could indicate a problematic diagnosis beforehand.

4.2.5. **VALIDATION**

Validation (Figure 4.7) is modelled similar as a basic decision structure. Compared to the authorization routine there is a difference in the political nature of the routine. Validation should be done by an actor independent of involved stakeholders. There should be no occurrence of negotiation, which often occurs during authorization. Negotiation could induce arbitrariness which will decrease the value of the validation process. The validation process is often used to check the financial and legal justification of the proposal.

<table>
<thead>
<tr>
<th>Validation Structure</th>
<th>-Detailed Notation</th>
<th>-Abstract Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Validation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Validation Request</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Validation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Meet Validation Requirements?</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Validation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Request Next Activity</strong></td>
<td></td>
<td>Validated</td>
</tr>
</tbody>
</table>

Figure 4-7: Validation Routine (developed by the author)
4.2.6. AUTHORIZATION

Authorization is modelled similar to the basic structure of a decision (FIGURE 4.8). However, in the real-world the authorization process is not binary. Often political processes play a role when there are multiple stakeholders. Bargaining is used to come to a mutual agreement. What happens is that apparently the decision criteria are not rigid but are molded by the bargaining process during the authorization routine. Thus on some level the determination of criteria follows the making of the choice. (MINTZBERG 1976)

<table>
<thead>
<tr>
<th>Authorization Structure</th>
<th>-Detailed Notation</th>
<th>-Abstract Notation</th>
</tr>
</thead>
</table>

![Authorization Routine Diagram](image)

Figure 4-8: Authorization Routine (developed by the author)

4.3. THEORETIC CHOREOGRAPHY MODEL

In FIGURE 4.9 a simple example is given on how a process could look like in theory once the routines have been connected. It is possible to change the order, although the process always starts with a recognition. It is also possible to have multiple of the same routine. It is quite common to have multiple development phases, when development goes through several departments. The figure 4.9 is an example to show how a total process could look like, but the specific design has no specific scientific value.
5. BARRIERS TO ORGANIZATIONAL EFFICIENCY

Firms do no behave like individuals. A group is a collection of individuals, brought together under a complex set of contracts both written and unwritten (Decanio 1993). Accordingly, the viewpoint of this research is that the total behavior of a company is formed by the aspects of individual behavior and the structure of the relations with each-other. Relations are naturally limited by individual aspects (§5.2). In successful collaborations the limits of the individuals are mitigated by the structures of the relationship (§5.3). Vice versa, faults in these structures can be barriers to optimal decision making.

In this research the principal-agent paradigm will be used to explain the several aspects of professional relationships.

5.1. THE PRINCIPAL-AGENT PARADIGM

Principal-agent relationships exist where the interests of one actor, the principal, depends on the action of another actor, the agent. An individual has multiple of such relations with his colleagues and dependent on circumstances he can be both agent and principal at the same time. Principal-agent problems are given as the primary reason for organizational problems by several review studies (Decanio 1993); (Jaffe & Stavins 1994); (Thollander et al. 2010); (Sorrell & Scott 2000). But at the same time, each review names different aspects of the principal-agent relation. The author of this research has combined the review studies and compared them to sources from organizational theory, specifically to (Mintzberg et al. 1985).

![Figure 5-1 Visualization of different concepts of Strategy (Mintzberg et al. 1985)](image)

Mintzberg reasons that the behavior of an organization is formed by strategy. But at the same time there is tension between leadership plans and what the organization actually does. The first can be called “intended strategy” and the latter “realized strategy” (Figure 5.1). Strategy is defined as a pattern of actions. These actions can be predetermined and deliberate and/or emerge from organization culture and behavior. (Mintzberg et al. 1985)

The viewpoint of emergent and deliberate strategy is key to the management of principal-agent relationships. The principal creates the deliberate part and the group of agents, often subconsciously, the emergent. Most importantly, both of the parties have expertise that the other has not as they have experience with other parts of the organization. A good manager therefore takes the best parts of the deliberate and the emergent strategy. In the extreme, it can be reasoned that good management creates a better realized strategy than intended.
University organizations are characterized often as users of emergent strategies. (Mintzberg & Rose 2003)

The following paragraphs examine the different aspects within the principal-agent relationship.

5.2. INDIVIDUAL BEHAVIOR

5.2.1. PERSONAL VALUES
Decision making can be abstracted as a process of applying decision criteria to presented options. A risk of management is to assume the individual should obtain the same decision criteria as the group. Obviously, personal values are not a barrier to the individual, but personal values can prevent the individual to act according to what is socially desired. Personal values differing from those of the group potentially prevent the group from acting synchronized as they result in conflicting strategies. (De Groot et al. 2001); (Sorrell & Scott 2000)

5.2.2. LIMITED COGNITIVE CAPACITY & BOUNDED RATIONALITY
Human intelligence is limited by the amount of causal relations it can understand, the amount of information it can process and length of period it can predict (Sterman 2000). Humans use heuristic decisions processes, such as rules of thumb, intuition, experience and company policy to compensate these shortcomings. The inaccuracy of these processes lead to possible sub-optimal decisions. Time and attention constraints pressure the situation even more. The limited cognition of humans prevents them from making the most optimal decision in complex situation (Baccarini 1996). They are thus bounded in their rational by their understanding of the situation. (Sterman 2000); (Sorrell & Scott 2000)

5.2.3. INERTIA
Inertia is passiveness in decision-making. It is the preference of individuals to stick to routines. It is in human nature to minimize regret. Once someone has made a small commitment, that person is likely to make a subsequent larger commitment as he is reluctant to admit his mistakes (Sorrell & Scott 2000). Moreover, the outcome of the current techniques and policies in use are known, versus the uncertain outcome of the alternatives, known as ‘strategic rigidity’ (Nisar et al. 2013). The current path will likely have a higher utility as the uncertainty of new choices is negatively valued. Psychologists have shown that the articulation of a strategy locks it into place, impeding willingness to change it. Instead of one individual being able to change his or her mind, the whole system must be redesigned. Inertia of individuals prevents total commitment to act on new opportunities. (Mintzberg et al. 1985)

5.3. PRINCIPAL-AGENT RELATIONSHIPS IN ORGANIZATIONS

5.3.1. INFORMATION DISTRIBUTION
Principal-agent relationships represent a form of asymmetric information. Principals will be unfamiliar with the specific local conditions in which the agent makes his decisions. Similar,
the agent will be unfamiliar with the company-wide circumstances in which the principal makes his decisions (Sorrell & Scott 2000); (Thollander et al. 2010); (Nicolas 2004). The information available to actors must exceed the information requirements implicit in a given solution to make optimal decisions, on principal and agent level (Cebon 1992). Perfect information is not possible because understanding all the details of the total company exceeds the cognitive limit of an individual. In addition, the costs of communicating and deciding on heaps of detailed information is relatively high. An example of consequence is that top management gives low priority to small cost cutting projects, because of the relatively high information transaction costs and decision costs (DeCani 1993). Thus, information gaps between principal and agent prevent optimal decision making.

5.3.2. Quality Management

Quality Management or quality assurance, is the inspection of completed tasks for changes. Changes can arise to correct defects, improve quality or as a response to upstream and downstream changes. The workload for quality management is equal to all tasks that have been finished but not yet checked. Of those tasks a certain percentage is flawed because they do not match the quality criteria. The quality manager needs to discover these flaws and decide if they should be redone. If the flaws are not discovered, they could be carried over to the next phase and cause an exponential increase in flaws, the further in the process. If the quality criteria are unclear the discovery will be less successful. If the quality criteria change during the process it is likely a greater percentage of tasks will not match. (Ford & Sterman 1998); (Ford 1995); (Sterman 2000); (Cooper 1994)

Quality management therefore encompasses the management of quality criteria and the comparison of them with the completed work. Errors in either of the activity could increase the number of flaws exponentially and/or result in rework, costs and delays that could have been prevented.

5.3.3. Strategy Management

When tasks and decisions are delegated there is always a risk the agent will perform differently than expected. As a consequence, there is difference between leadership plans and what the organization actually does (§5.1). Strategy Management is the attempt to optimize the combination of emergent and intended strategy. (Mintzberg et al. 1985)

Perfect control on (intended) strategy is not possible because of the information transaction costs (DeCani 1993); (Nisar et al. 2013). Perfect control is probably not even desired. As stated before, principals make sub-optimal decisions because they miss information of local conditions. The agent is able to make better decisions if his knowledge of the subject exceeds that of the principal. Stringent control structures prevent the agent to act on his information advantage and can potentially force him to choose a sub-optimal alternative. Open control structures prevent the manager from validating the actions of the agent, who may unintentionally deviating from overarching company goals. Thus a relation striking a balance between control and trust will lead to better results than a relation based on perfect control. (Mintzberg et al. 1985); (Thollander et al. 2010)
5.3.4. Decision-Authority

A principal-agent relationship is based on the premises that the principal has the authority to make decisions and the agent will execute them. Authority is gained by the hierarchical structure, but has to be accepted by the agent. The agent needs to trust the principal he has the expertise to make the right decisions and needs incentives (such as financial compensation) to execute the tasks. (Thollander et al. 2010); (Colebatch 2002); (Sorrell & Scott 2000)

As discussed before perfect control, i.e. full decision authority on the principal side, is undesired. Therefore part of the decision authority is delegated by the principal to the agent. The principal trusts that the agent has the correct expertise to make the desired decisions (Mintzberg et al. 1985). Problems arise when one does not trusts the other, leading to conflicts, or when the decision-authority is allocated to the actor with less expertise than the other. Thus, flawed decision-authority allocation prevents the best qualified actor to take the decision.

5.3.5. Split-Incentives

The premise of implementation of technology is that the measure is economically viable; the project has a higher rate of return than competing projects. The budget structure within an organization can reduce the viability of the measure. Universities have typically no arrangement for decentralized accountability of energy costs. The energy costs are usually included in the general budget for operational costs or charged on the basis of space occupied (Schleich & Gruber 2008); (Sorrell & Scott 2000). This situation causes the principal-agent’s split-incentives problem. The central administration (the principal) would like to reduce the energy bill they pay. However, the faculty (the agent) has no incentive to reduce their energy usage as they pay a fixed price anyway. Spending resources on energy reduction without the ability to profit from the result reduces the faculty’s budget and is therefore not economically viable from the faculty’s perspective. The obvious solution would be to decentralize the energy costs, however the costs of gathering and transacting the information with sub-metering are usually found to high.

The above example is the best known example within energy-efficiency. But in reality split-incentives occur in every relationship in which the agent is loyal to two different principals with conflicting interests (Laslo & Goldberg 2008). Collaboration is then only possible with the second principal if the first gives permission. Split-incentives prevent the agent to act to full desire of each principal.

5.4. External Effects

Close examination of effects external to the organization fall not within the scope of this research. Nonetheless they should be taken into account, as they might affect organizational decision-making and research-data. Therefore a ‘quick-list’ of possible events and limits is given. Composed from: (Hirst & Brown 1990); (DeCanio 1998); (Sorrell & Scott 2000); (Thollander et al. 2010); (Gillingham et al. 2009); (Nisar et al. 2013)
LEGAL RESTRICTIONS - Public institutions are typically limited by law in capital acquisition and long-term investments. Moreover city-zoning and safety regulations may permit some technologies.

GEOGRAPHIC ASPECTS - Geographic aspects can limit the effectiveness of technologies. Not all technologies are available in every country or priced equally.

CURRENT BUILDING TECHNOLOGY - The new technology should be compatible with the current technology. In addition it should be compatible with the lifespan of the building.

DISTORTED ENERGY MARKETS - National tax-structures and/or international events affect the energy price, making the return on investment uncertain and possibly too low to be profitable.

LACK OF INFORMATION ON TECHNOLOGY MARKET - The energy-technology market is characterized by the rapid rate of innovation of the product and the infrequent purchases of the buyer. There is a high chance knowledge of the buyer is out of date. There are costs associated with searching and acquiring information on the energy performance of technologies. Because of these costs, consumers may act without full information.

CREDENCE GOODS NATURE OF TECHNOLOGY - It is hard to establish the quality of energy-efficiency technologies before and after purchase. Such products are called credence goods. Beforehand the customer can assess quality only on abstract values based on tests conducted in bounded test-environments, which are impossible to replicate and likely deviate from the real-world. Even after purchase, the quality of the product is hard to establish as a large part of energy usage is tied to factors that vary over time, such as the weather. Credence goods lead to adverse selective behavior of buyers. As buyers cannot select on quality, they will select on secondary aspects such as price and esthetics instead.
6. CASE STUDY IDENTIFICATION

6.1. INTRODUCTION
As explained in §3.6 the process steps should first be identified to be able to assess the problem. The identification will be done on three levels: the process landscape, a process choreography and a detailed process description. As explained before, the last level is replaced by a theoretic study presented in §4.2 and the assessment will be done on the second level.

To support the process identification, additional information is acquired on the involved actors & actor relations, the financial structure and the history of strategic documents. The existing process is most certainly affected by these aspects (§5.3) and it is important to know how.

The acquired information will be assessed in CHAPTER 7.

6.2. ACTOR SELECTION & INTERVIEWS
For the identification of the existing processes three actors have been selected for interviews. The actors have been selected from different parts of the organization to represent the total process. The team-captain of the project-team, a member of the Financial department and a member of the top-management group GC 2020.

All three have been interviewed according to protocol presented in §3.6.3. The results have been cross-referenced to single out contradicting information. In a second interview the participants have been asked to react to the contradictions. The information gathered has been used to construct the organizational structure in §6.3, the process models in §6.4 and the financial structure in §6.5.

After the identification the project team captain has been interviewed two more times for the assessments in §7.1 and §7.2.

After finalization of the research the stakeholders have been contacted again to validate results and conclusions.

The interviews are not available to the public on request of the stakeholders as the interviews might contain sensitive information.

6.3. ORGANIZATIONAL STRUCTURE

6.3.1. CATEGORIZATION
Part of the problem at the TU/e is the complexity of its organizational structure caused by its many stakeholders and sub-division of authority. Actor relations are often informal and formed by mutual needs and social connections.
In order to make the information pragmatically understandable a schematic overlay is used to reduce the complexity. The overlay is the result of an iterative deduction, where actor groups with similar function have been gathered in the same category. In Figure 6.1 the overlay is shown and in §6.2 a description of the actors. Nonetheless the following actor descriptions are quite extensive, but necessary to understand the organizational complexity.

![Figure 6-1 Organization overlay](image)

**6.3.2. Top-management**

**College van Bestuur (CvB)** - The executive board (CvB) is responsible for all administrative matters and the management of the university. The board consists of three members of which one seat has changed in the fall of 2013. Two of the members take also part in group campus 2020. Ultimately, they decide on all investments. Officially this is done separately from GC 2020, but because two members take part in the GC2020 a significant amount of decisions is made in that group. (Dutch Government 2014); (Technical University Eindhoven 2014)

**Group Campus 2020 (GC2020)** - GC 2020 has been founded in 2009 because the CvB and the Supervisory Board agreed the decision making regarding the campus development could be more transparent. (Dienst Huisvesting 2013)

The group consists of:

- Two members of the CvB
- The director of DH
- The director of DFEZ
- A professor as architecture consultant
- A professor as sustainability consultant
- The executive officer of bachelor education
- Two faculty deanes of the faculty buildings in development
The group meets at least ten times a year, a meeting takes 90 minutes. The agenda consists of business cases in development, businesses cases which need a ‘go’ and projects in the implementation phase.

The agenda will be drafted based on the urgency of the requests of business case representatives and the financial size of the projects. Unfortunately, not all projects can be discussed and this could possible result in delays for the specific project. But as the members are highly positioned, a longer duration of the meeting is undesired. Moreover, adding more topics to the agenda will likely decrease the effectiveness.

6.3.3. Department Development Teams

Dienst Huisvesting / Department of Real Estate Management (DHDT) - The Department of Housing & Real Estate management is responsible for the development, maintenance and management of the complete campus and all of its buildings. In figure x is an overview presented of the hierarchy of DH. The organization consists of the sub-departments: real-estate policy, project management and campus maintenance. A project will pass through these departments in the presented order. DFEZ has a unit in DH specifically for controlling real estate investments and related costs allocation. (Dienst Huisvesting 2013)

DH Sustainability Teams - Parallel to the formal hierarchy, there is an additional hierarchy considering the sustainability of the campus. The “sustainability hierarchy” is led by the management team sustainability, which in turn is directed by the Stuurgroep duurzaamheid (SGD), but falls under authority of DH management. The management team is supported adhoc by experts from across the university. Project team are appointed according to four improvement areas mentioned in the MIA3. (Dienst Huisvesting 2013)

The hierarchy consists of people across several departments, but is unofficial. Therefore the relationships between people are formed by trust rather than authority. In addition, the group of people involved is highly fluctuant and is dependent on the expertise and available time of the individual. (Dienst Huisvesting 2013)

Faculty Workgroups - Ideas, plans and research projects at faculties are generally developed by work groups. Those work groups are often established adhoc with volunteers working within the faculty. (Dienst Huisvesting 2013)

6.3.4. Department Management Teams

Dienst Huisvesting Management Board (DHMB) - The management board is formed by the managers of the sub-departments and the director of DH. The DHmb decides which opportunities should be developed in to business cases. The DHmb has a member in the GC2020 and can therefore adjust the strategy of DH to that of the total university. And of course, the DHmb manages the day to day business at DH. (Dienst Huisvesting 2013)

Stuurgroep Duurzaamheid / Strategic Group Sustainability (SGD) - SGD has been founded in august 2012 with the objective to monitor the progress towards the sustainability goal set in June 2012. The SGD is the managing authority on the sustainability groups in Dienst Huisvesting. The group consists of a member of the CvB, the director of DH and several
experts from across the university (Dienst Huisvesting 2012). However, the group only has met once each half a year and since the specific member of the CvB of this group has left the university, the SGD has unofficially been disbanded in the fall of 2013 until further notice.

Faculty Housing Officers - The university has nine faculties. Each faculty has a housing officer acting as the building owner. They are consulted by a building coordinator who is in function in the faculty, but falls under authority of the Department of Internal Affairs. (Technical University Eindhoven 2012b); (Dienst Huisvesting 2013)

The formulation of housing plans is done within the faculty but the execution of housing needs and maintenance are arranged from DH. The faculty therefore needs to request improvements at the DH and is not capable of authorizing real-estate investments themselves. Business cases based on faculty needs are thus developed in collaboration.

6.3.5. Validators

Supervisory Board - The Supervisory Board is appointed by the minister. The supervisory board gives advice and checks the justification of actions, but does not play an active role in the decision making process. They validate the university's actions from a legal perspective. (Dutch Government 2014)

Dienst Financieel en Economische Zaken / Department of Finance (DFeZ) - The department of finance is responsible for the financial administration of both the TU/e as a whole and locally of the faculties. They take part in the development of the business cases by advising on the financial aspect of investments. Secondly, they check the consistency of the business cases. Lastly, they are responsible for the financial planning and control during the implementation phase. Each year, they report the financial statement of the university. They do not make decisions, but are involved for advice and validation.

6.3.6. Internal Advisors

Strategic Area: Energy (SA:E) - In 2011 the Strategic Area: Energy has been formed by the TU/e to focus education, research and innovation. The task will be fulfilled by the Eindhoven Energy Institute, founded in 2010 from previous institutes. One of the main tasks of the EEI is collaborating with the market to start and fund research and development projects. The EEI is involved in the campus development by starting new business cases and acquiring the funds for it. In addition, the director of SA:E has been a regular consultant and contributor to the DHpt with the development of the PV panel businesscase. (Dienst Huisvesting 2012)

6.3.7. External Advisors

During the development of sustainability on the TU/e three consultancies have been involved. They are not actors within the boundary of the university, but their reports did have a significant impact. Therefore a short description.

Urgenda - Urgenda is a non-profit foundation promoting sustainability policy on business agendas. They approach the problem from the perspective of CO2 reduction. They have
created the ‘living lab’ report and the ‘city of tomorrow’ report. (Urgenda 2012); (Urgenda 2011)

DWA - DWA is a construction and building consultancy, who strive for “a balance between user comfort, finance and reduction of environmental impact”. They created the “critical performance indicators” report. (DWA 2013)

Novesco - Novesco is an energy service company (esco). An esco arranges the investment capital and maintenance and energy reduction projects in return for an ongoing fee based on the reduction of the energy bill. Novesco has been involved with the financial aspect of the pv-panel business-case for the roof of the sportscenter. (Novesco 2014)

6.4. PROCESS IDENTIFICATION

As delineated in §3.6 identification on this case will be done on two levels; first on the level of process landscape and second on the level of process choreography. As explained, the assessment of the detailed process models are replaced by a theoretic study in §4.2.

6.4.1. PROCESS LANDSCAPE

The boundaries of the process landscape have been chosen from the start of the strategic development of sustainability in 2010 to the development of the PV business case, because actors indicated that the development of the PV panels might have suffered from the strategic development.

The development of the PV panels at the FLUX building have been excluded, because it is linked to the development of the building itself and follows a different development process.

The purpose of the process landscape is to check whether exceptions in context processes have induced negative effects on the case development process. The landscape is presented in figure 6.2 with a description in table 6.1.

6.4.2. PROCESS CHOREOGRAPHY

The process choreography is build up from the second series of interviews and the routines provided in §4.2. The process steps identified in this phase are the steps which will be used in the Added-Value Assessment in §7.1 and the Risk Assessment in §7.2. The steps are numbered similar as in the assessments. The model is shown in figure 6.3 and the description in table 6.2.
**Process Landscape Description**

**STRATEGY DEVELOPMENT: LIVING LAB**

**2010 Oct.**  The redevelopment of the campus creates opportunity for renewal. GC 2020, DH & CvB agree there is a need for sustainability. They desire to capture this need by composing an “ambition”. A group of 20 professors are invited to contribute. Urgenda is hired to manage this process. The result is the “living lab” report concluding with four strategic areas of communication, research, education & facility management.

**ORGANIZATION**

**2011 Oct.**  DH takes up facility management. Research & education is distributed to the education programmers; Communication to the strategic areas teams of the university. Within DH the sustainability hierarchy is founded and project teams are formed. The StuurGroep Duurzaamheid is formed to manage the development of sustainability development.

**STRATEGY DEVELOPMENT: CITY OF TOMORROW**

**2012 Jan.**  Urgenda is asked to develop an action plan and goal; the “city of tomorrow” report. The results are three scenarios. CvB chooses the second but states the necessary investments will only be done if there is budget in the upcoming years.

**TECHNOLOGY ASSESSMENT**

**2012 Sep.**  DHpt analyses which energy generation technologies are suitable at the TU/e. It appeared wind-energy is unsuitable for the area. A trajectory for biomass energy is started with local authorities to develop a generator in the region of Eindhoven. Another trajectory is started for the development of PV projects at the TU/e. (The campus heat-pump is already in the implementation phase) Research is done to check the potential of several campus buildings. The roof of Vertigo appeared to be the best option for PV.

**EXCEPTION**

**2013 Mar.**  During the assessment, the project team and management team recognized there were problem with the way the process is monitored. This led to the decision the hire consultancy DWA.

**STRATEGY DEVELOPMENT: STUREN AAN DUURZAAMHEID**

**2013 Jun.**  DWA was assigned to develop “Critical Performance Indicators” with which the SGD could monitor the progress. The report is finished in October 2013, but is still not implemented.
EXCEPTION

2013 Aug.  A member of the CvB, who is also member of SGD, leaves the university.
2014 Jan.  The new CvB member does not join SGD and the SGD is unofficially disbanded until further notice.

EXCEPTION

2014 Jan.  The DWA report was meant as a quality management tool for the SGD. But as the SGD has been disbanded, the DWA report has not been implemented.
Ongoing

BUSINESS CASE: PV VERTIGO ROOF

2013 Jun.  Novesco has supported with expertise on technical and financial aspects.
2013 Oct.  The process was cut off due to an exception.

EXCEPTION

2013 Oct.  The faculty of Architecture filed a request to develop PV panels on the Vertigo roof for research purposes. The request obviously conflicted with the project plans of DH resulting in an exception. The decision was made to grant the request to the Faculty of Architecture as research is the primary objective. The development plans of DH were thus cut off.

BUSINESS CASE: PV SPORT CENTER ROOF

2013 Oct.  From the diagnosis phase of the previous business case was already known the roof of the sportscenter was the secondary option. Novesco again helped with the financial development of the case.
Case-Study Process Landscape

Scenario: TU/e, as happened
Unit of Analysis: strategy, organization, technology assessment, business case
Part: 1 of 1

Case边界：From strategy development to PV case development
Time horizon: October 2010 - April 2014

图6-2 Process Landscape
**Process Choreography Description**

**RECOGNITION (1)**

2012 Jan

Urgenda was asked to develop a strategic document, “City of Tomorrow”, with ideas on improving the campus regarding sustainability. The report mentioned PV-panels as a potential opportunity. But the goals to which the opportunity was measured are problematic as explained in §6.5. The recognition phase of the pv-panel investment proposal thus took place as part of the strategy development process.

2012 Jul

**DIAGNOSIS (2)**

During the technology assessment process, the financial viability of PV-investments was estimated. The analysis yielded the roof of Vertigo as best option, with the roof of the sportscenter second. In §4.2.2. it is stated that part of a functional diagnosis routine is establishing a process plan for the upcoming phases. In addition a process feasibility test should be done to estimate if the project would get final approval. Both were not done. The teamleader admitted in March 2014 he still didn’t know which authorizations and validations he needed to acquire. He also had doubts the final business case would get approval.

2013 Jul

**DEVELOPMENT (3)**

A business case for the Vertigo roof is developed with help of Novesco for financial and technical expertise. But almost at the same time an exception occurred.

2013 Mar

**EXCEPTION**

The Faculty of Architecture filed a request for installing PV Panels at the Vertigo for research purposes. As research and education is the primary objective of the university it is decided to grant the request and abort the ongoing development at DH. It is decided to start development of the second option.

2013 Jun

**DEVELOPMENT (4)**

A business case is developed with help of Novesco. The best option of a few technical alternatives was chosen at the end of the phase. No explicit quality control took place. The Team Captain stated that there were no explicit success criteria to which the case should satisfy, except they wanted to use third party capital, because they estimated the chance for approval would then be higher.
Table 6-2: Process Choreography Description

<table>
<thead>
<tr>
<th>Exception -&gt; Authorization (5)</th>
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<tr>
<td><strong>2014 Mar</strong></td>
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<th>Validation (6)</th>
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<th>Authorization (8)</th>
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<td><strong>Expected</strong></td>
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Investment Proposal Development - Case Study - Choreography Model

Scenario: As happened
Unit of Analysis: PV Investment Proposal
Part: 1 of 2

Actors:
- DH Development Team
- Top-Management
- Supervisory Board
- DH Department Management
- Novesco
- Financial Department
- Fac. Architecture

Diagram:

- Recognition
- Diagnosis
- Development
- Consult
- Request Development

Current Situation: Expressed Ambition
Opportunities: PV Expected to be Feasible
Figure 6.3 Current Process Choreography

**Investment Proposal Development - Case Study - Choreography Model**

**Scenario:** As happened

**Unit of Analysis:** PV Investment Proposal

**Part:** 2 of 2

**Actors:**
- DH Development Team
- Top-Management
- Supervisory Board
- DH Department Management
- Novesco
- Financial Department
- Fac. Architecture
6.5. FINANCIAL STRUCTURE
As concluded in §5.3.5, the financial structure can affect the effectiveness of organizational relationships. Secondly, national financial legislation can induce external effects on internal processes. Therefore it is necessary to check whether the financial structure causes either of the above effects.

Information has been acquired from national legislation (Ministerie van Onderwijs Cultuur & Wetenschap 1993); (“UITVOERINGSBESLUIT WHW 2008”); (Ministerie van Onderwijs Cultuur & Wetenschap 1987); (NWO 2013), the annual financial report of the university (Technical University Eindhoven 2013) and interviews with a member of the Department of Financial and Economic Affairs at the TU/e.

6.5.1. NATIONAL LEGISLATION
Each year the ministry of Education, Culture & Science makes a lumpsum available of which all public universities are paid according to the allocation clause in Dutch law. The budget is divided among universities according to their service of education, measured in the number of student subscriptions and graduations. In addition, the TU/e receives additional funds from the budget available for technical universities. This is called the primary flow of finance. (Ministerie van Onderwijs Cultuur & Wetenschap 1993) (“UITVOERINGSBESLUIT WHW 2008”)

Finance from the secondary flow can be obtained from the NWO (Dutch Organization for Scientific Research) The NWO has been founded by the ministry of ECS according to Dutch law. The NWO is financed by several ministries, social institutes and private parties and invests their money by forming strategic research programs. Universities can form budget requests for scientific research or equipment to these research programs. (Ministerie van Onderwijs Cultuur & Wetenschap 1987)(NWO 2013)

All other forms of finance are collectively named the third finance flow. This flow mostly consists of private businesses and enterprises or non-profit organizations financing research.

6.5.2. TU/E FINANCIAL POSITION
The TU/e is a non-profit organization and strives to balance the gains and expenses. Due to national budget cutting the 1st cash flow has been reduced with 4.8 million. Because of the crisis, less research grants are available resulting in a lower 2nd and 3rd cash flow. The reduction of incoming cash-flows has forced the TU/e to significantly cut costs. This has mainly been achieved with the reduction of personnel. The housing costs, depreciations and capital costs have risen as a result of the development of campus 2020. (Technical University Eindhoven 2013)
6.5.3. TU/e FINANCIAL POLICY

**BUDGET STRUCTURE** - All income will flow into one big pot. The second and third cash flow will be booked straight to the faculty budgets. From the first flow the service departments and housing costs are paid. What is left will be booked to the faculty budgets according to generally the same rules as used by the government.

**HOUSING AND ENERGY COSTS ALLOCATION** - The housing and energy costs are not allocated to the faculty budgets, but to the central budget. Sub-metering energy and housing can theoretically stimulate efficient behavior. However this is not done at the university, because the TU/e owns more square meters than necessary and thus housing efficient behavior will not reduce costs. Energy sub-metering is also not possible, because multiple departments use the same building. The amount of energy meters required would be too costly and reduce the flexibility of the buildings. In addition, there is chosen to solve the problem from a university-wide perspective. There is an exception; if real estate investments are used as a research tool, the depreciation costs will be allocated to the faculty.

**CAPITAL ACQUISITION** - The University is legally allowed to borrow money from banks. However, the bank has demands regarding the solvability of the university. The solvability ratio cannot

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### Table 6-3 Summary Financial Statement (Technical University Eindhoven 2013)

<table>
<thead>
<tr>
<th>Summary Financial Statement</th>
<th>2012</th>
<th>2011</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gains</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Cash Flow</td>
<td>€ (million)</td>
<td>%</td>
<td>€ (million)</td>
</tr>
<tr>
<td></td>
<td>196.7</td>
<td>64.5%</td>
<td>200.3</td>
</tr>
<tr>
<td>2nd &amp; 3rd Cash Flow + other</td>
<td>108.5</td>
<td>35.5%</td>
<td>116.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>305.2</td>
<td>100%</td>
<td>317.1</td>
</tr>
<tr>
<td><strong>Expenses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>€ (million)</td>
<td>%</td>
<td>€ (million)</td>
</tr>
<tr>
<td></td>
<td>191.0</td>
<td>62.6%</td>
<td>204.9</td>
</tr>
<tr>
<td>Housing costs, depreciations</td>
<td>41.9</td>
<td>13.7%</td>
<td>38.6</td>
</tr>
<tr>
<td>Inventory &amp; other</td>
<td>66.4</td>
<td>21.8%</td>
<td>71.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>299.3</td>
<td>98.1%</td>
<td>314.6</td>
</tr>
<tr>
<td><strong>Gross Result</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.9</td>
<td>1.9%</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Capital Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-2.8</td>
<td>-0.9%</td>
<td>-1.5</td>
</tr>
<tr>
<td><strong>Net result</strong></td>
<td>3.1</td>
<td>1%</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Liquidity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>64.2</td>
<td></td>
<td>20.0</td>
</tr>
<tr>
<td><strong>Net working capital</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.8</td>
<td></td>
<td>-24.0</td>
</tr>
<tr>
<td><strong>Solvency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.36</td>
<td></td>
<td>0.43</td>
</tr>
</tbody>
</table>
sustain additional loans, especially regarding the upcoming financing of the campus development.

**PROFIT** - The University strives to balance gains and expenses. Profit will be reinvested in the university. A small profit margin is necessary to build up capital and match inflation interest. It is untrue that the university is obliged to return remaining profits to the government. But it is possible that some other universities with very high profits, +50 million/year, will get a reduction in their annual contribution due to political decision-making.

**FINANCIAL INVESTMENTS RULES** -

- Projects with investments costs around 50,000 euro and above will be treated as investments.
- The university employs an internal rate of return of 6%. This rate is based on the interest the university gets on loans. It is not expected this rate will change much the upcoming years.
- The university employs a spending cap for housing costs of 14%. This limit consists of ongoing housing costs, investments / depreciations and capital costs. This limit is for upcoming years already exceeded as a consequence of the development of campus 2020. (For 2012, the ratio was 13,7 +0,9 = 14,6%, as shown in Table 6.3).
- The size of the housing budget is not expected to fluctuate significantly. The recent political activity regarding the budget cutting in education has had only slightly effect.

**6.6. EXISTING STRATEGY**

The strategy employed at the TU/e requires further delineation as the process landscape has shown that there were development problems with the strategy. In addition, the lack of explicit quality criteria suggest additional problems.

The policy documents have two reading groups. They communicate policy and performance to the government so they can validate the actions of the public institute. Secondly, they have the important function to communicate policy to the staff of the TU/e. As mentioned in §5.3.3, communication of strategy is essential for a working organization. In Table 6.4 the policy documents throughout the research time horizon are depicted. The Annual Performance Reports are a good indicator on how the TU/e Board continued their policy regarding sustainability. (Note: only sustainability policy regarding real estate and technology will be examined, not education).

The targets mentioned across the years are (Table 6.4):

- 30% energy usage reduction between 2005-2020
- 50% energy generation on own campus in 2030
- 5 living labs in 2016
- SustainaBUL winner 2016
- “Invest in all technical measures that will have a payback period smaller than the life expectancy of the buildings.”
However, the targets mentioned in the latest report are:

- 30% energy usage reduction between 2005-2020
- 50% energy generation on own campus in 2030

It is clear from Table 6.4 and the above list that the policy targets are highly inconsistent. Moreover, quantitative performance reports regarding the targets are missing. Therefore it is unknown if the board manages on feedback of performance. Secondly, it is unknown for the staff if they are doing well or not. Lastly, the goals are not operational useful: It is unknown what constitutes as a ‘living lab’; It is unknown if energy usage is relative to square meter, as is national practice in the Netherlands; The energy generation target is formulated relatively instead of absolute, making the performance dependent on secondary factors.

Thus the policy documents fail to fulfill their essential purposes: They fail to communicate consistent targets throughout the years; They fail to make the targets operational useful; They fail to communicate performance feedback. The result is a very poor policy communication. The Risk Assessment should prove if the quality of the strategy management also has effect on the process.
<table>
<thead>
<tr>
<th>Year</th>
<th>TU/e Policy Publication</th>
</tr>
</thead>
</table>
| 2011 | **ANNUAL PERFORMANCE REPORT 2010**  
Mentions MJA target: reduce energy usage with 30% between 2005 and 2020.  
A relation with an investment policy is not made. But it is expected the main efficiency will be acquired in the development of the new campus buildings. ([TECHNICAL UNIVERSITY EINDHOVEN 2010](#)) |
| 2011 | **ENERGY POLICY STATEMENT**  
Refers to the MJA3 targets. In addition it is stated that “the board will annually provide financial means to reach the stated targets”. However a financial provision cannot be found in the financial report. ([COLLEGE VAN BESTUUR 2011](#)) |
| 2011 | **STRATEGIC PLAN 2020**  
Does not mention anything on sustainability. ([TECHNICAL UNIVERSITY EINDHOVEN 2011](#)) |
| 2012 | **ANNUAL PERFORMANCE REPORT 2011**  
Mentions MJA 3 target. It is stated that a real estate sustainability strategy will be developed in 2012 ([TECHNICAL UNIVERSITY EINDHOVEN 2012A](#)) |
| 2012 | **INSTITUTE POLICY PLAN 2013-2016**  
Mentions targets: MJA Target, 5 Livings labs in 2016, SustainaBUL award 2016. 50% of energy use generated on own campus in 2030 ([TECHNICAL UNIVERSITY EINDHOVEN 2012B](#)) |
| 2013 | **ANNUAL PERFORMANCE REPORT 2012**  
Mentions MJA3 target, ambition to implement living labs, but without a target. 50% of energy use generated on own campus in 2030. Sustainability is part of the tender criteria for campus development. But no quantitative numbers are mentioned. For the first time a financial guideline for sustainability is published: “The TU/e will invest in all technical measures that will have a payback period smaller than the life expectancy of the buildings.” ([TECHNICAL UNIVERSITY EINDHOVEN 2013](#)) |
| 2014 | **ANNUAL PERFORMANCE REPORT 2013**  
Mentions the MJA3 target. 50% of energy use generated on own campus in 2030. However the financial investment rule regarding sustainability is not mentioned this time. ([TECHNICAL UNIVERSITY EINDHOVEN 2014](#)) |
7. ANALYSIS

The analysis is best done in collaboration with the client. The client will have extensive experience on his company and the scientist in process management. As denoted in §3.6, the analysis consists of an Added-Value Assessment and a Risk Assessment.

7.1. ADDED-VALUE ASSESSMENT

In this assessment the individual steps of the process are rated to the value added to the process and product quality relative to their costs. Key to the assessment is TABLE 7.1. On the horizontal lines are the individual steps listed, which have been determined during the identification phase in §6.3.2. In the columns are the performance criteria listed which have been determined in §3.4.

The client, the project-team captain, has filled in each cell during an interview. The rating represents the measure in which a particular step should be changed. The output of this assessment pinpoints which process-steps should be improved on which aspect. With this information it is possible to intervene minimalistic in only the most critical steps.

7.1.1. FINDINGS

During the assessment the reasons for the ratings have been discussed with the client. The most important findings have been listed below.

- The diagnosis was completed with a satisfactory result, but was experienced very badly due to disagreement between the project team and the department management.
- Even though, the development of the proposal for PV-panels at the vertigo roof was cut short, added-value was still gained as the experience and knowledge could be used for the development of the other proposal.
- After the development of the proposal was finished, it required the authorization of the department management. However, this came as a surprise to the project team. The authorization was perceived as unnecessary and the resulting conflict as unpleasant.
- After the financial validation it is expected that department management would need to authorize the handover to top-management. The project team is scared that a similar conflict could occur.

The process issues are centered on the collaboration between the project team and the department management. There are three instances of potential conflicts: at the end of the diagnosis, after the development, and after the financial validation. The client noted the following causes for the conflicts:

- Ambiguity on the necessity of the authorization.
- The unannounced implementation of the authorization.
- Technologic knowledge is located at the project team (and potentially lacking at management)
## Added-Value Assessment Results

<table>
<thead>
<tr>
<th></th>
<th>Customer Satisfaction</th>
<th>Staff Satisfaction</th>
<th>Processing Time</th>
<th>Waiting Time</th>
<th>Finance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quality</strong></td>
<td>++</td>
<td>++</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Cycle Time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|   | Recognition | ++ | ++ | 0 | + | + |
| 2 | Diagnosis   | 0  | -  | -- | -- | - |
| 3 | Development (Vertigo) | +  | +  | + | + | + |
| 4 | Development (Sports Centre) | +  | +  | + | + | + |
| 5 | Authorization (Dep.Management) | -  | -  | -- | -- | -- |
| 6a| Financial Validation\(^1\) | +  | +  | 0 | 0 | 0 |
| 6b| Hand-over\(^1,2\)               | -  | -  | - | - | - |
| 7 | Authorization (Top-Management)\(^1\) | + | + | + | 0 | + |

\(^1\)Expected Phases
\(^2\)Added during assessment on request of client

### Legend

<table>
<thead>
<tr>
<th>--</th>
<th>represents</th>
<th>Routine should be improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>&quot; &quot;</td>
<td>&quot; &quot; recommended to improve</td>
</tr>
<tr>
<td>0</td>
<td>&quot; &quot;</td>
<td>&quot; &quot; could be improved</td>
</tr>
<tr>
<td>+</td>
<td>&quot; &quot;</td>
<td>&quot; &quot; not recommended to change</td>
</tr>
<tr>
<td>++</td>
<td>&quot; &quot;</td>
<td>&quot; &quot; should not change</td>
</tr>
</tbody>
</table>

Table 7-1: Added-Value Assessment
7.2. RISK ASSESSMENT

The second test is the risk assessment, described in §3.7.2. Its purpose is to assess the stability of the process. The results of the assessment are depicted in TABLE 7.2. The horizontal lines depict, again, the process steps, which have been determined during the identification phase in §6.3.2. The columns depict the risks which might occur. The lists of risks is populated with the risks found in theory in §5.3 and with risks which have already occurred in the past. This last group of risks will be delineated in §7.2.1. The risks will be rated by the client by their probability of occurrence and their impact on the process.

7.2.1. CASE-SPECIFIC RISKS

CONFLICTING PROJECTS The conflict between the project developed by Dienst Huisvesting and the project by the Faculty of Architecture illustrates the possibility that different departments are working in the same technologic design space.

PROCESS CONFLICTS Several times actors did not agree on the process structure. There was disagreement on when a step was finished and what the consecutive action should be.

PROJECT COMPETITION Due to the legal investment limit, proposals need to compete against each other as there are more proposals contributed than there is budget. Even though a proposal could be a valid option, it has the risk to be outcompeted by another.

STAFF FLUCTUATION In the past a member of “stuurgroep Duurzaamheid” left, which eventually led to the disbanding of the group. As the TU/e is on budget constraints such could occur again.

7.2.2. FINDINGS

The results of the table have been discussed with the client. Findings are listed below:

- The diffusion of information, from market to the project team and from the project team to the rest of the organization plays a major role in an innovation process such as this. It affects the validity of decision-making.
- The risks are overall higher at the end of the development phase and at the authorization of it. Remarkably, the authorization by top-management is rated lower; even though the impact of failure on the development costs is then objectively higher. Apparently failure during development is perceived as worse than cancelling the proposal once it is finished. It could be that cancelling is perceived as a choice rather than a failure.
- The low risk due to the quality of the strategy stands out because the development of the strategy has been problematic at the TU/e and multiple consultancies were necessary for support.
- Unique to the TU/e case, is the existing of project competition. This risk was rated as highest as it could cause cancelling of the proposal even though the proposal matches all the quality requirements.
The high rating of the risks by Information Gaps, Decision Authority, Quality Management and Process Conflicts are centered on the collaboration between the project team and department management.

Remarkable is that the development phase scored very well in the Added-Value Assessment, but is still highly sensitive to various risks.

7.3. EXTERNAL FACTORS
In §5.4 is stated that, even though the research scope is limited to organizational effects, the results might be affected by external causes. The possible external effects listed in §5.4 are checked according to the case. Possible influence is explained below.

Legal Restrictions - The TU/e is not limited more by external legal restrictions than other companies. The 14% investment rule is set internally.

Geographic Aspects - The TU/e is not more limited by geographic aspects than other buildings in the Netherlands.

Current Building Technology - The feasibility of PV panel investments is limited by existing installations taking up roof space.

Distorted Energy Markets - The TU/e is in the lowest energy-tax class, therefore energy-efficiency measures net low economic value.

Lack of Information on Technology Markets - It has taken time to find market parties to provide technologic information and it takes time for the market party to assess the situation and develop a consult. Information diffusion takes time, but there is not a lack of information as the competitive market can readily provide it.

Credence Goods Nature of Technologies - The “crowded” roofs make it harder to calculate the possible benefit of PV panels. Moreover, the current energy monitor system is severely flawed. Energy usage cannot be allocated to buildings and therefore it is harder to calculate energy savings by new technologies.

Overall, the quality of the process is likely not influenced by external effects. However, the feasibility of new ideas is limited by the low tax rate and a technologic inheritance of “crowded roofs” and a broken monitoring system.
## Risk Assessment Results

<table>
<thead>
<tr>
<th></th>
<th>Information gaps</th>
<th>Decision Authority</th>
<th>Quality Management</th>
<th>Strategy</th>
<th>Finance Structure</th>
<th>Conflicting projects</th>
<th>Process Conflicts</th>
<th>Project Competition</th>
<th>Staff fluctuation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P • I</td>
<td>P • I</td>
<td>P • I</td>
<td>P • I</td>
<td>P • I</td>
<td>P • I</td>
<td>P • I</td>
<td>P • I</td>
<td>P • I</td>
</tr>
<tr>
<td>1</td>
<td>Recognition</td>
<td>3 1</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>21</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Diagnosis</td>
<td>3 2</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>21</td>
<td>11</td>
<td>3 3</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Development (Vertigo)</td>
<td>2 3</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>21</td>
<td>2 2</td>
<td>1 2</td>
</tr>
<tr>
<td>4</td>
<td>Development (Sports Centre)</td>
<td>2 3</td>
<td>2 4</td>
<td>2 4</td>
<td>1 3</td>
<td>3 3</td>
<td>1 1</td>
<td>4 3</td>
<td>5 5</td>
</tr>
<tr>
<td>5</td>
<td>Authorization (Dep.Management)</td>
<td>3 3</td>
<td>3 4</td>
<td>1 2</td>
<td>1 1</td>
<td>3 3</td>
<td>1 1</td>
<td>3 3</td>
<td>4 4</td>
</tr>
<tr>
<td>6a</td>
<td>Financial Validation¹</td>
<td>2 2</td>
<td>2 2</td>
<td>2 2</td>
<td>1 1</td>
<td>3 3</td>
<td>1 1</td>
<td>3 3</td>
<td>2 3</td>
</tr>
<tr>
<td>6b</td>
<td>Hand-over¹</td>
<td>1 1</td>
<td>1 1</td>
<td>1 2</td>
<td>1 1</td>
<td>2 1</td>
<td>1 1</td>
<td>2 2</td>
<td>2 3</td>
</tr>
<tr>
<td>7</td>
<td>Authorization (Top- Management)¹</td>
<td>2 2</td>
<td>1 1</td>
<td>2 2</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
<td>2 2</td>
<td>2 3</td>
</tr>
</tbody>
</table>

¹Expected Phases

### Legend

- **P • I** represents **Risk = Probability • Impact**
- **P** represents **Probability value between 1-5**
- **I** represents **Impact Value between 1-5**

Table 7-2: Risk Assessment

---

63
8. (RE)DESIGN

The objective of the redesign is to gain a better performance on the quality criteria, costs, time & risks. The ideal solution would use the least performing routines as an opportunity to improve the risk resistance of the process. In collaboration with the process-actors it is decided to aim to reduce conflicts between actors and late-stage project dismissal.

The first step in reducing conflicts is by removing ambiguity through installing a strategy database (§8.1) and a functional case administration (§8.2). After making the decision material explicit, agreement between actors is necessary (§8.3).

To focus the development efforts project competition is reduced (§8.4). Instead of spreading attention to various aspects, the university benefits from focus on key projects.

Finally, a proposal for a new process structure is presented in §8.5.

8.1. STRATEGY DATABASE

8.1.1. CONTENT

The strategy database provides the framework to which the developments should comply. It should provide the necessary university-wide consistency in the action of employees. Goals provide the target which the cumulative investments should achieve. The decision criteria provide the relative importance between goals. Of course energy efficiency is important, but how much in relation to student population growth? Goals and criteria should both be expressed in operational units of measure. A functional goal should be measurable in physical units and be absolute. Intake forms, further discussed in §8.2, are necessary such that development teams deliver their proposals in the same format and decision makers can make fast and objective decisions. Lastly a process plan is necessary to provide a valid path of action during the development.

A good strategy ensures consistency and validity of actions, but also reduces time as development teams do not have to design their own goals, process plan and intake form.

---

- Goals
- Decision Criteria
- Operational Units of Measure
- Legal and Finance Rules
- Intake Form / Deliverable Template
- Process Plan

Table 8-1: Strategy Database Contents
8.1.2. Management
The strategy base is not a one-time achievement, continual management is necessary to keep up with the ever changing entrepreneurial environment. It should be up-to-date with the latest strategy changes to which top-management has decided. Changes should be checked on consistency with the sub-department strategies, financial rules and legal rules. The documents should be easy accessible for all employees on one central site and there should be no room for ambiguity and misinterpretations.

8.1.3. Actions
In order to achieve a working strategy base the single most important action is the appointment of a central objective actor, who is responsible for the consistency and updating of the database. He or she should be a management expert and could judge the quality of the strategy documents created by other departments.

8.2. Case Administration & Evaluation Form
Decision-making benefits from standardization by means of evaluation forms. It increases the objectivity as proposals become comparable to each other. In addition, it decreases the decision time. Noting the train of thought prevents second guessing earlier made decisions. The evaluation form can provide the guideline. Lastly, the evaluation form serves as a scope hardline for the developer. Anything not mentioned on the form is likely not worth the effort.

8.2.1. Actions
The creation of the evaluation is of essence. Even in early stages the form should be filled in schematically with predicted results. The proposed management expert could take the lead. The evaluation form could also be subject of further research.

Second, an educational course on project administration and version control is ought to be beneficial.

8.3. Process Clarification & Agreement
The main conflicts have been caused by ambiguity and disagreement on decision authority and the process trajectory. Agreement on the process plan is probably more important than the actual process design itself as business conflicts will guaranteed lead to reduced internal quality and additional costs.

In §5.3.4 is delineated that decision authority should be allocated to the actor with the most expertise. Actors should therefore acknowledge the difference in their expertise. The project team will likely know more on the technical possibilities and the department management will know more on the strategic level. Dependent on the authority distribution, it should be determined whether decision moments should be formulated as authorization routines or quality control routines.
8.3.1. Actions
It is strongly recommended that the project team and department management will organize a meeting in which they discuss and agree on the process, decision moments and each other’s authority. It will be beneficial to update the agreement at least once a year. The agreement could be recorded and added to the strategy database.

8.4. Focus Development
The strength of the university is its capability to generate many innovative ideas. But due to the financial investment limit only a few ideas can eventually be implemented. Ideas compete against each other. The losing proposals will have only generated costs and no profit. It is beneficial to develop only the best of ideas. It is therefore necessary to organize the project competition at the beginning stage of the process.

In addition, it is necessary to increase the project focus among the staff of Dienst Huisvesting. Currently, many ideas are developed parallel to each other. The Staff is forced to divide their attention across several proposals, and the development teams are switching members dependent on who has available FTE. Another way of handling the population of proposals is to develop them consecutive from each other. Teams can then focus on one project at a time and it is easier to allocate the development hours to the project and track its costs. Moreover, proposals do not compete with each other and development of new ideas can be stopped once the investment limit has been reached.

8.4.1. Actions
It is proposed to hold a meeting at the beginning of the year in which all ideas are contributed. In the meeting will be decided which ideas are most eligible, considering the university strategy. Second, the order of development should be determined. Lastly, it should be decided who will work on which project team.

8.5. Model Description
The design of the new process is depicted in figure 8.1. The new design is not the objective, but a means to come to a better organization. The necessary actions mentioned have been incorporated, but the client/reader should be aware that some actions are not depicted in the model but nonetheless important.

Of course the process starts with the recognition of a problem and of the opportunity to do something about it. At any time any staff member might come up with an idea. However, the ideas are stored until the “Annual Development Planning” event. The purpose of the meeting is to establish the development schedule and related targets. Early project competition will reduce development costs (§8.4). The benefit of the early project competition can be found later on during the authorization. Fewer ideas have to be considered, reducing the existing backlog.

The placement of Development Planning before or after the diagnosis is a design choice. In this case it is chosen to do it before, because the diagnosis often involves a market party for a consult or preliminary quotation. It would be costly to spend money for consults on every
idea. But this means there is a certain lack of information on the feasibility during scheduling and therefore a second out is necessary after the diagnosis.

Dependent on the actors’ choice a quality control routine can be added on the diagnosis. It is recommended to implement it at least in the first year to allow the actors to gain experience.

The strategy database provides consistency throughout the process and reduces time as developers do not have to worry about creating important process documents themselves (§8.1).

The documents containing the idea, diagnosis, alternatives and best-option are all done according to the same evaluation form and will be used in all consecutive phases (§8.2).

The change proposed is minimal, feasible and with high impact. None the less, the most important step is that actors reach agreement on the process structure (§8.3). For that, this model is only a supportive tool, not the solution.
Investment Proposal Development - Redesign - Choreography Model

Scenario: Redesign
Unit of Analysis: Investment Proposal
Part: 1 of 2

Actors:
- Development Team
- Department Management
- Supervisory Board
- Financial Department

- Goals
- Decision Criteria
- Operational Units
- Legal & Finance Rules
- Process Plan
- Evaluation Forms

Start Rest on Schedule
Diagnosis
Quality Control

Start Development (next page)

Investment Proposal
- Idea
- Diagnosis
Figure 8-1: Redesign of the Investment Proposal Development Process

**Investment Proposal Development (Redesign) - Solution - Choreography Model**

- **Scenario:** Example Solution
- **Unit of Analysis:** Investment Proposal
- **Part:** 2 of 2
- **Actors:**
  - Development Team
  - Department Management
  - Top-Management
  - Supervisory Board
  - Financial Department

- **Goals**
- **Decision Criteria**
- **Operational Units**
- **Legal & Finance Rules**
- **Process Plan**
- **Evaluation Forms**

**Diagram Description:**
- **Development**
  - Request Development (Proposal Stage)
  - Development
  - Quality Control

- **Validation**
  - Financial Department
  - Technical Department

- **Authorization**
  - Supervisory Board

- **Investment Proposal**
  - Idea
  - Diagnosis
  - Alternatives
  - Best Option
  - Validation
  - Authorization

- (Reduced Population)
9. CONCLUSION

Energy-efficiency of higher education institutes is an international problem, pronounced in different levels of governance. On European level the Directive 2006/32/EC, on national level the Dutch Long-term Agreement MJA3 and on university level the Energy Policy Statement of the TU/e Board. However, despite the implementation of new policy at the TU/e, consultancies, as well as internal actors, have been critical on the organizational execution of it. Thus, even though the TU/e possesses aspects traditionally required for innovation in the field of energy-efficiency (ambition, capital access, scale, long-term strategy & knowledge) and is internationally leading in technologic research, they struggle to live up to their potential. Therefore the research question is formulated as:

“What are the critical points within university organizations that limit investments in energy-efficiency, and how can they be solved?”

The sub-questions lead to a step-wise delineation of the conclusion.

9.1. STATE OF THE ART

- “How does the state of the art affect society?”
- “How should it be improved?”

Policy of the Dutch government is solely based on top-down research. Top-down research can only be used to illustrate the need of governmental intervention, by estimating attainable economic value through investment in energy efficiency. As a result the current policy, the MJA-3 focusses on awareness and monitoring and has been proven costly, without achieving a significant result.

In order to develop a specific policy design that is efficient and effective, knowledge on the internal behavior of organizations is necessary. This knowledge is best acquired with bottom-up research in the form of case-studies. Unfortunately the current scientific field is lacking in these types of researches. It appears most universities have only just formulated their sustainability goals, and therefore the scientific field is equally behind. In addition, a gap exists between experts on energy efficiency and organizational science.

The existing case-studies do not provide a structured methodology to repeat and compare with other cases. Therefore, the current state of the art can best be improved by developing a standard methodology for improving the development process of innovative investment proposals in campus estate energy-efficiency.

9.2. METHODOLOGY

- “How can organizational processes analyzed?”
- “How can the research be standardized?”

The methodology developed in this research is founded on the field of Business Process Management, New Product Development, Strategic Decision Making, Case-Study Research Methodologies, Case-study research on Sustainability in Higher Education.

Assuming a clear problem description and case selection, the methodology is centered on:
- **AN IDENTIFICATION OF THE PROCESS STEPS**, with data gathered from interviews and policy documents.
- **AN ADDED-VALUE ASSESSMENT**, according to the process performance criteria.
- **A RISK ASSESSMENT**, according to the probability and impact of expected risks.

The output of the analysis will be used for a redesign of the low-value steps and reduction of risks during the whole process; followed by the implementation, monitoring and optimization of the solution.

The key to standardization is developing a default protocol for the Definition, Added-Value Assessment and Risk Assessment (shown in TABLE 3.3, 3.4 and 3.5). During the definition the process will be broken down in standard behavioral routines. The routines will be rated according to a standard list of performance criteria and risks during the assessments. The case can then be compared to other studies using the same building blocks.

### 9.3. THEORETIC FUNDAMENT

- **“HOW DOES THE STANDARD DEVELOPMENT PROCESS OF AN INVESTMENT PROPOSAL LOOK LIKE, ACCORDING TO THEORY?”**
- **“WHAT ARE THE PERFORMANCE CRITERIA OF A PROCESS?”**
- **“WHAT ARE ORGANIZATIONAL RISKS TO THE PROCESS, ACCORDING TO THEORY?”**

The development of investment proposals starts with the recognition of a problem and the opportunity to act on it, followed by a diagnosis of the problem, the development of the proposal and ending with an authorizing decision. There are likely additional routines to support the process; such as a quality control/rework cycle, validations and additional authorizations. During the case-study it appeared that a Hand-over routine, not mentioned in literature, plays also an important role. This routine describes the hand-over from responsibility at the end of a process step from one actor to the next.

Traditional performance criteria of a process are cycle time, process cost, quality and risk sensitivity. The quality of a process can be divided in internal and external quality. Internal quality is related to the satisfaction of the process participants. External quality is related to the satisfaction of the client, which is in this case the Executive Board of the University.

Organizational risks have their roots in the flaws of individuals. Individuals are limited by Personal Values, Limited Cognitive Capacity and Inertia. A certain amount of inefficiency is to be expected. Individuals try to overcome their limits by forming organizations. Organizations are then structured by the principal-agent relations of individuals. In these relations, risks occur on the aspects of:

- Information Distribution
- Quality Management
- Decision-Authority Allocation
- Strategy Management
- The budgeting structure
These risks increase the chance that the best option according to the employed decision criteria is not chosen, leading to loss in performance or total process failure.

9.4. THE CASE

- "HOW IS THE PROCESS ORGANIZED AT THE TU/e?"
- "WHAT ARE THE CRITICAL POINTS IN THE PROCESS?"

In abstraction, the process at the TU/e is determined by the Project Team, the Department Management and Top-Management. The development of ideas can be considered as ‘emergent’. Plans are started locally at project teams and work their way to the top.

Two factors stand out. First, the existing process structure is still in its grassroots stage. Organizational relations are informal and formed when the need occurs. As no predetermined plan exists, actors had different expectations on the process structure and decision criteria when they collaborated. Especially the process phases where the project team and department management needed to collaborate where nominated for improvement. The existing ambiguity severely increases the organizational risks, which can have severe impact on the development of the proposal.

Second, likely unique to the TU/e, is competition among investment proposals. The university employs a maximum of 14% of the turnover in campus estate investment. As for the upcoming years budget is mostly spend in the current redevelopment, only a few proposals will be accepted. Therefore there is a high risk a proposal is dismissed even though it is a valid option. The development costs are then lost without returning profit.

9.5. SOLUTION

- "HOW CAN THE PROBLEMS BE SOLVED?"

The objective is to reduce both problems mentioned above, ideally with a re-design of the collaboration moments, as those were rated as weakest. The measures are designed to reduce the ambiguity during decision making and secondly to move the proposal competition to the start of the process such that unnecessary development is avoided.

It is proposed to:

- **IMPLEMENT A STRATEGY DATABASE**, containing the goals, decision criteria, process plan, legal & finance rules and a “Hand-over Form”. The hand-over form is a quick overview of the proposal and makes them easy to compare. The database ensures all staff strives for the same objectives.

- **IMPROVE THE CASE ADMINISTRATION**. In innovative processes there is a constant flow of new information. To prevent decision making with outdated or missing information an effective administration is necessary. The administration could be centered on the hand-over form.

- **REACH AGREEMENT** on the strategic documents and process plan before the actual process starts. Ultimately it is the decision of the client how the process is structured. But the case-study has proven that clarity and agreement between actors is essential.
IMPLEMENT ANNUAL DEVELOPMENT SCHEDULING. Currently, there are far more ideas being developed than there is budget for. It is proposed to hold a meeting at the beginning of the year in which all ideas are contributed. In the meeting will be decided which ideas are most eligible considering the university strategy. This reduces competition at the end of the process and prevents unnecessary development costs.

A visual design of the proposed process structure can be found in FIGURE 8.1

9.6. ADDED VALUE TO SOCIETY

- “CAN CONCLUSIONS BE GENERALIZED?”
- “HOW CAN GOVERNMENTAL POLICY BE IMPROVED?”

It is not recommended to just copy the conclusions to other cases. Cases are unique and the solution is custom-made. Risks to the TU/e might not occur at other cases. Rather, it is recommended to obtain the knowledge presented. The principal objective of this research has been to develop a methodology that is re-usable for other cases. The methodology can be used to quickly improve the implementation capacity of other organizations.

As for the governmental policy, it is recommended to reduce the administrative burden of the MJA3 program and instead focus on education on “how to implement technology”. Additionally, it is contradictory to spend money on policy, while the universities are still in the lowest energy-tax class.

The research has been a major step to promote the importance of organizational design and strategy in the path to an energy-efficient nation.

9.7. TAKE AWAY POINT

This thesis has been a means to convince the reader that:

“BY DESIGNING A BETTER ORGANIZATIONAL STRUCTURE, COMPANIES CAN INCREASE THEIR ABILITY TO ADAPT ENERGY-EFFICIENT INNOVATIONS AVAILABLE ON THE MARKET; AND THEREBY INCREASE THEIR OWN AND NATIONAL ECONOMIC VALUE.”
10. DISCUSSION: FOOD FOR THOUGHT

10.1. RESEARCH EVALUATION

The process of this research has been tough. The difficulty is in the combination of fields: engineering and organizational sciences. Even in literature there is a separation between both fields. It was tough to find my way in a field of science in which I had only limited experience. But in the end I am satisfied with the result. The thesis has given me clarity in the relation between both fields. The ultimate proof that I learned is the feeling that I could do it so much better if I would do it again.

10.1.1. IMPROVEMENT OPTIONS

If I would have more time (and got paid for it) I would:

- Increase the number of actors within the TU/e to do the assessments.
- Measure the results after implementation of the solution.
- Do parallel case-studies on the other technical universities.
- Do some additional research to the hand-over routines.
- Use an improved data collection administration.
- Cross-reference with some additional literature.

10.2. VALORIZATION OPTIONS

Valorization is an important part of research. Research is useless if nobody uses the new knowledge.

10.2.1. CONSULTANCY & PRESENTATIONS

Ideally the thesis could be reworked in a booklet and used as course material for workshops or be sold as a consultancy product. The client was enthusiastic about the created protocols.

10.2.2. MJA3 PLATFORM

As one of the main topics has been the governmental policy, it would of course be suitable to spread the knowledge to the MJA3 platform.

10.2.3. PUBLICATION

In its current form the research can be considered as a pilot-study. But none the less it is publishable in the International Journey for Sustainability in Higher Education. The journal contains a lot of case-studies and they accept also studies with an experimental level. If we would submit a paper I would rename it to:

“A STANDARD METHODOLOGY FOR IMPROVING THE DEVELOPMENT PROCESS OF INNOVATIVE INVESTMENT PROPOSALS IN CAMPUS ESTATE ENERGY-EFFICIENCY.”
10.3. FURTHER RESEARCH

Working on this thesis of course opens up even more questions, such as:

- **How to decide for a feasibility study?**
  - Information costs money: but how to measure the return on investment of information?

- **How to measure the consistency in the perceived strategy of individuals across the organization?**
  - Individuals can have different viewpoints on the same strategic documents, which can lead to undesired conflicts. It may be possible to use a choice experiment and check if actors make the same choices.

- **How does the roof of the future look like in the face of competition between installation technology, energy generation and social space?**
  - The roof becomes increasingly more important, but different functions compete for space. This may be a subject for an architectural design assignment.

- **How to rate the value of an energy usage monitoring system?**
  - Energy monitoring systems provide essential information, but are costly. It is important to know how to express that information in exact financial figures to justify investment.

- **What is the value of setting a quantitative target in emergent strategies?**
  - We all learn that goal setting is important. But in emergent strategies, the opportunities and possibilities are often not know beforehand. So does goal-setting still makes sense if you don’t know what the organization is, positively and negatively, capable of?

- **How to standardize an evaluation form for (energy efficiency) investment proposals?**
  - The next recommended step following this thesis, should be research towards a standardized evaluation form. Such a form creates efficiencies by setting the scope of development and creates consistency among decisions.
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