Aligning Supply and Demand for Energy Service Companies in the Cure Market using Analytical Hierarchy Process and System Dynamics.

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Construction Management & Engineering

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PREFACE

This graduation report elaborates on the subject of energy service companies in the cure market. With this report I will finish my education program 'Construction Management & Engineering' at the Technical University of Eindhoven. I will end a very interesting and enjoyable study time.

I want to thank Kuijpers Ecopartners giving me the opportunity to graduate on an interesting and topical subject. They facilitated me in everything that was necessary and made everything possible I would like to do. I enjoyed working at the office and following all developments in the sector. In particular I would like to thank my external supervisors Bob Bloemers and Valentijn van Wanrooij. I really enjoyed the supervision and conversations on the topic. They gave me the freedom and opportunities to experience with the scientific methods in the practical field. Next to this I would like to thank all the other employees of Kuijpers Ecopartners who took some time for me to discuss the content of my graduation project.

The conducted interviews with experts related to hospitals or energy service companies provided a lot of new insights and in-depth information. Also the respondents of my survey helped me answering my research questions.

I want to thank my supervisors of the TU/e Wim Schaefer for the general support and feedback directing me, Qi Han guiding me in the application of the research methods and Frank Dekkers for coaching my process, product and presentation.

Finally, I would like to thank my family and friends supporting and distracting me during my graduation period.

I hope you enjoy reading this thesis.

Koen Hemink

Eindhoven, 17 July 2013

According to research from SBR, the building sector uses 40% of the total primary energy use, living and service together. Thinking and acting differently contributes to reducing the CO-2 emission and reduced energy pollution and costs (SBR). A high potential concept of Energy Service Companies (ESCos) is arising and relatively new for the cure market. The energy intensiveness resulting in a high energy saving potential, a growing privatizing and liberalizing health care market, lack of financial or technical abilities of hospitals and an increasing focus on health care within hospitals favor the introduction of energy service companies. However there is an indistinct exploration in the willingness and considerations of hospitals to collaborate with energy service companies. Market supply and demand of Energy Service Companies should be aligned to benefit from energy savings and lowering energy costs.

Regression Analysis is used to give insight in the needs and considerations for a hospital in their decision to outsource. The method of Analytical Hierarchy Process assesses the relative importance of key performance indicators that can be incorporated in energy performance contracts. Data for these methods is collected from employees of the Technical Service or Facility Management from different hospitals. In addition, perspectives from financial directors make the overall picture of the attitude of a hospital towards energy service companies complete. The main conclusion of this research is that the most optimal energy service company that can be offered to a hospital at this moment is highly dependent of the current demand and structure of the organization. Answers to the following questions need to be identified before offering a product to a hospital:

- At which point of the transition after the governmental interventions is the hospital at this moment?
- How are the departments of technical service, real estate and facility management structured within the organization of a hospital?
- What are the technical and financial capabilities of the organization?
- Who is responsible for energy management and the energy bill?
- What are the sustainability targets of the hospital and associated municipality?
- What is the current state of installation techniques and condition of the building?

System Dynamics in combination with Monte Carlo simulation is used for a sensitivity analysis of a specific business case of an energy service company. The two methods proved to be useful in estimating the total and individual risks influences of a business model. The simulation method can also be used to underpin the bandwidths of key performance indicators theoretically. Based on these bandwidths, a penalty or bonus distribution can be agreed upon at the start of the project.

The most optimal energy service company design for the cure market allocates responsibilities equivalent to the influence of a party involved in the project. Smart arrangements for profit sharing should be made to decrease submerging responsibilities. The so-called special purpose vehicle aims to create a long-term collaboration in which every party has the influence it comforts.

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ESCo	Energy Service Company
EPC	Energy Performance Contract
EPC	Energie Prestatie Coefficient
CEM	Contract Energy Management
MJA	Multiyear Agreements (MeerJarenAfspraken)
EPBD	Energy Performance Building Directive
ETS	Emission Trading System
EL	Energy Label
EU CA&EP	European Union Climate Action and Energy Package
EMJV	Electronic Environmental Annual Report
EEP	Energy efficiency Plan
MCS	Monte Carlo Simulation
SWOT	Strengths, Weaknesses, Opportunities, Threads
EIA	Energy Investment Deduction (Energie-Investerings Aftrek)
GJ	Giga Joule
CLD	Causal Loop Diagram
AHP	Analytical Hierarchy Process
CI	Consistency Index
CR	Consistency Ratio
WKO	Heat and Cold Storage System
DBC	Diagnosis Treatment Combination (Diagnose Behandel Combinatie)
Wtzi	Law Admission Care (Wet Toelating Zorginstellingen)
DBFMO	Design, Build, Finance, Maintain, Operate
BREEAM	Building Research Establishment Environmental Assessment Method
DLL	De Lage Landen
KPI	Key Performance Indicator
NPV	Net Present Value

TCO	Total Costs of Ownership
TPF	Third Party Financing
MWh	Megawatt hour
GJ	Giga joule (10^9 joule)
PJ	Peta joule (10^5 joule)
Cure market	Hospital market not involving care
UMC/AMC	University Medical Centre / Academic Medical Centre

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1 INTRODUCTION

1.1 RESEARCH CONTEXT

The European target for renewable energy for the Netherlands is 14% in the year 2020. The following three targets have been set by the European Union (Ministerie van Economische Zaken, Landbouw & Innovatie, 2011):

- 20% reduction of greenhouse gas emissions by 2020 compared to 1990.
- 20% reduction of the energy consumption in EU compared to projections for 2020.
- 14% of the Dutch energy consumption will consist of renewable energies by 2020.

The national government of the Netherlands set targets for new construction to be energy neutral by 2018 (Ministerie van Economische Zaken, Landbouw & Innovatie, 2011). Making use of natural energy sources is becoming more important in the application of installation techniques for buildings to save energy costs. According to research from SBR, the building sector uses 40% of the total primary energy use, living and service together. Thinking and acting differently contributes to reducing the CO-2 emission and reduced energy pollution and costs (SBR).

Implementing energy service companies (ESCos) is an arising concept and relatively new for the cure market. A few hospitals are starting to implement energy performance contacts, outsourcing parts of the energy supply chain to an energy service company. At first glance a lot of opportunities for hospitals to outsource exist. Overall hospitals lack the capacity to actively deal with energy savings. The user and maintenance company do not have sufficient knowledge and experience on the energy subject (Builddesk, 2011). A lot of energy and money can be saved by applying sustainable energy systems and installations which can be implemented by energy service companies. According to van AgentschapNL and Heumen and Traversari, a healthier, safer working and living environment can thereby be created (van Heumen & Traversari, 2010) (AgentschapNL, 2010). The developments mentioned in this paragraph form the main reason for this research.

1.2 FIELD OF INTEREST

Due to its high potential, the interest for the concept of energy service companies is growing and growing, scientifically as well as commercially. Gert-Jan Peeks states that the implementation of energy service companies involves a new way of thinking both for the supplier and the client. A precondition is that building owners leave their traditional way of thinking and tendering. This new way of thinking creates a lot of opportunities with which a lot of energy savings can be achieved (Peek & van Remmen, 2012). What is necessary to change the cover of thought for the cure market will be investigated in this research. The energy saving potential, especially for the target market of hospitals, is high as will be explained by the literature study (Builddesk, 2011). This research aims to contribute to an understanding of the cure market needs and potential of energy service companies in this market.

Scientific relevance: The last year, a couple of scientific graduation reports on the subject of energy service companies have been written under the guidance of the Technical University of Eindhoven and knowledge cluster KenWiB^2. These reports have been created in cooperation with companies to ensure the practical application. Since the concept of energy service companies is relatively new in the Netherlands, scientific underpinnings are highly recommended. Scientific research methods support the practical commercial field on a more abstract level. Existing research methods already used in other fields proved to assist aspects of the new concept of energy service companies in earlier graduation projects. For this research the proven methods of Analytical Hierarchy Process (AHP) and System Dynamics (SD) in combination with Monte Carlo simulation (MCS) are used to give insight in the considerations of the client and key performance indicators and to create a business case incorporating uncertainty.

Commercial relevance: More and more companies are looking for ways to incorporate the principles of energy service companies. Kuijpers aims to take the role of an energy service company for their current markets. Although Kuijpers is a commercial company, their aim is to create a win-win situation in implementing sustainable installation techniques. With the implementation of an energy service company both the client and environment are better off since energy and costs savings are achieved. According to Albert Hulshoff and AgentschapNL, new business cases should be created based on trust and performance (AgentschapNL, 2013). Since one of the target markets of Kuijpers consists of health care with great potential, this research focuses on hospitals in particular. The high potential of the cure market will be elaborated further ahead in this report. Numerous aspects of energy service companies still need attention for the implementation to succeed. Especially financial and performance risks have to be constrained and flexible contracts and business models should be created (Te Boekhorst, 2012). The energy bill in the cure and care market can be lowered up to 25% according to Agentschap-NL, ActiZ and energy centre MKB (Zeijpveld, 2010). Energy Service Companies are able to play a key role in taking over the financial risks, knowledge grounds and manpower (International Finance Corporation, 2011). A lot of energy savings and costs can be saved by applying sustainable energy systems and installations which can be implemented and maintained by energy service companies (Builddesk, 2011).

Personal relevance: The subject of energy service companies is an interesting and topical subject. An opportunity was taken at the university and company where a combination of scientific and commercial knowledge can be acquired. New concept development creating new business cases stimulates the creative mind. New concepts always have to fit into society which is quite a challenge. Introducing technological developments to current markets is what interests me, playing on the dividing line of the fields of industrial engineering and construction management.

1.3 PROBLEM DESCRIPTION

The main problem statement listed in the box below shows the main problem of this research. The research questions that will be explained in the fifth paragraph of this chapter touch upon this problem area to come up with conclusions and recommendations to solve the problem by the end of the project.

> A lack of insight in the willingness and considerations of hospitals to collaborate with energy service companies exists while substantial and profitable energy savings can be achieved.

The priority for outsourcing the issue of energy using energy service companies in the cure market in the Netherlands is low while substantial and profitable energy savings can be achieved by collaboration with energy service companies (NL Energie en Klimaat, 2010). The problem is that supply and demand are not aligned. On both the supply and demand side several misunderstandings, ambiguities and lack of trust are present (Builddesk, 2011). In general the concept is relatively new in the Netherlands and there is a distrust towards other parties. I state that also in the current hospital market a misbalance between the considerations and ambitions of hospitals, energy service companies and financial institutions exist. A pilot project 'Energy saving measures for health care' has been organized by Actiz and the Energiecentrum MKB in 2010. They state afterwards that there is a high willingness of health care institutions to save energy but the available capacity to actively deal with energy saving measures is lacking. This is mainly due to the extensive task that has to be executed within the broad field of facility management. A lack of knowledge on specific energy saving possibilities can be observed within health care institutions (Actiz; Energiecentrum MKB, 2010). A lot of health care institutions still do not apply sufficient energy saving measures, despite appropriate advice reports. Suggestions and conclusions from these reports are not yet translated to actions. The user of the building and maintenance company do not have sufficient knowledge and experience on the energy subject over the whole supply chain (Builddesk, 2011). Some measures are taken but are relatively short-term oriented. A board of direction agrees on investing in energy saving measures, only if the payback period is short (Actiz; Energiecentrum MKB, 2010). Thereby the priority is low since energy costs are only a short percentage of the total costs of a health care institution. From interviews with hospitals a percentage of approximately 1-5% of the total budget is estimated. The primary process of health care needs a lot of attention and value development of the buildings is less of an issue. Another obstacle can be a cultural difference concerning outsourcing energy which is closely intervened in the primary process of climate control in hospitals (Actiz; Energiecentrum MKB, 2010). There might therefore be a perception of risk in the minds of a hospital.

1.4 PURPOSE OF THE RESEARCH

The main objective for this research is listed in the box below.

> To give insight in the consideration framework of hospitals in their decision to collaborate with an energy service company and the measures to be taken to respond to hospitals to cooperate in ESCo projects.

The goal of the research is to advice the energy service company about how they should behave in the cure market to eventually put their product on the market. This research will assess the most important needs of the hospitals to outsource. Also the different attitudes towards energy service companies between hospitals and within hospitals will be assessed. Hospitals have a rather complex decision-making structure. In order to implement the concept of energy service companies in hospitals, the structure of the organization should be clear. It is important to know who are the initiators, the influencers and the decision maker eventually. This differs per hospital in the Netherlands but some general conclusions should be derived. A precondition for a successful implementation of energy service companies within the cure market is that the concept is an added value for the hospital, which should also be tested in this research.

According to AgentschapNL, outsourcing to an energy service company results in the most optimal maintenance and control based on energy performance. Increased value and quality can be created by ESCos with expertise in energy efficiency, renewable energy, water conservation and reduced emissions based on energy savings contracts (AgentschapNL, ESCo voor Wederzijds Voordeel en Gratis Energiebesparing, 2012). Energy service companies have a high incentive to provide high-quality equipment, timely services, financial control and thorough project commissioning. However it is important that good references and flexible contracts are created (Te Boekhorst, 2012). Flexible contracts are to a great extent based on key performance indicators (KPI). The importance and bandwidth of the most relevant KPI should be found. Another obstacle that should be overcame is the risk perception of the client as well as the energy service company. When risks are incorporated in the business case, trust for both parties can be increased. These measures should be able to take away the obstacles and to stimulate the need for energy service companies in my opinion.

The demand of hospitals for energy service companies should be clear but also the type of energy service company that can be put on the market. This research will therefore comprise a kind of market analysis and business case.

1.5 RESEARCH QUESTIONS

The main research question that should be answered by the end of this research is listed in the box. This question directly relates to the research objective and problem area, outlined in the previous chapters.

> How can we improve the implementation of Energy Service Companies in the cure market?

1.1 Which contract types and options of energy service companies can be distinguished?

1.2 What are the stakeholders involved in an ESCo project and how are they structured?

1.3 What is the status, potential and what are the risks of implementing energy service companies for hospitals?

1.4 Which kind of hospitals has the highest potential for energy service companies?

2.1 What are the most important considerations of a hospital to engage in an ESCo-project?

2.2 What are the differences between hospitals in the attitude towards energy service companies?

2.3 What are the differences within the organization of hospitals in the attitude towards energy service companies?

2.4 What are the most important key performance indicators that can be incorporated in an energy performance contract for hospitals?

2.5 Is the combination of System Dynamics and Monte Carlo Simulation an effective and useful method in estimating the bandwidth of key performance indicators and risks within the business model of an energy service company?

3.1 How should an energy service company respond to the considerations of a hospital?

3.2 How does a most optimal energy service company look like for the cure market?

The main research question can only be answered when all the sub questions listed above are answered before. The first four questions will be answered by the literature research. With the answers on these questions, the other question can be answered by the research methodologies of Analytical Hierarchy Process, System Dynamics and Monte Carlo Simulation and deriving conclusions and recommendations from them. The numbers of the research questions can also be found in the research design in paragraph 1.8.

1.6 RESEARCH BOUNDARIES

Although a wide network of stakeholders is involved in an ESCo project, this research focuses on the client, with the hospital in particular, the financial institution and the energy service company. For this research within the organization of a hospital, financial directors, facility management, technical service and the real estate department play a role.The other stakeholders are mentioned in the literature study and are taken into account in the literature study but are not the main subject of interest. For example, some external influences like the regulations of governmental organizations should be taken into account but are only present in the boundaries of the process.

According to 'Stichting Kien' the following considerations for further development of the ESCo are necessary (Te Boekhorst, 2012). This research focuses on the aspects in bold. Logically the aspects will be elaborated for the cure market specifically.

- **Covering financial and performance risks.**
- Governmental assurances and guaranteeing conditions
- **Developing financing constructions**
- Setting up a knowledge platform for all the stakeholders
- Standardization of performance contracts and ESCo-business models
- **Defining critical key performance criteria**

1.7 READING GUIDE

The basis of this report is written in the previous paragraphs highlighting the problem, research questions and purpose of this research. In the next chapter an overview of all used scientific research methods is given. The first part of the research design consists of the literature research where the concept of energy service companies is explained, stakeholders are analyzed and the threads and opportunities of ESCos for hospitals are described. Expert interviews are part of this research phase supporting the literature study and models. The second part consists of field research and modeling. Analytical Hierarchy Process and Regression analysis is applied to assess the market demands and System Dynamics in combination with Monte Carlo Simulation is used for a dynamic sensitivity analysis of a business case. In the last part the results are presented and conclusions are derived, giving answers to the research questions. Based on these conclusions recommendations and a vision for a most optimal energy service company for the cure market is shared.

1.8 RESEARCH METHODS

At first, expert interviews in the field of hospitals and energy service companies and additional experience of Kuijpers should appoint the most important considerations of hospitals towards energy service companies. A set of considerations and key performance criteria will be provided in a survey to respondents. Respondents will answer questions related to ESCos and compare the key performance indicators pair-wisely. The data outcomes will be processed by the method of Analytical Hierarchy Process. Regression analysis will be used to identify interaction effects of variables from the questionnaire. System Dynamics is used to set up a business case. Monte Carlo Simulation incorporates the most important risks within this business case. The research methods will be elaborated in detail in the upcoming paragraphs. An overview of the research design with all steps that should be taken, is shown in Figure 1-A. The numbers at the different steps correspond with the research questions.

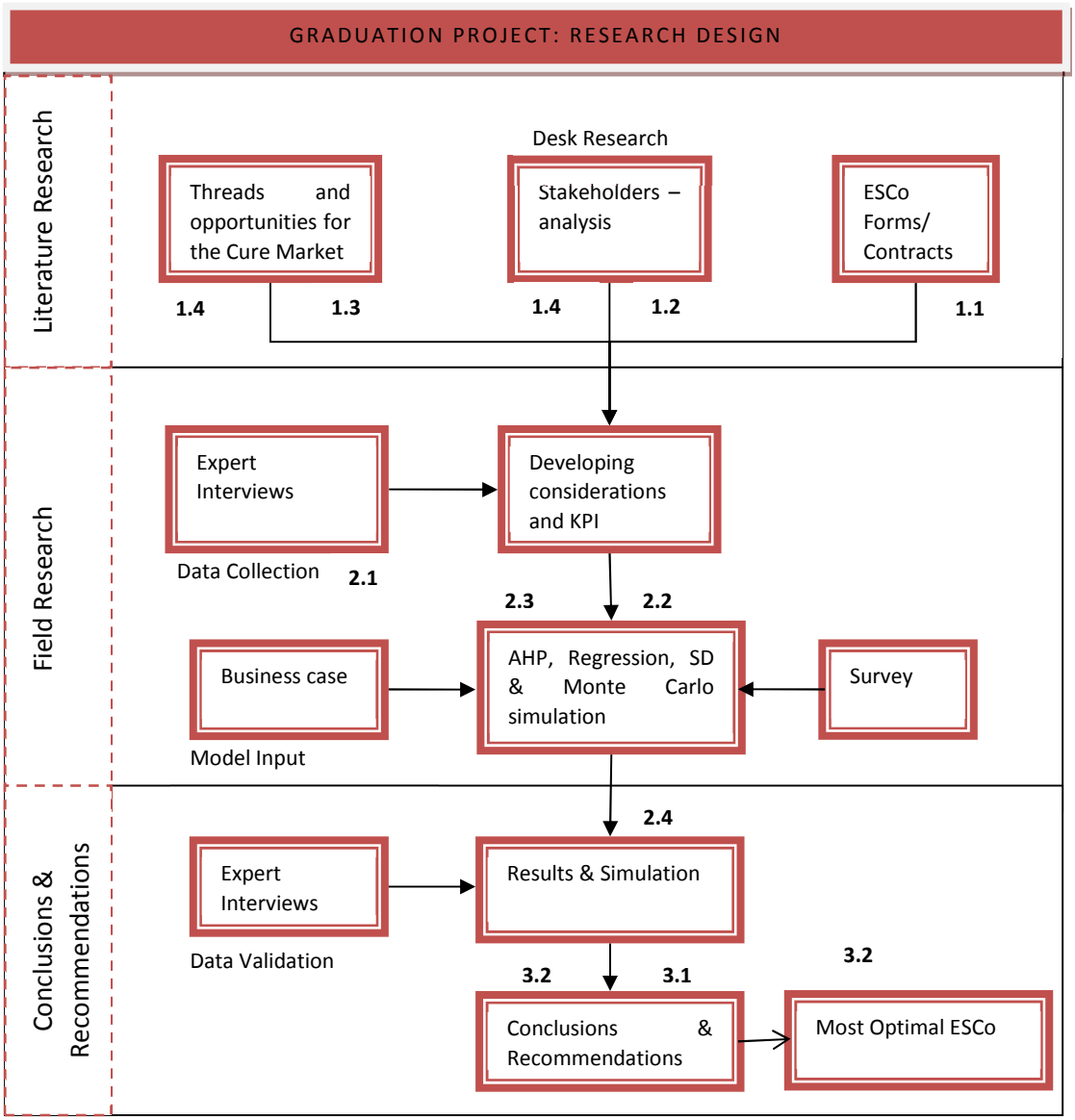


FIGURE 1-A: RESEARCH DESIGN (DEVELOPED BY AUTHOR)

1.9 ANALYTICAL HIERARCHY PROCESS

The Analytical Hierarchy Process (AHP) is a decision-aiding method developed by Thomas L. Saaty in the late seventies. It aims at quantifying relative priorities for a given set of criteria on a ratio scale, based on the judgment of the decision-maker, and stresses the importance of the intuitive judgments of a decision-maker as well as the consistency of the comparison of alternatives in the decision-making process (Saaty, 1980). Each element in the hierarchy is considered to be independent of all the others. Because the method is able to structure tangible and intangible factors which influence a decision making process in a systematic way, it is widely used to support complex decision making in which multiple stakeholders are involved. The Analytical Hierarchy Process method is based on the following three principles:

- **Decomposition**: the decision problem is decomposed into a hierarchy that captures the essential elements of the problem.
- **Principle of comparative judgment**: assessment of pair-wise comparisons of the elements within a given level of the hierarchical structure, with respect to their parent in the next-higher level.
- **Synthesis principle**: takes each of the derived ratio-scale local priorities in the various levels of the hierarchy and constructs a composite set of priorities for the elements at the lowest level of the hierarchy. In this final step, the goal is aggregate the relative weights of the levels obtained in the previous step to produce composite weights, this is done by means of a sequence of multiplications of the matrices of relative weights at each level of the hierarchy. The relative weights are generated after five iterations of multiplications.

Before using Analytical Hierarchy Process the objective or goal is stated and the selection criteria are defined. When this is done, the Analytical Hierarchy Process is used to complete the following steps:

- Arranging the information; goals, criteria, and sub criteria, into a hierarchical model.
- Constructing the hierarchical model with the goal or problem to be solved at the root and the evaluation criteria as nodes.
- Using pair-wise assessment to determine the relative importance of each criterion and each alternative.
- Pair-wise assessment specifies which criteria is more important, preferable, or likely, with respect to its parent node (the goal or the selected criterion).
- Judging each criterion as to its relative importance to the goal.
- Use the AHP mathematical process that generates relative ratios of measurement, to rank the priorities from the pair-wise assessments.

1.9.1 CONSISTENCY ANALYSIS

After the Principal Eigen Value has been obtained, the Consistency Index (CI) can be calculated. The goal is to compare this CI with the Random Consistency Index (RI), depicted in Table 1-A. Professor Thomas, L. Saaty, who introduced the AHP research method in 1980, has defined these RI by investigating numerous AHP experiments. He decided that in order for a dataset of answers on an AHP-experiment to be consistent that the Consistency Ratio

(CR) should be 10% or less (Teknomo, K. 2006). The underlying formulas are listed below. This will be incorporated in the Analytical Hierarchy Process data analysis.

1. $CI = \frac{\lambda\, max - n}{n-1}$
2. $CR = \frac{CI}{RI}$

TABLE 1-A: RANDOM CONSISTENCY INDEX (RI) RELATED TO THE NUMBER OF CRITERIA (N) (TEKNOMO, 2006)

n	1	2	3	4	5	6
RI	0	0	0.58	0.9	1.12	1.24

1.10 LOGISTIC AND MULTIPLE REGRESSION

The method of logistic and multiple regression will be used to interpret the data output of the questionnaire. At first with correlation some descriptive information can be obtained. Correlation indicates the interaction of two variables. However correlation does not tell anything about the predictive power of variables. The subsequent step is the regression analysis where one variable is predicted by another. Multiple regression seeks to predict an outcome variable from several predictor variables. A general regression model is defined by the following equation:

$$Yi = b0 + bi * Xi$$

Where Yi is the outcome that should be predicted and Xi is the i'th respondents score on the predictor variable. b1 and b0 are known as the regression coefficients with b0 as the baseline constant. Logistic regression is nearly the same as multiple regression but with an outcome variable that is a categorical dichotomy and predictor variables that are continuous or categorical (Field, 2005) (Alriksson & Öberg, 2008).

The logistic and multiple regression analysis provides the descriptive and explanatory statistics of the dataset. The analysis is carried out by using Stata, a statistical program.

1.11 SYSTEM DYNAMICS

The System Dynamics method (SD) is used to understand complex issues by modeling it in a mathematical way. It represents real life problems with different scenarios and tests to realize an optimal result in the end. The public and private sector can be supported by system dynamics models with which policies can be designed. Dynamic systems characterized by interdependence, information feedback, mutual interaction and circular causality can all be modeled by using System Dynamics.

Causal loop diagrams (CLD) are flexible and useful tools to display the feedback structure of systems. It quickly communicates the important feedbacks responsible for a problem. The causal links among variables are represented by arrows from a cause to an effect. It shows the architecture and boundary of the model but does not show how variables are related. Stock flow models (SFM) are built on information from the causal loop diagrams, adding quantities to the variables. SFM emphasize the underlying physical structure. Stocks and

flows track accumulations of material, money and information as it moves through the system. Flows are the rates of increase or decrease in stocks. Stocks characterize the state of the system generating information upon which decisions are based (Sterman, 2000).

1.11.1 MONTE CARLO SIMULATION

Monte Carlo simulation is a technique used to understand the impact of risk and uncertainty in financial, project management, cost, and other forecasting models. Since energy service companies guarantee energy savings established in a contract over a long time, the project involves a lot of risks and uncertainties. These uncertainties should be incorporated in the business model of a project. Monte Carlo simulation generates a probability distribution of outcomes, indicating with what probability certain risks will most likely occur. The statistical method will eventually give insight in the following three aspects:

- Exceedance probabilities
- Range/bandwidths
- Individual risk contributions

The Monte Carlo simulation is carried out by using Vensim PLE Plus. Available input for the MCS consists of a minimum, maximum and most likely value of uncertain costs variables of the business case. The basis of the input will be described further on in the business case chapter. After the estimation of the minimum, maximum and most likely value, a distribution model is chosen that best represents reality. The accurateness of risk analysis relies heavily on the appropriate use of probability distributions. The probability distributions suitable for this research are the Triangle distribution and the PERT distribution, graphically shown in Figure 1-B.

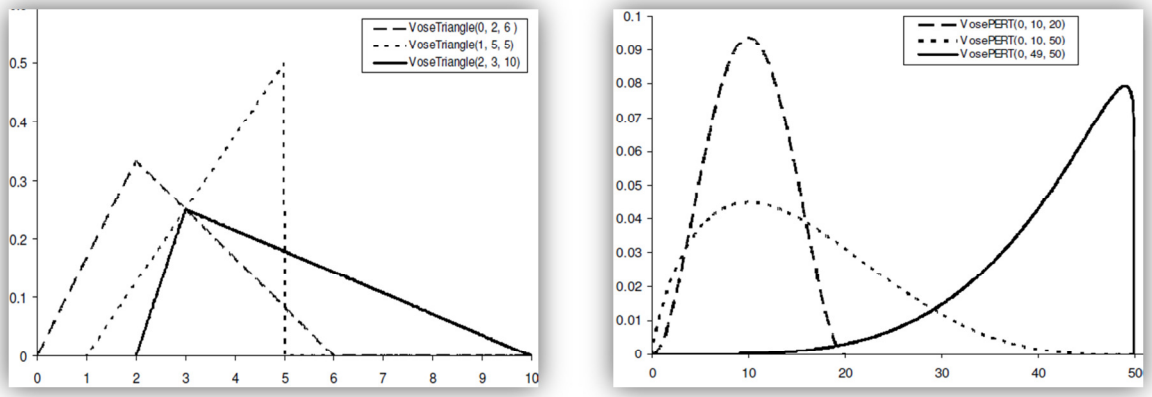


FIGURE 1-B: TRIANGLE AND PERT DISTRIBUTIONS (VAN HAUWERMEIREN, VOSE, & VANDEN BOSSCHE, 2012)

The Triangle distribution offers considerable flexibility in its shape, coupled with the intuitive nature of its defining parameters and speed of use. The PERT distribution also uses the most likely value, but it is designed to generate a distribution that more closely resembles realistic probability distribution. Unlike the triangular distribution, the PERT distribution constructs a smooth curve which places progressively more emphasis on values near the most likely value, in favor of values around the minimum and maximum (van Hauwermeiren, Vose, & Vanden Bossche, 2012). After simulation with 50.000 steps, output is generated graphically

in a histogram showing the bandwidth of a business case with all risks incorporated. A tornado plot is generated to estimate individual risk contributions of the parameters.

1.12 VALIDATION & VERIFICATION

Validating and verifying the designed scientific research models is a very important part of the development process. It makes sure that the models represent the intended system and the outcomes are real. According to John Sterman verification and validation is carried out on three fields (Sterman, 2000):

- **Comparison to reference modes:** Does the model reproduce the problem behavior adequately for the purpose?
- **Robustness under extreme conditions:** Does the model behave realistically when stressed by extreme conditions?
- **Sensitivity:** How does the model behave given uncertainty in parameters, initial conditions, model boundary and aggregation?

These test will be used for the System Dynamics and Analytical Hierarchy Process model. Validation and verification will be carried out by experts who will give their opinion on the System Dynamics model with Monte Carlo simulation and outcomes of the Analytical Hierarchy Process model. The input information for the questionnaire is also verified by different experts from hospitals. Experts on the field of energy service companies and installations from Kuijpers and scientific experts from the Technical University of Eindhoven are used to verify and validate the results.

Literature already addressed on the problem will be discussed from different perspectives. The most important findings from literature and articles on the subject of outsourcing to energy to energy service companies have been elaborated. The current status of the energy service companies in the Netherlands and the potential cure market will be dealt with specifically. The opportunities arising from the cure market for the transition of implementing energy service companies will be investigated. Within the stakeholders analysis, the energy service company is explained in detail because a lot of different forms of ESCos exist. The three key players in the process; the hospital, financial institution and the energy service company will be explored to see their power and interests.

2 STAKEHOLDERS WITHIN ESCO PROJECTS

A high amount of stakeholders in energy savings for the utility sector can be distinguished. A building can have an owner, user and operator. Those three functions can be reflected by the same party but most of the time it is represented by different parties (Builddesk, 2011). The structure of the organization of the hospital will be dealt with in paragraph 2.3. Most of the time an energy service company does not have the financial capital to invest in sustainable energy systems (van Renselaar, 2013). A bank or a fund acts as a financier for the projects in this case. Next to the depicted parties, also governments and all the (advisor) parties, that could be responsible for a part of the supply chain, play a role in the process. Governments can take the role of policy makers, regulator, user of a building or building owner (Bertoldi, Hinnels, & Rezessy, Liberating the Power of Energy Services and ESCos in a Liberalised Energy Market, 2003). The most important actors for this research are thus the energy service company, hospitals and financial institutions. The interviews with experts from hospitals and financial institutions will thereby give an indication of the most important considerations in implementation of energy service companies. A general example is shown schematically of the relations among the most important actors in Figure 2-A. However since the concept of energy service companies is rather broad, different relation structures result from the different forms of energy service companies which will be explained in the next paragraph.

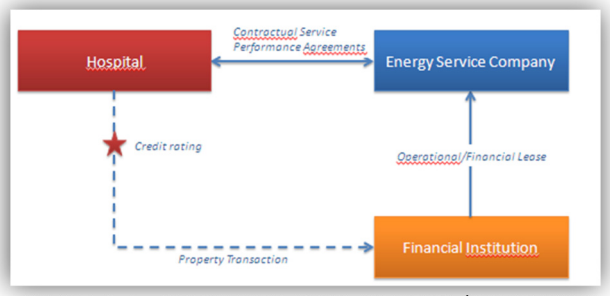


FIGURE 2-A: RELATIONS ESCO PARTIES (DEVELOPED BY AUTHOR

2.1 ENERGY SERVICE COMPANIES

This chapter will reflect on the definition and the role as a stakeholder. The definition for an energy service company maintained throughout this research holds (de Boer, 2011).

"Companies providing energy services to final energy users guaranteed in energy performance contracts, including, but not necessarily, the supply and installation of energy-efficient equipment, building refurbishment, maintenance and operation, facility management, finance and the supply of energy, accepting some degree of financial risk in doing so".

Notifying about this definition is that it is rather broad. The definition of an energy service company is a comprehensive collect term in which certain elements can either be included or not. Further on in this paragraph the energy service company will be divided in those elements to be used and referred throughout this research. Technically speaking a company can already be called an energy service company in case they maintain and operate a small installation for a remuneration according to the energy saved established in a contract. Energy service companies differ from other companies that offer energy efficiency or energy services in that the payment to the energy service company is directly linked to the amount of energy saved (in physical or monetary terms). Energy service companies (ESCo) should be distinguished from energy service provider companies (ESPC) (Bertoldia, Rezessyb, & Vine, 2006). Energy service provider companies provide energy services but are remunerated with a fixed fee and do not have the same clear incentive for energy efficiency as energy service companies (ESCo). Their main incentive is not reducing energy demand but rather reliability and safety, operation and maintenance. They do not have any risk in case of underperformance. They are paid on their service or advice instead of the results of their work which is the case for energy service companies (de Boer, 2011). Energy service companies are able to unburden the client by taking over the technical, financial and other risks (Ürge-Vorsatz, 2007). Energy Service Companies use Energy Performance Contracting to guarantee energy savings over a certain time. The definition according to the European Energy Service Initiative holds: Energy Performance Contracting is a contractual arrangement between the beneficiary and the provider (normally an ESCo) of an energy efficiency improvement measure, where investments in that measure are paid for, in relation to a contractually agreed level of energy efficiency improvement.

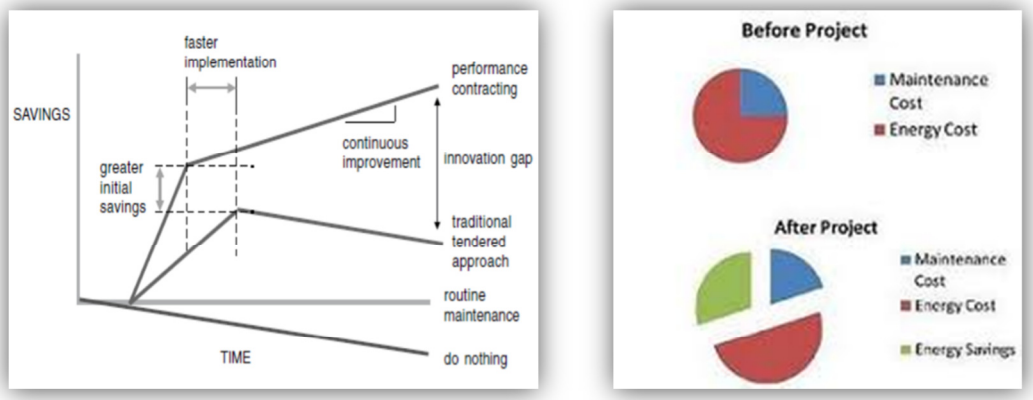


FIGURE 2-B: BUSINESS MODEL ENERGY SERVICE COMPANIES (ENERGY CHARTER SECRETARIAT, 2003)

The business model of energy service companies is graphically shown in Figure 2-B. Greater initial savings with a faster implementation are achieved in the first place. Due to the continuous responsibility of the energy service company to save energy through operation and maintenance a continuous improvement is achieved. Where an energy service company is not involved, savings often decline after the initial investment due to lack of maintenance or lack of attention to the detailed operational savings. This is reflected in the figure by the decreasing slope of the traditional tendered approach (Energy Charter Secretariat, 2003).

Energy service companies provide energy and costs savings for a hospital in this case by taking care of (either one of) the aspects depicted in Figure 2-C. Energy service companies need to add value to the current organization of a hospital. Energy service companies can be an added value for the client in that they have the knowledge, the technology, energy and money while making use of the legal framework (Sorrel, 2007). The client can be relieved from these tasks and accompanying risks.

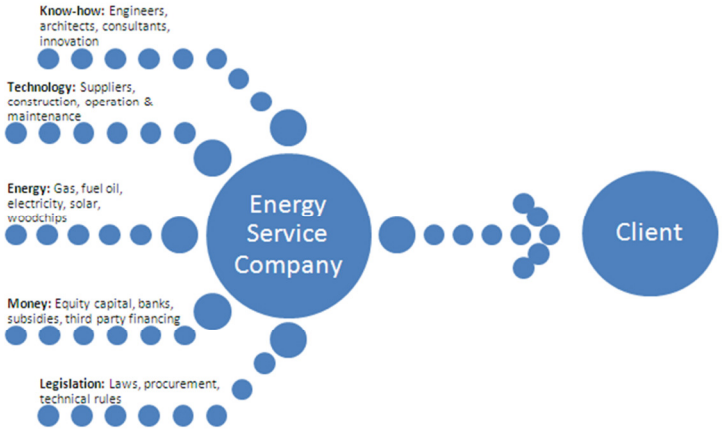


FIGURE 2-C: UNIQUE SELLING POINTS ESCO (SORREL, 2007)

In my perception most of the available models and options of Energy Service Companies from literature give a too one-sided picture. Either only a small part of the concept is described or a too broad model is outlined in which several options can still be distinguished. Soller proposed to describe the different forms of energy service contracts used by energy service companies in terms of *Scope, Depth* and *Method of Finance* (Sorrel, 2007). The depth, scope and method of finance can be varied, generating multiple options for an energy service company. When these three elements are combined, all potential options of the concept can be described in my opinion. The same division will therefore be used throughout this research, also incorporated in the survey.

Contract Scope: The *scope* of an energy service contract may be defined as: The number of useful energy streams and/or final energy services that are wholly or partially under the control of the contractor. All of the figures below in Figure 2-D show the different options for contracts in *scope*. Although this also says something about the depth, take in mind that the models can still be varied in *depth.*

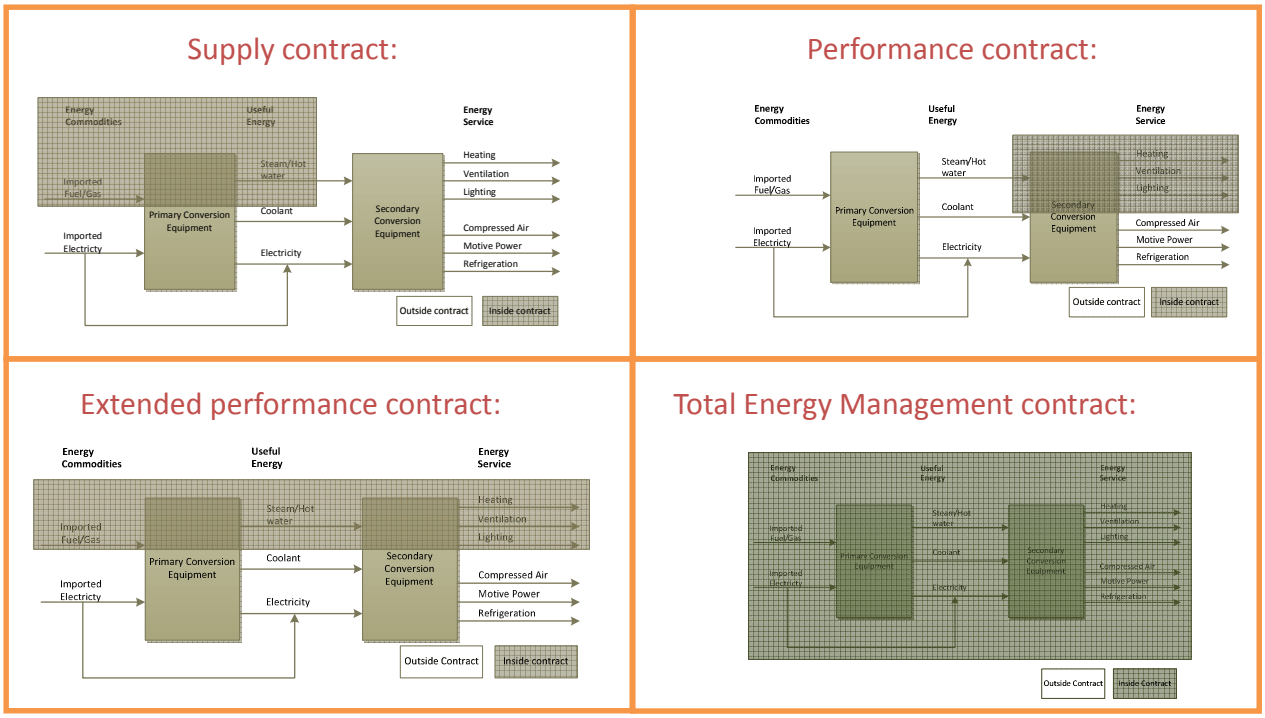


FIGURE 2-D: SCOPE ENERGY PERFORMANCE CONTRACT (DEVELOPED BY AUTHOR BASED ON RESEARCH FROM SORREL)

Contract Depth: For an individual useful energy stream or final energy service, contract *depth* may be defined as: The number of organizational activities required to provide that stream or service that is under the control of an energy service company (Sorrel, 2007). The contract depth can be related to the contract type since the composition of the elements together form a contract type. In assessing the different contract types for hospitals, the elements will be offered later on in this research to respondents from hospitals. When you take a DBFMO contract for example, the contract is represented by the following elements: the project design and engineering, installation, Project financing, Maintenance and Operations. Another contract model, where the Ownership element is important, is Build-Own-Operate-Transfer (BOOT). A BOOT model involves an energy service company in designing, building, financing, owning and operating the equipment for a defined period of time and then transferring this ownership to the client. In this case a Special Purpose Vehicle (SPV) is set up and this SPV is financed. BOOT contracts are often used in Public-Private Partnerships (PPP) and are comparable with DBFMO contracts. The following total of elements are composed in cooperation with Kuijpers:

- Energy purchasing
- Project design and engineering
- Equipment specification
- Installation,
- Operations
- Ownership
- Project financing
- Commissioning and maintenance of equipment
- Monitoring and verification of performance
- Staff training

Method of Finance: Projects involving energy service companies can be financed in three ways depending on the financial capital of the organizations. When the energy service company is able to take the financial risk they can invest in the project on their own. Also the client can decide to take the financial responsibilities. In this case an internal fund can be used to finance upfront investments depending on the guaranteeing on energy savings of the energy service company. Consequently the achieved energy savings benefit/credit the customer. However the client favors the other types of contracts most of the time. This form of contracting does not reflect our definition of energy service companies, since a fixed fee is paid to the supplier providing no additional incentive to energy efficiency. In the left picture of Figure 2-E only the cost streams are shown. In case both parties do not have the financial capabilities, Third Party Financing (TPF) can be a considerable option. Especially because non-profit organizations cannot make use of the tax arrangements like the EIA and MIA which can be utilized by energy service companies, also in case of Third Party Financing. However hospitals might in some cases be able to arrange financing with the municipality at low interest rates. The information is schematically summarized in Figure 2-E where different streams of costs and responsibilities can be appointed. Because TPF also involves the financial institutions, the models of Third Party Financing will be elaborated in the next paragraph more deeply.

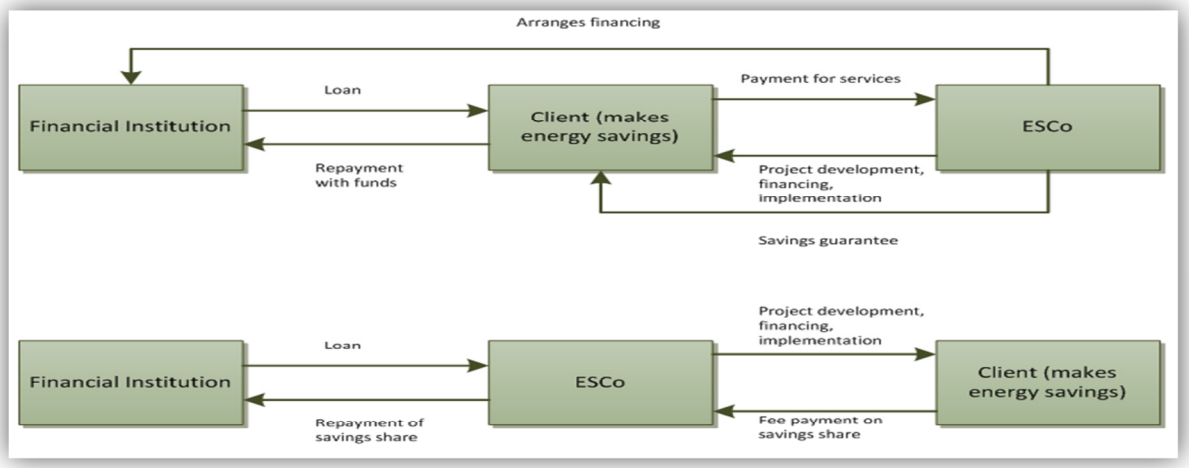


FIGURE 2-E: METHODS OF THIRD PARTY FINANCE (DEVELOPED BY AUTHOR BASED ON SEVERAL LITERATURE ITEMS)

2.2 FINANCIAL INSTITUTIONS

In case of Third Party Financing, financial institutions play an essential role. Due to accompanying large investments, the energy service company as well as the client do not have the knowledge and ability to arrange financing themselves. Financial institutions may provide a solution to this. Two basic financing models can be distinguished, schematically shown in Figure 2-E (SEAI).

- Guaranteed Savings Model
- Shared Savings Model

Within the guaranteed savings model the loan and the assets go on the client's balance sheet thus the client both has a contract with an energy service company and the financial institution. The energy service company only takes the performance risk while the client takes the credit risk. Due to these additional risks, the client is rewarded with a higher proportion of energy cost savings. In contrast to the guaranteed savings model, within the shared savings models the loan and assets go on the energy service company's balance sheet (SEAI). Both the performance and credit risk imply a higher incentive to save energy (costs) for the energy service company. These high risks imply a higher proportion of the energy cost savings to the ESCo. Logically these models require a creditworthy client and energy service company respectively. The creditworthiness of the client of energy service company is an important consideration for the financial institution to invest (Bertoldia, Rezessyb, & Vine, 2006). The shared savings concept is a good introductory model in developing markets because clients have little financial risks. However it limits long-term market growth and competition because new energy service companies with little experience are unlikely to enter the market with such financial risks. On the other hand, the guaranteed savings concept is difficult to use in introducing the ESCo concept in developing markets because it requires customers to engage a high investment risk (Bertoldia, Rezessyb, & Vine, 2006). The owner of a building will probably not engage in such a project, especially in the start-up phase. In addition, as could also be learned from the ESCo case in Rotterdam, an additional incentive for the energy service company exists when they also own the credit risk (Haagendijk, 2011). Also derivatives of the two models are possible. First Out is a method of finance in which the ESCO is fully paid of the energy savings until the project costs, including a pre-defined amount of ESCO profit, are completed. The exact duration of the contract thus depends on the level of achieved savings; the greater the savings, the shorter the contract.

To arrange financing using Third Party Financing, banks should be approached. According to the Energy Charter Secretariat, banks are risk averse per definition, especially within this period of time and can therefore be hard to approach as an energy service company (Energy Charter Secretariat, 2003). Derived from expert interviews with banks in the Netherlands, a credit application is rated on the quality of the management, financial ratios, the business case and the execution value of the building. This narrows down to the following characteristics of a credit application for an ESCo project:

- Cash flow characteristics
- Capital power
- Assurancy

There is a considerable risk since the value of the object to be leased is uncertain over time. The assurance of a project can be measured in terms of experience and status of the ESCo market. When the experience and knowledge of energy service companies increase, also the assurance of financing an ESCo project will increase. The total volume of the ESCo market can be very important in the future (Vreeken, 2012). The risks for the bank in financing an ESCo project are related to the following aspects:

- Little experience
- Technical risk, performance
- Technical risk, maintenance/durability
- Indistinct assurance position

- Multiple financiers
- Large pay back period
- Inmarketable buildings

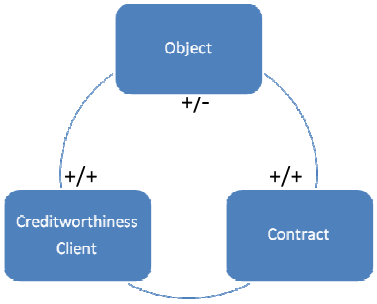


FIGURE 2-F: CONSIDERATIONS FINANCIAL INSTITUTION (BASED ON INTERVIEW)

How these (financial) risks can be tackled will be described in chapter 3.3 by using a SWOT analysis. According to Jack Wasser from the Lagelanden, a subsidiary of the Rabobank, the object, creditworthiness of the customer and the quality of the agreements between the involved parties should be kept in balance, graphically represented in Figure 2-F.

2.3 CURE MARKET

In contrary to the definition of the care market a rather straightforward definition exists for the cure market which constitutes of the hospitals. However the structure and real estate developments of hospitals are less unambiguous. In this paragraph the structure and characteristics of a hospital will be explained. Some hospitals will be more suitable for an energy service company than others. Public health care facilities, like hospitals and retirement homes, constitute an important part of today's society. The structure of the hospital has a large influence on their potential of outsourcing to an energy service company. The CBS distinguishes three kinds of hospitals in the Netherlands: *Academic Hospitals (UMC), Regional Hospitals* and *Specialized Hospitals.* The Netherlands currently occupies 106 hospital concerns and have a combined capacity of 55,000 people. The main characteristics for hospitals in the Netherlands are depicted in Table 2-A in which also the total operating revenues are presented (CBS, 2012).

TABLE 2-A: MAIN CHARACTERISTICS HOSPITALS IN THE NETHERLANDS (CBS, 2012).

	Number of Corporations	Operating Revenues (Million Euros)
Total Cure	106	21845
UMC	8	6866
General Hospitals	75	13775
Specialized Hospitals	23	1204

In Table 2-B the characteristics of energy usages for the care and cure sector are outlined. Hospitals use the most electricity and gas within the care and cure market resulting in high emissions and high energy costs (CBS, 2012).

TABLE 2-B: ENERGY USE HEALTH CARE INSTITUTIONS (CBS, 2012)

Cluster	Gas (*1000 m^3/Year	Electricity (MWH/Year)	Primary (PJ/Year)	CO_2 Emission (kton/Year)	Energy Costs (M€/Year)
Hospitals	237.600	741.600	15.2	842	163
Nursing Homes	213.000	518.300	12.3	672	130
Residential Care	210.000	511.000	12.1	757	146
Total	660.600	1.770.900	39.6	2.271	439

As stated earlier, within the total budget of a health care institution the part of the energy costs are low but can be lowered even more with little efforts. However within the budget of the facility management, the energy costs are substantial. Facility managers should feel the need the save energy. This effect has been derived from expert interviews with hospitals. Another event distracted from interviews is that the actual decision-maker for a potential implementation of an energy service company is the financial director. All other stakeholders are inferior to the financial choices. However strategic (real estate) decisions can hardly be taken without approval and participation of internal and external stakeholders like medical staff, financial institutions, health insurance companies and governmental organizations.

When looking at annual reports from hospitals, 'sustainability' has been increasingly mentioned last years. According to research from Ernst & Young the term sustainability is explicitly mentioned in annual reports and focuses on waste while half of the forty randomly selected reports also mention energy management. However this can also be assigned to copying behavior. Only some cases discuss the issue of energy in an extensive manner. Also no notification on sustainability is placed on the part of the report from the supervisory board. None of the reports mention that sustainability is discussed during one of the meetings (Ernst&Young, 2011). This indicates that the higher management levels of hospitals do not prioritize energy management. This indication will also be tested in the survey and interviews with financial directors later on in this research.

An important governmental vision is the enlargement of regulated market mechanisms in the health care sector to increase efficiency and to align with the patient wishes. In 2005 the Diagnosis Treatment Combination (DBC) has been introduced for the hospital centralizing the demand of the patient. Since then the financing for all activities and operations of the hospital and medical professionals derive from the demand of the patient instead of fixed tariffs (TNO, 2010). Another important financial characteristic of the hospital is that they have limited possibilities for profit sharing. The majority of all the hospitals does not have the possibility to share their profit since the rules have been sharpened recently. Hospitals can only share their profits if they have a solvability of at least 20 percent (Smit, 2013). According to benchmark research from BDO, only ten hospitals have a solvability larger than 20 percent (BDO, 2012). From annual financial statements from 2011, an approximate solvability of 15 percent could be appointed (Financieel Dagblad, 2013). According to the Law Admission Care (Wtzi) profits should be kept within the organization to strengthen own equity and to invest in the own organization (Kerste & Kok, 2010). This also means that energy cost savings directly influence the quality of health care provisioning.

The real estate of health care has been organized differently among hospitals. Fewer health care institutions remain the owner of the real estate. More and more collaboration is introduced with commercial real estate investors. Within these developments, in favor of the implementation of energy service companies in the cure market, is that the health care real estate is characterized by long-term rental contracts, attractive returns and solvent rentals (Jones Lang LaSalle, 2011) (van Oostvoorn & van Wonderen, 2011).

3 IMPLICATIONS TO ESCOS IN THE CURE MARKET

3.1 ESCO IMPLICATIONS

Potential obstacles for hospitals to implement energy to energy service companies can be derived from literature. Several literature articles and reports from foreign countries address a lot of barriers in implementing energy service companies (Bertoldi, How are EU ESCOs behaving and how to create a Real ESCO Market?, 2000) (Bertoldi, Hinnels, & Rezessy, Liberating the Power of Energy Services and ESCos in a Liberalised Energy Market, 2003) (Builddesk, 2011) (Energy Charter Secretariat, 2003) (Hansen, Bertoldi, & Langlois, 2009) (Institute for Building Efficiency, 2013). In essence these barriers correspond among the articles. However since the ESCo concept is relatively new in the cure market, no experienced obstacles within the Netherlands can yet be distinguished scientifically. However in most cases the barriers can be generalized because the market is nearly similar. The following causes for a lack of implementation of energy service companies are appointed in literature which will be elaborated further in this paragraph:

- Unknown concept
- Distrust and begrudge of profits
- No core activity
- Lack of financing models
- Technical risks/complexity
- Traditional Procurement frameworks
- Wrong image
- Little experienced need
- Split incentives

As discussed in the problem statement paragraph, a pilot project 'Energy saving measures for health care' has been organized by Actiz and the Energiecentrum MKB in 2010. They state afterwards that there is a high willingness of health care institutions to save energy but the available capacity to actively deal with energy saving measures is lacking. This is mainly due to the extensive task that has to be executed within the broad field of facility management. A lack of knowledge on specific energy saving possibilities can be observed within health care institutions (Actiz; Energiecentrum MKB, 2010). A lot of health care institutions still do not apply sufficient energy saving measures, despite appropriate advice reports. Suggestions and conclusions from these reports are not yet translated to actions. Some measures are taken but are relatively short-term oriented. A board of direction agrees on investing in energy saving measures, only if the payback period is short (Actiz; Energiecentrum MKB, 2010). Thereby the priority is low since energy costs are only a short percentage of the total costs of a health care institution. From interviews with hospitals a percentage of approximately 1-5% of the total budget is estimated. The primary process of health care needs a lot of attention and value development of the buildings is less of an issue. Another obstacle can be a cultural difference concerning outsourcing energy which is closely intervened in the primary process of climate control in hospitals (Actiz; Energiecentrum MKB, 2010). There might therefore be a perception of risk in the minds of a hospital.

Factors in the decision making process of the energy service company and hospital are standardization, knowledge and experience, scope, references, awareness and trust, finance, project management, execution of example projects and guaranteeing measures (Te Boekhorst, 2012). According to research conducted by the Institute for Building Efficiency, a limited financial capital for the large investment and an unclear treatment and accounting of the energy performance contract resist clients from cooperating. Little financial or legal incentives are provided by the public sector. The legal framework in favor of energy service companies is not enforced by governmental organizations. Although energy performance guaranteeing and financing can be taken care of, the technical and business risk still seems to be reflecting large conservative behavior of the client. A lack of expertise and understanding of energy performance contracts exist. A lack of trust and awareness is a logical consequence of the phase of the concept in which it is situated. Little experience has been obtained from the past in the execution of an ESCo project with only a few reference projects. This can lead to distrust and a wrong image of the possibilities of the concept in the Netherlands (Institute for Building Efficiency, 2013). Several researches indicate that a lack of trust is a major barrier in the implementation of energy service companies (Energy Charter Secretariat, 2003) (Bertoldi, Hinnels, & Rezessy, Liberating the Power of Energy Services and ESCos in a Liberalised Energy Market, 2003) (Marino, Bertoldi, & Rezessy, 2010)

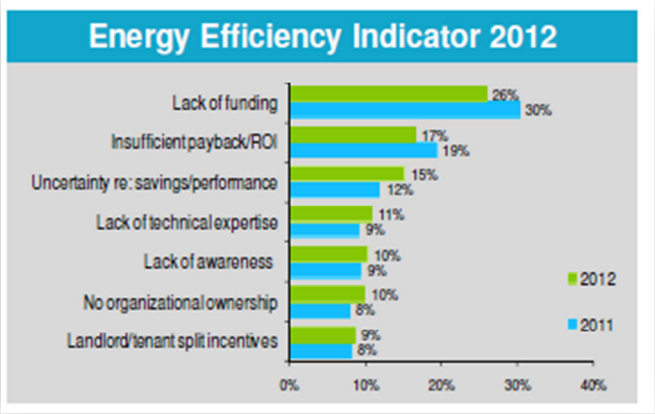


FIGURE 3-A: ENERGY EFFICIENCY INDICATOR 2012 (INSTITUTE FOR BUILDING EFFICIENCY, 2013)

Energy performance contracting in the public sector almost always requires public procurement and therefore needs to follow public procurement rules, such as a tendering obligation. Unfortunately, public procurement decisions are often taken centered on assets rather than energy services and based only on the best price without taking into account the lifecycle costs of new equipment. It is therefore very difficult to consider energy performance contracting in public procurement (Energy Charter Secretariat, 2003) (Marino, Bertoldi, & Rezessy, 2010). However in the Dutch cure market, regional hospitals do not have the obligation to follow public procurement (Rasenberg, 2012). In favor of ESCo projects, the clients should specify output specifications. The contractor/tenderer should be directed in headlines. The criteria should be based on the expected result instead of the way in which it is achieved. Even some tools exist to help weigh pros and cons of progressive contracts (TNO, 2010). According to TNO the time is ripe for such contracts for healthcare assets. The lifecycle costs of property is an increasingly important issue (TNO, 2010).

According to AgentschapNL, an energy service company has the most potential when the owner and user of a building are the same. When the owner and user of a building are not the same, several implications can be present whereas different interests exist creating a split incentive. When an owner decides to invest in sustainable energy savings measures, he also wants to benefit from the energy savings. In case of a renter of (part of) the building,

the energy costs saving and benefits will be passed on to the renter of the building. In this case the owner only benefits from the rent ability or potential increase of the real estate value of the building (AgentschapNL, Leidraad Green Lease: Naar Duurzaam Gebruik en Exploitatie van Gebouwen, 2011). Fortunately the structure of the hospital is in favor for energy service companies so this barrier is irrelevant in this research (Builddesk, 2011).

3.2 ESCO POTENTIAL FOR THE CURE MARKET

Although the implications explained in the previous paragraph are of significance, the potential for energy service companies for the cure market should be able to exceed its weaknesses and threats in my opinion. A lot of the implications for the successful transition to energy service companies are due to its novelty and traditional oriented organizations. It is striking to notify the lack of energy saving measures within the cure market despite societal and political attention and the available amount of instruments to stimulate the use for energy saving measures. This paragraph will show the potential characteristics and quantitative energy saving potential for hospitals and healthcare real estate. The paragraph closes with developments and trends in the health care real estate market influencing the need for sustainable energy systems and possibly also energy service companies in the cure market.

According to Builddesk the unique selling point of energy service companies comprises *neutralizing split incentives*, *guaranteed energy savings by energy performance contracts* and *investing without capital* (Builddesk, 2011) of which the split incentive is irrelevant for the cure market since the owner and user is the same for a hospital.

High energy intensive sector: The health care sector in particular has a high potential because the sector is energy intensive. In hospitals doctors and nurses are standing-by 24 hours a day and 7 days a week as well as the medical equipment. A lot of high energy efficiency improvements can be applied. Especially hospitals are of special interest to the ESCO industry because of its high energy consumption level, so an energy reduction of a few percent already leads to a relatively large amount of monetary savings (Builddesk, 2011). Within the academic hospitals, approximately 50 percent of all the energy is used for patient treatment, diagnostics and clinical research. A lot of energy is necessary for medical equipment and the desired air treatment (AgentschapNL, Resultatenbrochure convenanten meerjarenafspraken energie-efficiëntie, 2011).

Evolution of energy price levels: The energy prices have been rising sharply from 2000-2008 in the Netherlands. With the recession the energy prices were falling but are gradually rising again (van Dril, Gerdes, Marbus, & Boelhouwer, 2012). Despite general disadvantages of high energy prices, rising energy prices might result in a stimulant for alternative measures using energy service companies. For example Germany increased the energy taxes which was a main success factor for the ESCo business (Ürge-Vorsatz, 2007). There is a long time debate on the effects of the energy market liberalization on sustainability which is dependent of a lot of factors. Falling and volatile prices are also expected to have a negative impact on ESCo projects maximizing turnover and margins according to research from Vine, Bertoldia and Rezessyb. At the same time improved efficiency at the demand side may be fostered by distribution companies trying to retain consumers and attract new ones by offering energy

services as added value to an otherwise homogeneous commodity as electricity (Bertoldia, Rezessyb, & Vine, 2006).

Liberalization and Privatization Hospitals: Privatization and liberalization of hospitals increase the incentives to apply energy cost saving measures through improved efficiency, according to research from TNO. The vision of the government on health care is to enhance a regulated market to both stimulate the patient wishes as well as improved efficiency. The shift in the funding system of the health care sector creates an additional incentive to realize energy saving measures. In the traditional funding system, health care provisioning and health care real estate were decoupled. Hospitals were given budgets for their energy expenses. However since the first of January in 2012 the financing system for capital and energy expenses changed for the healthcare sector (TNO, 2010). The public allowances for these expenses have gradually been integrated in the tariffs of the health care packages. The funding system of the health care sector now focuses on performances and quality which makes it interesting to outsource non-core activities. Energy costs savings directly favor the budget for health care provisioning since the total compensation remains the same. All expenses considering accommodation are paid out of the fixed care level packages (Friedel, 2012). From now on hospitals should increasingly be aware of potential cost saving measures.

Energy Saving Potential: According to research conducted by TNO Dutch Centre for Health Assets (DuCHa), hospitals should be able to save energy from 12 to 25 percent on an annual basis. Some hospitals can even make half a Million Euros by using energy saving measures according to Andre Bode from TNO. An energy saving of 2.50 Euros per square meter is able to provide an average health care institution a saving of 20.000 Euros per year (AgentschapNL, Zorginstellingen, 2012). These costs savings can be used in turn to improve the quality of Health Care. The areas of lightning, ventilation and humidification have the highest saving potential. This has been concluded from master classes where nine hospitals from the region of Rijnmond participated (AgentschapNL, 2012). Langbroek and Quispel state that the indoor climate needs special attention in the interest of the patient. Hospital wards are cooled more extensively to a comfortable climate. The formerly heat demanding hospitals transfer to well cold heat balanced hospitals asking for new sustainable measures, also in renovation projects (Langbroek & Quispel, 2011).

Builddesk from the Netherlands published a report on the current activities and potential opportunities and threats of 'Energy Service Companies' (ESCos) in January 2011 (Builddesk, 2011). ECN estimated the total primary energy use of the utility sector in the Netherlands on 479 PJ in 2020 (April 2010), 460 PJ in 2005. In the Netherlands an expected technical savings potential for the utility sector of existing buildings is estimated on 4,7 PJ per year, saving 446 Million Euros. The market potential of energy service companies is set to 0,86 PJ, saving 69 Million Euros. The cure market constitutes a large part of this market. The most CO-2 reduction (0.32 Mton CO-2/Year) and energy savings (0.23 PJ/Year) can be reached in this sector. An overview of the utility market potential of energy savings is depicted in Table 3-A. Base point for the numbers in this table is an inventory model with the current transition of common measures and interventions on regular replacement moments. This table implies a high potential for energy service companies in the cure market in comparison with other sectors.

TABLE 3-A: OVERVIEW MARKET POTENTIAL ESCO (BUILDDESK, 2011)

Indicator	Education	Care	Shops	Offices (Private)	Offices (Public)	Industrial Buildings	Others	Total
CO-2 reduction (Mton CO-2/Year)	0.18	0.32	0.11	0.25	0.10	0.06	0.06	1.07
Energy Savings (PJ/Year)	0.13	0.23	0.09	0.23	0.09	0.05	0.05	0.86
Potential Market Revenue (Million Euros)	11	9	6	24	12	4	3	69

The market potential for the different sectors within the utility sector are shown in Table 3-B reflected in the scale, clustering, chance of success and contract period. The scale and chance of success for ESCo projects in the cure market are the highest of all sectors. The findings are based on expert judgment from Builddesk and feedback from expert panels. The chance of success is based on research on ownership structure from Mobius Consult and expert judgment from Builddesk with references (Builddesk, 2011). Notify that the percentages in this table are of qualitative nature which should be taken into account.

TABLE 3-B: MARKET POTENTIAL UTILITY SECTOR (BUILDDESK, 2011)

Market potential	Cure	Care	Offices	Industrial Buildings
Scale	100%	40%	90%	20%
Clustering	0%	40%	5%	5%
Chance of Success	55%	50%	45%	33%
Contract period	10 years	10 years	10 years	10 years

Regional hospitals are able to save a lot of energy with roof and floor insulation, heating boilers, lightning plans and system optimization. For new construction, a thermal storage installation has a high energy saving potential (Builddesk, 2011).

Healthcare Real Estate: The last couple of years, healthcare real estate developments are subject to trends in this sector. At first, a shift from supply-oriented to demand-oriented care can be observed. Hospitals want to focus on the patient. In the second place, the previously mentioned governmental set of laws and regulations affect health care institutions. Governments do not interfere anymore, shifting financial responsibility from public to private. Health care institutions have to strive for the best position in the market taking the high demands of patients into account. Last but not least; an increasing demand can be observed because of the aging population (Langbroek & Quispel, 2011).

According to van Oostvoorn & van Wonderen, healthcare real estate needs more attention since a limited cyclical sensitivity can be observed. Value development of health care real estate is most dependent on demographical developments. The long-term rental contracts for hospitals exceed twenty years for most of the time (van Oostvoorn & van Wonderen,

2011). These characteristics of healthcare real estate result in a lower level of risk for energy service companies in comparison with other sectors. In the market sectors of offices and commercial spaces, cyclically sensitive investments show a strong relapse/downfall (Jones Lang LaSalle, 2011). However the care and cure sector can even be seen as a growth sector as a result of ageing, high wealth, longer life expectancy and quality improvements of health care supply. However others state that a lot of uncertainties exist due to all the developments in the health care sector (Wessels & de Blauw, 2013).

The impact of sustainability of a building on the return on the real estate market has been questioned and is still not linked scientifically in the Netherlands. Following from similar research in the United States, Dutch research on the relation between the energy label and energy efficiency on the one hand and rent ability of a building is being conducted by DTZ Zadelhoff in cooperation with AgentschapNL at this moment. Reliable data on of Dutch real estate is necessary in this case. The positive relation between value development and energy efficiency has been proven in other countries but skeptics imply a total different real estate market structure in the Netherlands. According to Albert Hulshoff a research of sustainability and real estate of the Dutch market can be very useful. Two important financial institutions within the real estate sector, APG and PGGM, reported to make their investment property more sustainable. Also the public sector only rents buildings labeled with at least energy label C, indicating a focus on sustainability which is relevant information for sustainability investors (de Beer, 2011).

The external influences arising from laws and instruments from governmental organizations are described in Appendix A. The most relevant decisions and guidelines on a governmental level are schematically shown in the tree of decision making depicted in Figure 3-B. The influence of governmental targets on the implementation of energy saving measures is expected to increase in the future, derived from several interviews with hospitals. However at this time, little pressure is felt from governmental organizations.

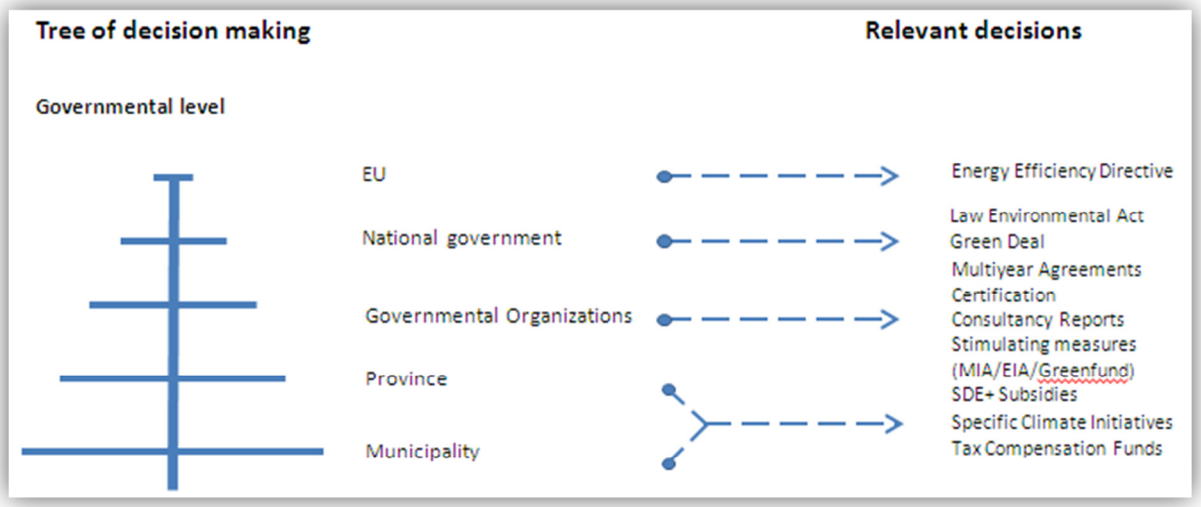


FIGURE 3-B: TREE OF DECISION-MAKING (DEVELOPED BY AUTHOR BASED ON LITERATURE)

In Figure 3-C the most important considerations for hospitals towards energy service companies are appointed as a summarizing overview of the last two paragraphs. In interviews with different working functions of hospitals these considerations have been validated.

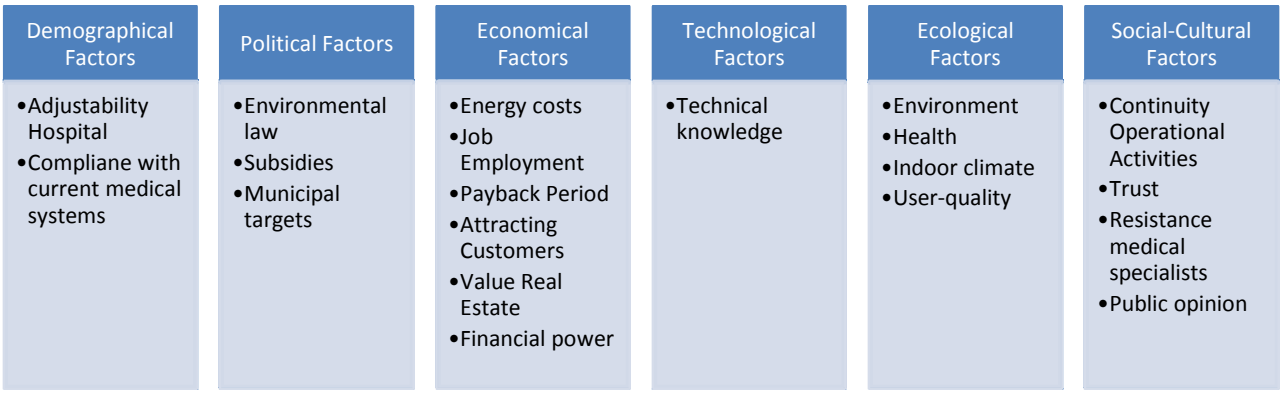


FIGURE 3-C: DESTEP ENERGY SERVICE COMPANIES IN THE CURE MARKET (DEVELOPED BY AUTHOR BASED ON INTERVIEWS)

3.3 SWOT ANALYSIS

The obtained knowledge in this chapter has been summarized in a SWOT-analysis to give an overview of all strengths, weaknesses, opportunities and threads in case of taking the role of an energy service company within the cure market. The analysis in this paragraph mostly resembles my own perception based on earlier findings. The strengths and weaknesses are internal oriented while the opportunities and threads are external oriented, arising from the cure market and environment. Strengths and weaknesses can be influenced directly by the energy service company while the opportunities and threats can only be influenced indirectly. In most cases the opportunities and threats are constants that should be anticipated by the energy service company. Strength and weaknesses are the advantages and disadvantages that an energy service company is able to deliver to the cure market. A strategy for the energy service company responding to the market is derived at the end.

An overview of all SWOT elements is depicted in Appendix B where the opportunities and strengths of the energy service company outnumber the amount of weaknesses and threats. However both the quantitative and qualitative behavior of the four elements should be taken into account. Therefore a qualitative analysis has been carried out on the three most influential strengths, weaknesses, opportunities and threats for the implementation of energy service companies, depicted in Figure 3-D. The numbers have been assigned based on intuition and expert interviews. A limitation of this qualitative SWOT analysis is that not every item is taken into account. This has consequences for the opportunities in particular, where relevant factors like the change in the funding system is also significant next to the opportunities addressed in the figure below. However some useful interpretations and conclusions can be derived from it, described beneath the figure.

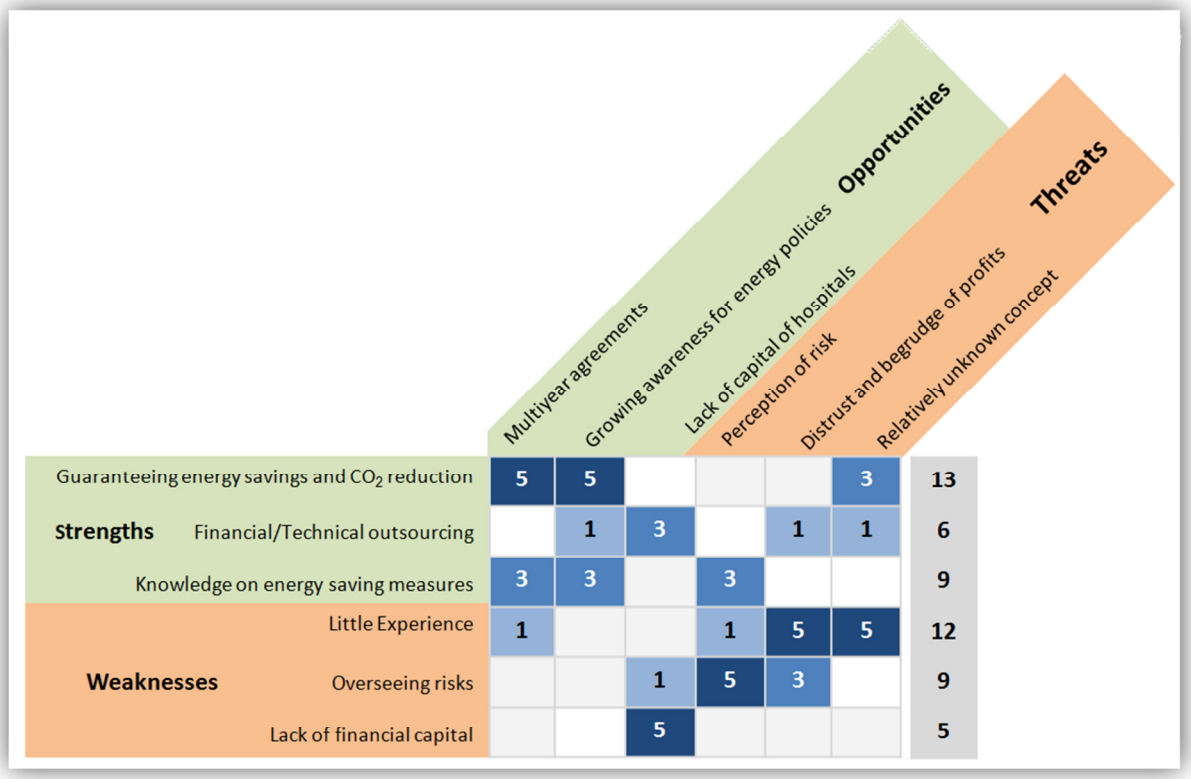


FIGURE 3-D: SWOT ANALYSIS FOCUS (DEVELOPED BY AUTHOR BASED ON LITERATURE)

As can be distracted from the figure ,strengths and opportunities complement each other while also the weaknesses and threats are highly related at the same time in implementing the energy service company concept for the cure market. The link between weaknesses and threats could be expected since the implementation is currently in the initial phase where a lack of trust exists by the hospital caused by the novelty and the lack of experience of energy service companies. Trust in the energy service company is crucial since it is a relatively new business concept, the contracts have a long duration and there is a lot of skepticism towards the business. By standardization and certification, trust can be created by clients in ESCO services. However, energy service companies themselves often prefer not be bound to fixed standard contracts but want to elaborate their own unique contract approaches instead. For this reason, standardization of key contractual provisions is often more helpful than complete standardized contracts. Standardization of measurement and verification, for instance through the International Protocol for Measurement and Verification (IPMVP), can be helpful in increasing trust of customers and banks in ESCO activities (Vine, 2005). The certification of ESCos is quite desirable from the point of view of clients. It can build confidence, ease the procurement process (particularly in the public sector) and it can even be a great marketing tool for energy service companies. An important issue to certification of ESCos and their services is the fact that any certification scheme should be backed by independent organizations and feedback of customers and ESCos should be taken into consideration. Implementation of an ESCo certification scheme avoids complex bureaucratic efforts and very high transaction costs. As the market of energy services is still a very young one high implementation costs could constrain the development of the Dutch ESCo market (Bertoldi, 2000). Energy service companies should build up a track record as quickly as

possible. For customers it is important to know what projects the energy service company has undertaken in the past and how the contractor performed previously. A track record is a very useful tool for clients to assess the competence of the energy service company. This will transform the three most important threats into opportunities; creating trust and willingness of the client. The connections between the strengths and opportunities favor the chance of a successful implementation. This means that demand and supply can be aligned when the weaknesses and threats are elevated. Threats might be countered by some strengths. For example, the perception of risk of the client can be negated by extensive knowledge and persuasion of the energy service company. The opportunities arising from the cure market in particular are the multiyear agreements of academic hospitals, the growing awareness of energy policies and the lack of financial capital but also the lack of knowledge on energy saving measures within hospitals. These opportunities should be seized by the energy service company by providing and guaranteeing energy savings and CO_2 reduction, using the knowledge and taking care of the financial aspects.

Analytical Hierarchy Process will be used to assess the needs and considerations of a hospital to implement energy service companies. Attributes in the list below can be distinguished for the wish of the client/hospital of an energy service company in the attitude towards outsourcing energy provisioning. The most important problems for the transition to energy service companies for the cure market should be derived from these considerations. Expert interviews with hospitals and experience of Kuijpers should further appoint the most important criteria. A varied set of criteria based on outcomes of expert interviews and studies will be presented to respondents and are then obliged to make pair-wise comparisons between those criteria.

4 MODEL

The scientific models used in this research aim to align supply and demand for energy service companies within the cure market. The demand for energy service companies is assessed by the questionnaire while supply is related to the business case where a system dynamics model is created and a Monte Carlo simulation is executed. In this business case a practical example with a sensitivity analysis using Monte Carlo simulation is presented. The sensitivity analysis is important since a lot of risks arise over a long-term contract. These risks have to be anticipated beforehand to prevent misunderstandings during the contract time.

4.1 LOGISTIC AND MULTIPLE REGRESSION

Logistic and multiple regression analysis aims to find the influences among the variables included in the questionnaire. In this research the differences between and within hospitals are investigated. Differences between hospitals are reflected by the characteristics of the hospital itself while differences within hospitals reflect different functions within the organization of the hospital. The purpose of the descriptive and explanatory analysis by using correlation and logistic and multiple regression is twofold: Next to finding causal relationships between variables, it also functions as a check whether the respondents completed the questionnaire in a logical way. When the need of the customer for the number of outsourcing elements rises, the need for an energy service company should also increase for example. From the regression analysis, conclusions can be derived on the preconditions of a hospital for the successful introduction of an energy service company.

4.2 ANALYTICAL HIERARCHY PROCESS MODEL

The purpose of the Analytical Hierarchy Process model (AHP) is to assess the relative weights of all the key performance indicators (KPI). The key performance indicators are objective and measurable values that can be used within energy performance contracts. By finding the relative importance of the key performance indicators, a focus on KPI can be estimated. The following paragraph elaborates on the key performance indicators that will be taken into account for the method of AHP.

4.2.1 KEY PERFORMANCE INDICATORS

Focus on output performance is an important element within the new cover of thought of energy efficiency. The hospital should learn to let go, not to think in solutions directly but in describing the expected end result. In March 2013 a new document on defining key performance criteria was published by AgentschapNL (van den Herik, Hulshoff, van Roskam, & Adema, 2013). The document focuses on the maintenance and operate phase but is broadly applicable. These guidelines give insight in the potential aspects that should be present in an energy performance contract. The client and the energy service company should be willing to base the performance on output and trust since a long-term relationship is established. In order to do so, quantifiable key performance criteria should be agreed upon within a contract. A good relationship is always based on trust but some boundaries should be set. This way the performance of the energy service company is measurably and objectively evaluated. General phrases should be avoided but the contract should also not be too extensive. When the energy saving performance is under or overestimated, a bonus or penalty for the energy service company should be agreed upon beforehand. The penalty or bonus for the energy service company is based on the predetermined values of the key performance criteria. The different key performance criteria are subdivided in five groups. All the aspects will be shortly explained with practical implementation examples in Table 4-A.

TABLE 4-A: DESCRIPTIONS KEY PERFORMANCE INDICATORS (DEVELOPED BY AUTHOR BASED ON LITERATURE FROM AGENTSCHAPNL)

	Key Performance Indicators	Description	Measurement
Service (people)	User experience	The service provisioning can be reviewed and valued by the different stakeholders of a building by distributing a questionnaire to the users of a building.	Questionnaire with a rating of 1 to 5.
	Status installations	Installations should be on a specific technic status level agreed beforehand.	Checklist NEN2767
	Malfunctions	The amount of malfunctions on a monthly basis can be distracted from the 'Building Control System' (GBS)	Number of malfunctions per month
	Response time	The response time is the maximum amount of time per malfunction after fault signaling.	Number of hours/days depending on type
	Safety	Safety can be incorporated in an energy performance contract by controlling compliance with legal requirements and mandatory inspections.	Checklist of legal requirements
Sustainability (planet)	Energy use	The expected energy demand can be estimated based on reference levels and baseline values. The actual energy use should be checked regularly during the contract time.	kWH/m^2 electricity or m^3/m^2 gas on an annual basis
	Efficiency installations	The efficiency of the installations can be represented in terms of the coefficient of performance (COP). Deviations of the COP result in a change of delivered energy.	COP-value
	Energy label	Valuation of a building introduced according to European guidelines. Acquiring a sustainable label can be a target for building owners. All new building have to be labeled with an energy label.	Label A -G
	BREE-AM certification	Voluntary indication of the sustainability of a building. Several indicators serve as the underlying basis for the certification.	Excellent, very good, …
Costs (Profit)	Energy costs	In a broader perspective when the operations phase is included the energy costs might be a better alternative than the energy use.	Euros / m^2
	Maintenance costs	Agreements on the level and development of the maintenance costs. These costs can be influenced by the supplier in contrast to the energy costs.	Euros / m^2
Comfort (People & Planet	Thermal indoor	Temperature of the indoor space measured by a thermometer. Different values of temperature can be assigned per type of room.	Degrees of Celsius
	Air quality	Air quality on the basis of measurements of CO^2 concentration.	ppm
	Lightning and scenic vision	The quality of lightning and scenic vision based on measurements of a lux meter.	Lux
	Acoustic indoor	A decibel meter can be used to measure the quality of an internal space acoustically.	Decibel levels
Innovationn (Planet &	Renewal	Over time several improvement measures can be implemented to increase the energy savings even more. This indicator can be implemented to increase the supplier to innovate continuously.	Number of implemented improvement proposals
	Revision Information	Revision information should be up to date for the client in order to control. Implemented revisions are to be documented regularly.	Sample test of presence revision information

4.3 SYSTEM DYNAMICS

As input for the business case and System Dynamics modeling and following from the literature study, a Causal Loop Diagram (CLD) has been created using Vensim PLE. With this mind map a broader understanding of the functioning of the market is created. The causal links among variables are represented by arrows from a cause to an effect. A plus indicates a positive causal relation while a minus represents a negative causal relation. It does not matter where to start in the model. The Causal Loop Diagrams in Figure 4-AFigure 8-A and Figure 4-B show the causal relations among all relevant variables. The relations are described below the figures. The complete CLD can be found in Appendix C.

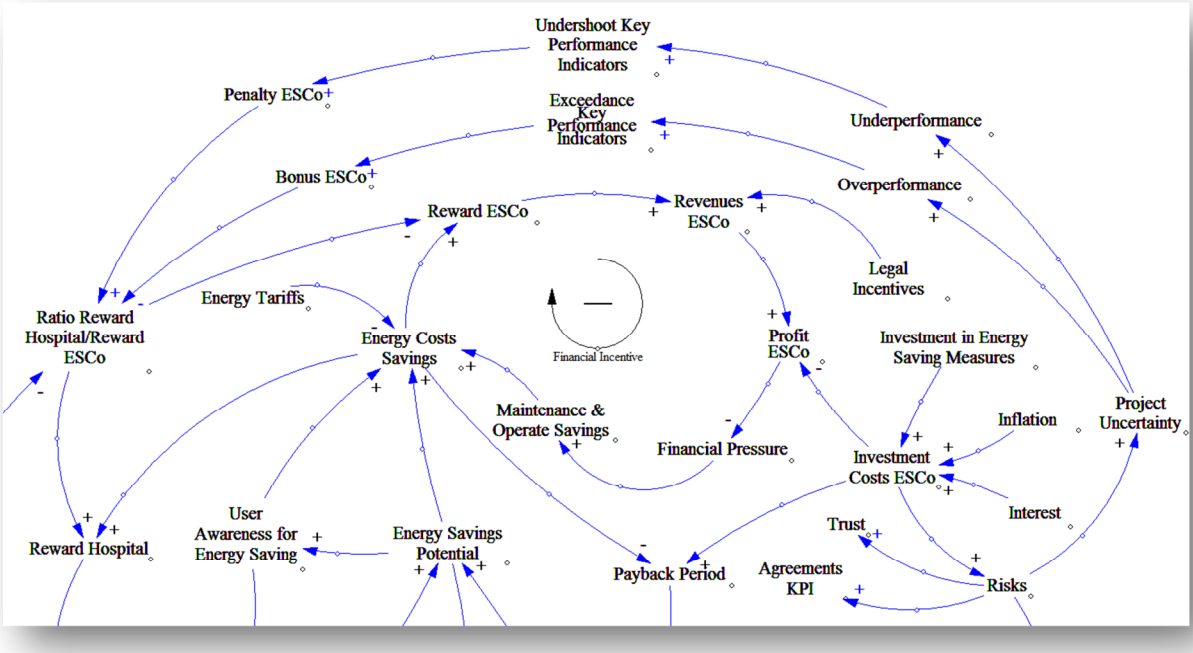


FIGURE 4-A: CAUSAL LOOP DIAGRAM PART 1 (DEVELOPED BY AUTHOR)

Implementation of Energy Service Companies involves risks and uncertainty because of the long duration of the collaboration between the client and the ESCo including high investment costs. Higher investments costs over a long period imply higher risks. High risks of the project need to be anticipated by a good balance of trust and agreements on key performance indicators. In case of high risks with more project uncertainty, there is more chance of over- or underperformance during the contract time. An underperformance dropping below the bandwidth of the established key performance indicators results in a penalty for the energy service company. In case of over performance, the bandwidth of the KPI is exceeded and a bonus is achieved by the energy service company. The actual performance determines the distribution of rewards between the hospital and ESCo. Higher rewards from a good performance of the ESCo results in higher revenues, which is also dependent of subsidies (EIA/MIA). More revenues for the energy service company result in a higher profit which is also dependent of the total (investment) costs. However in case the profits are decreasing, the energy service company will feel more financial pressure. This effect creates more incentive to compensate by saving energy through good maintenance and operations. The financial incentive to save energy on all aspects is one of the unique

selling point of an energy service company in my opinion. This way the total energy costs savings are higher because the energy service company is responsible for multiple aspects. For example, when the energy service company is only responsible for maintenance of an installation, the calibration of an installation system is less important implying less total energy savings. Higher energy costs savings is also caused by lower energy tariffs and more user awareness for energy saving. The payback period is dependent of the total investment costs and savings generated over the contract time.

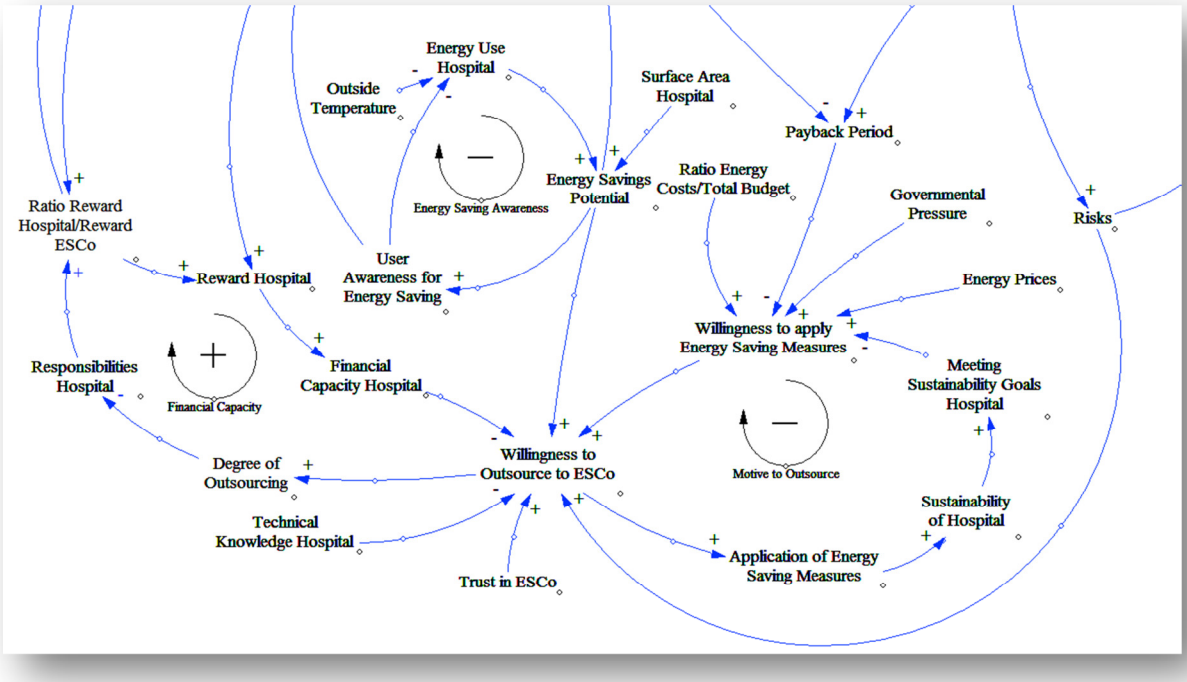


FIGURE 4-B: CAUSAL LOOP DIAGRAM PART 2 (DEVELOPED BY AUTHOR)

The second part of the CLD model depicted in Figure 4-B focuses on the willingness to outsource. The motivations have mainly been distracted from the literature study. A higher willingness to outsource is caused by a high energy savings potential, amount of risks, trust in the energy service company, a lack of technical knowledge and lack financial capacity of the hospital. The degree of outsourcing is determined by the willingness to outsource. The degree of outsourcing tells something about the responsibility of the hospital. When the degree of outsourcing is low, the responsibilities and risks for the hospital remains high, which is also reflected by the share of rewards. This can increase the financial capacity of the hospital in turn, closing the positive feedback loop. The willingness to apply energy saving measures, a precondition of the willingness to outsource, is dependent of the governmental pressure, energy prices, payback period and the sustainability goals of the hospital. The strength of these relations have been discussed in literature. When the willingness to apply energy saving measures is high, the chance of application of energy saving measures increases. Energy saving measures increase the sustainability of the hospitals, meeting sustainability goals of the hospital. When the goals are met, the willingness to apply energy saving measures decreases, closing the balancing feedback loop. The link from the energy savings potential to the user awareness for energy saving has not been proved scientifically

but should be the case to my perception. User awareness will decrease the energy use in total. This will make hospitals shared responsible for the actual energy savings.

4.4 MONTE CARLO SIMULATION

Risks and uncertainty have to be incorporated in the business model of the case. Energy performance contracts over 10 years are no exception. In this time a lot of positive and/or negative developments influences the process (Bertoldia, Rezessyb, & Vine, 2006). Different scenarios should be forecasted to be able to anticipate on fluctuations and to see whether the business case is interesting to follow up. Monte Carlo simulation (MCS) will be used for the sensitivity analysis of the business case. The specific business case for this research deals with an energy service company implementing a heat-cold storage installation. Although some specific details of the installation are included, the model can be generalized easily. In the business case several assumptions are made about the future. Three scenarios have been established in cooperation with Kuijpers Ecopartners and its operation department. The starting points and uncertain parameters that could vary over time are listed in Figure 4-C. Forecasts on the electricity price indexations have been distracted from CBS statistics (CBS, 2012) and figures from ECN (van Dril, Gerdes, Marbus, & Boelhouwer, 2012). Only the electricity prices are taken into account because it concerns a heat-cold storage installation. Maintenance costs indexation will probably differ from electricity price indexation. Other input information is based on expert opinions of earlier experiences on the possible future outcomes. The coefficient of performance is an important indicator for the efficiency of a heat pump. It reflects the required amount of electricity to provide heating and cooling. A potential risk is that the efficiency of the installation worsens over the contract time affecting the energy costs directly. Also the actual energy usage of the user could probably deviate from its expected value. The installation is subject to malfunctions affecting the fixing costs within the maintenance costs. This risk is incorporated by the percentage repair costs of the total maintenance costs. The minimum, maximum and expected values are used as input for the Monte Carlo simulation to incorporate risks in the business case.

FIGURE 4-C: ASSUMPTIONS BUSINESS CASE AND PARAMETERS MONTE CARLO SIMULATION (DEVELOPED BY AUTHOR IN COOPERATION WITH KUIJPERS)

Dependent variable	*Unit*	*Affects the*	*Expected Value*	*Uncertainty range*
Interest debt	%	Investment costs	5,7%	-
Indexation standing rights	%	Revenues	0%	-
Payments per year	Dmnl*	Total costs	12	-
Indexation loan	%	Labor costs	2%	-
Indexation electricity	%	Energy costs	6%	4-8%
Energy usage	kWh	Energy costs	90%	70-100%
Coefficient of Performance	Dmnl*	Energy costs	3.5	2.5 – 4,5
Indexation maintenance	%	Maintenance costs	2%	0 – 6%
Percentage repair costs	%	Maintenance costs	100%	80 – 120%

*dmnl → dimensionless

PART 3 RESULTS & CONCLUSIONS

5 RESULTS

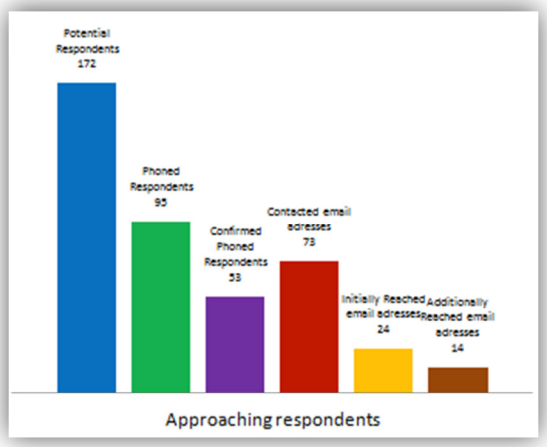
5.1 ANALYTICAL HIERARCHY PROCESS

All results from the questionnaire will be presented in this paragraph. The results will be of descriptive nature; the derived conclusions based on the results are presented in the next chapter. The results can be divided in descriptives, correlation and regression, consistency and relative weights. The consistency and relative weights are part of the Analytical Hierarchy Process analysis while the descriptives and correlation and regression analysis describe frequencies and potential interaction effects of variables included in the questionnaire.

5.1.1 TARGET GROUPS

The selection and approach of the respondents is an important part of this research to eventually get the most accurate and reliable results. The respondents should be working in a hospital environment with a function related to energy and installation techniques or contract management. A head of technical services, a facility manager, contract manager and energy purchaser within a hospital meet these criteria.

At first a search on hospital, facility management and technical services on LinkedIn and the network of Kuijpers created a large list of 172 names that could be approached. Of these persons, 95 people answered a phone call of which 53 persons confirmed to complete my questionnaire when I would send a link to the questionnaire by email. Main reasons to not participate were; not having time or a perceived lack of technical knowledge. All the phone calls were made using the general number of the hospital on behalf of the technical university of Eindhoven. Because I already had some email addresses from the network of Kuijpers, I was able to email a total of 73 potential respondents with a link to my questionnaire. 24 respondents completed my questionnaire after the initial email. After two reminders a total of 37 respondents completed my questionnaire. This amount of expert respondents turned out to be plenty enough to be able to carry out the AHP analysis. Requests on specific groups on LinkedIn were posted but it did not generate a single response. Approaching the respondents personally by telephone was essential for the high response rate. An overview is schematically shown in the graphs of Figure 5-A.



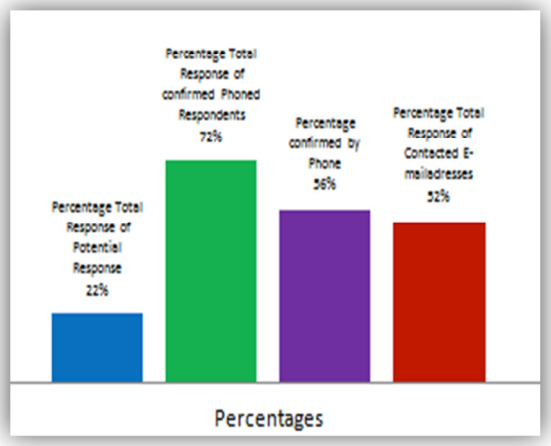


FIGURE 5-A: (PERCENTAGES OF) RESPONDENTS

5.1.2 DESCRIPTIVES

The descriptives have been distracted from the data set of the questionnaire by using Stata, a statistical package. All results in this paragraph are thus derived from 39 respondents of the questionnaire. The following figures and diagrams indicate frequencies and relative importance of individual variables directly resulting from the answers to the questions of the survey. One of the first questions asks for the perceived priority of the energy policy of the executive board. More than half of the respondents indicate that the priority of the energy policy is significant in the hospitals as can be seen in Figure 5-B.

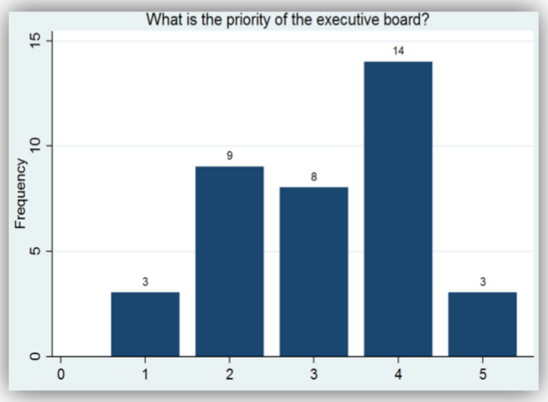
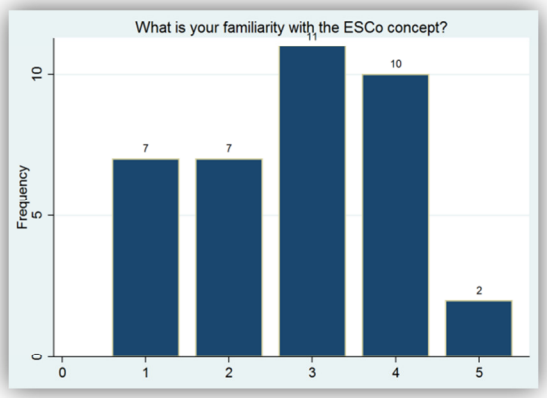


FIGURE 5-B: PRIORITY ENERGY POLICY

An important control variable is the familiarity of the respondent with the concept Energy Service Company. When the respondent is completely unknown with the concept, the answers on the other questions are less reliable. A rating of 5 indicate that the respondent is very familiar with the concept while a rating of 1 indicate that the respondent is very unfamiliar with the concept. As can be seen in Figure 5-C the majority of the group of respondents are familiar with the concept of energy service companies. A perceived influence of medical specialists on the decision to outsource is not experienced. In Figure 5-C 30 respondents rate the influence 1 or 2 on a scale of 1 to 4.



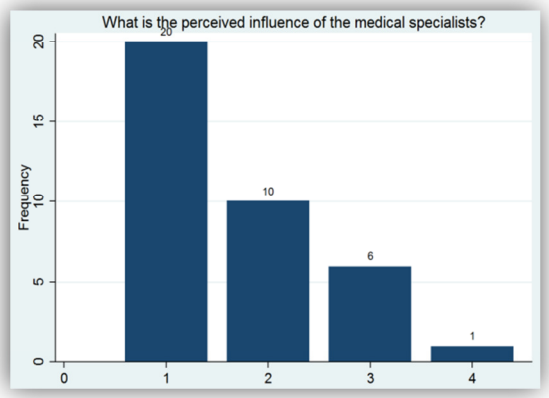


FIGURE 5-C: FAMILIARITY ESCO AND PERCEIVED INFLUENCE MEDICAL SPECIALISTS

Respondents were able to check the hospital's category of gross floor area and construction year. With the answers on these questions, differences between hospitals might be identified for the attitude towards energy service companies. It appeared that the categories of both variables are widely spread over the dataset. This implies a varied set of hospitals on which potential correlation and regression results might possibly be found, described in the next paragraph. Most hospitals fall in the category of 40.000 to 100.000 square meters with some extremes on both sides. Next to differences between hospitals, also differences within the organization of a hospitals in the attitude towards energy service companies might be identified. People with different working areas were approached to complete the questionnaire. Target groups are the technical service and facility management. In the questionnaire the respondents were specifically asked for their specialism. Next to facility management and technical service, respondents could check contract management and/or energy purchase. The latter two represent a small group of the respondents. Facility managers and heads of technical service can be perfectly divided in two groups. The information above is graphically shown in the three diagrams in Figure 5-D.

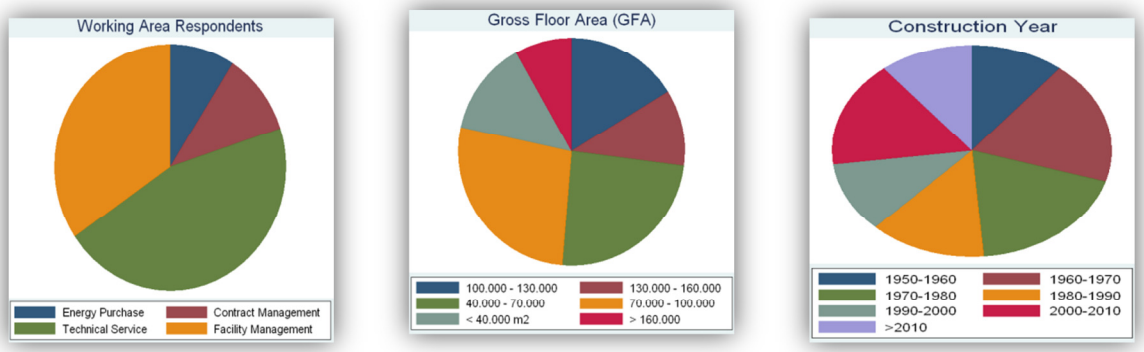


FIGURE 5-D: DESCRIPTIVES FUNCTIONS, GFA AND CONSTRUCTION YEAR

The respondents were asked about the motives to outsource to an energy service company. From literature two most important motives were addressed in terms of technical and financial outsourcing (AgentschapNL, ESCo voor Wederzijds Voordeel en Gratis Energiebesparing, 2012) (Bertoldi, Hinnels, & Rezessy, Liberating the Power of Energy Services and ESCos in a Liberalised Energy Market, 2003) (Bertoldi, How are EU ESCOs

behaving and how to create a Real ESCO Market?, 2000) (Bertoldia, Rezessyb, & Vine, 2006) (Hansen, Bertoldi, & Langlois, 2009). Hospitals might not possess the technical knowledge and financial capital to operate themselves. Almost half of the respondents group indicate that financial outsourcing is a motive to outsource to an energy service company. However technical outsourcing is less of an incentive to outsource since merely a quarter indicate that technical outsourcing is a motive. 10 % of the total group respondents view both aspects as a motive to outsource. The answers to the motives are summarized in the diagrams of Figure 5-E.

FIGURE 5-E: DESCRIPTIVES FINANCIAL AND TECHNICAL OUTSOURCING

Monitoring and the use of energy performance contracts are important elements within the concept of energy service companies. The current activities on these elements are shown in Figure 5-F. 80 percent of the respondents state that they make use of monitoring of energy performance. Nearly a quarter of the respondents make use of energy performance contracts. Important to note is that energy performance contracts might only cover maintenance and not the full energy supply chain. This means that only a small amount are making use of energy performance contracting indicating the novelty of the energy service company concept. Currently only 10% imply to use both monitoring and energy performance contracts.

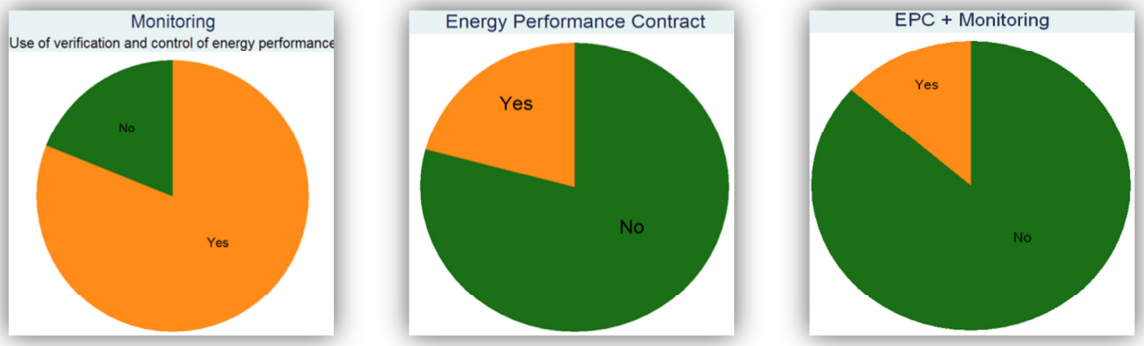


FIGURE 5-F: DESCIPTIVES MONITORING AND ENERGY PERFORMANCE CONTRACT

The attitude of hospitals towards energy service companies is distracted from the question for the most optimal type of ESCo and desired contract depth. The options for both questions are based on the literature study. For the type of ESCo, respondents can be split into two groups. Merely half of the respondents think the current energy systems in the

hospital satisfy. The other half of the group favors the installation-ESCo. This indicates a very divided opinion. Most interesting is what determines the choice for an installation ESCo, outlined in the next paragraph. The contract depth relates to the desired phases that can be outsourced. Maintenance, financing, and the activities related to operations are preferred, although a broad distribution can be observed. Operations and maintenance are also the phases with a large energy saving potential, explained in literature study. The outcomes are summarized in the diagrams of Figure 5-G. A limitation of the questionnaire is that the Technical Service and even the Facility Management might have a conflict of interest with the introduction of Energy Service Companies. The next chapter will therefore elaborate on the perspectives of financial directors.

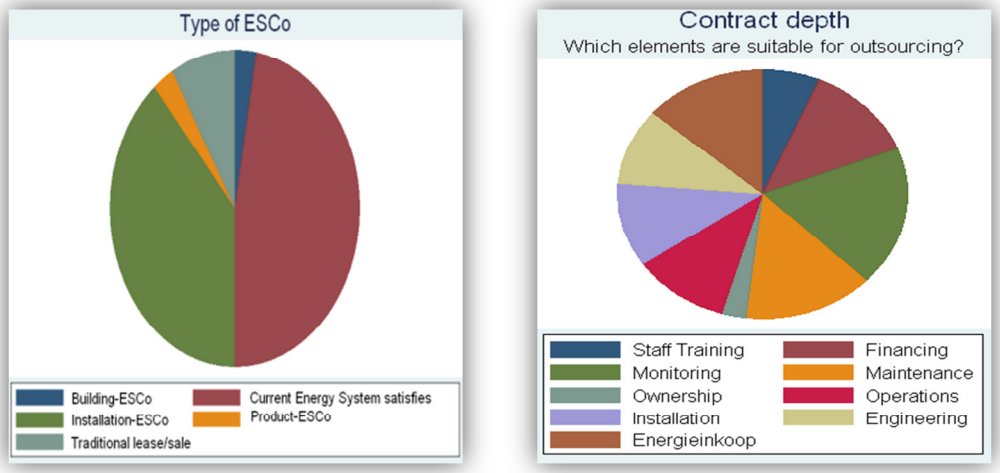


FIGURE 5-G: DESCRIPTIVES TYPE OF ESCO AND CONTRACT DEPTH

Respondents were able to check more phases than one within the contract depth. The amount of phases outsourced in the most optimal situation, is shown in Figure 5-H. Only one respondent wish to outsource all phases and four respondents do not want to outsource anything. This means that a lot of hospitals search for a solution in the middle. Assessing the specific needs of hospitals towards contract depth is therefore recommended.

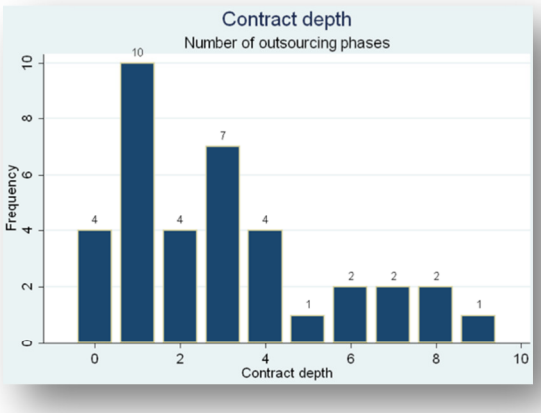


FIGURE 5-H: CONTRACT DEPTH NUMBER OF OUTSOURCING PHASES

5.1.3 CORRELATION & (LOGISTIC) REGRESSION

This paragraph continues on the last paragraph where the individual variables were explained. In this paragraph interaction effects and influences among the variables are described. Both variables that represent the attitude towards energy service companies are checked on correlation for verification. The number of desired phases to be outsourced is negatively correlated with the answer 'current system satisfies' and positively correlated with the wish for an installation ESCo, depicted in Table 5-A. This effect improves the assumption that the variables give an indication of the attitude towards energy service companies.

TABLE 5-A: CORRELATION CONTRACT DEPTH – TYPE OF ESCO

Correlation	Outsourcing phases	Current system satisfies	Installation ESCo
Outsourcing phases	1.00		
Current system satisfies	-0.3212	1.00	
Installation-ESCo	0.3195	-	1.00

The perceived priority for energy policy within the organization is positively correlated (0.4077) with the familiarity of the energy service company concept, shown in Table 5-B. When the attention for energy saving is high, energy service companies are taken into account. Furthermore a significant regression effect (0.012) with a coefficient of 0.39 of the familiarity could be identified with the priority of the energy policy as a dependent variable, shown in Table 5-C. This means that the concept of energy service companies is a relevant alternative in case of perceived emphasis on sustainability.

TABLE 5-B: CORRELATION ENERGY SAVING PRIORITY – ESCO FAMILIARITY

Correlation	Energy saving priority	ESCo familiarity
Energy policy priority	1.00	
ESCo familiarity	0.4077	1.00

TABLE 5-C: ESCO FAMILIARITY AND PRIORITY ENERGY POLICY

Linear Regression	**Dependent Variable: Priority energy policy**		
Independent variable:	Coefficients	Standard Error	Probability
ESCo familiarity	0.3859833	0.146137	0.012

The preference for an installation ESCo is predicted by the extent of which technical outsourcing is a motive. This means that technical outsourcing is a strong motive in the decision for an installation ESCo. The preference for an installation ESCo was not predicted significantly by a financial motive in this research. Although it is surprising, a possible explanation is that people from the technical service are less cost-driven. The effects are shown in Table 5-D.

TABLE 5-D: LOGISTIC REGRESSION INSTALLATION ESCO – TECHNICAL/FINANCIAL OUTSOURCING

Logistic Regression	**Dependent Variable: Installation ESCo**		
Independent variables:	Coefficients	Standard Error	Probability
Technical outsourcing	1.573796	0.8287984	0.058
Financial outsourcing	0.412988	0.7306859	0.572

Within the organization a difference exists for the motives to outsource. For facility managers the technical outsourcing is a strong motive to outsource while for the other groups no effect could be observed, shown in Table 5-E. The same is observed for the perceived influence of the medical specialists. Facility managers notify more influence of the medical specialists on the strategic decisions, as can be seen in Table 5-F. This is probably due to the fact that facility managers operate on a higher level in the organization.

TABLE 5-E: LOGISTIC REGRESSION TECHNICAL OUTSOURCING - FUNCTIONS

Logistic Regression	**Dependent Variable: Technical outsourcing**		
Independent variables:	Coefficients	Standard Error	Probability
Facility management	2.042341	1.046879	0.049
Technical service	0.7586044	0.9856254	0.441
Contract management	-0.7127658	1.386722	0.607

TABLE 5-F: MULTIPLE REGRESSION INFLUENCE MEDICAL SPECIALISTS - FUNCTIONS

Multiple Regression	**Dependent Variable: Perceived influence medical specialists**		
Independent variables:	Coefficients	Standard Error	Probability
Facility management	0.6731739	0.2855951	0.025
Technical service	-0.3653949	0.2995947	0.232
Contract management	-0.186762	0.4179057	0.658
Energy purchase	-0.4596214	0.4255525	0.288

Following the results from Table 5-G the willingness of implementing an ESCo is correlated with a lower floor surface (-0.5581) and older hospitals (-0.4875). This confirms the expectation that the necessity for older hospitals to outsource is higher. The most plausible explanation is that older hospitals have installations that require renovation. In case of a high floor surface the potential might be lower because the hospital consists of more buildings that all have different conditions. However these causes have not been proven scientifically yet.

TABLE 5-G: CORRELATION WILLINGNESS – GFA – CONSTRUCTION YEAR

Correlation	Willingness ESCo	Gross Floor Area Hospital	Age Building
Willingness ESCo	1		
Gross Floor Area	-0.5581	1	
Age Building	-0.4873	0.0000	1

5.1.4 CONSISTENCY ANALYSIS

An important part of the Analytical Hierarchy Process data analysis is the consistency check to ensure sufficient reliability of the model by calculating the consistency ratios. A consistency of at least 10% is demanded per set of pair wise comparisons. A respondent might both have a consistent set of comparisons as well as an inconsistent set of comparisons. All inconsistent set of comparisons are excluded from the model. As can be seen in Figure 5-I the number of consistent responses varies per set of criteria. The comparisons between the main criteria appeared to be most difficult for the respondents. The main criteria are also the most general criteria which have the most overlap. The comparisons between the sub criteria result in more consistent responses. Especially the comfort indicators could well be distinguished. The costs and innovation indicators only contain two sub criteria so do not include any inconsistency.

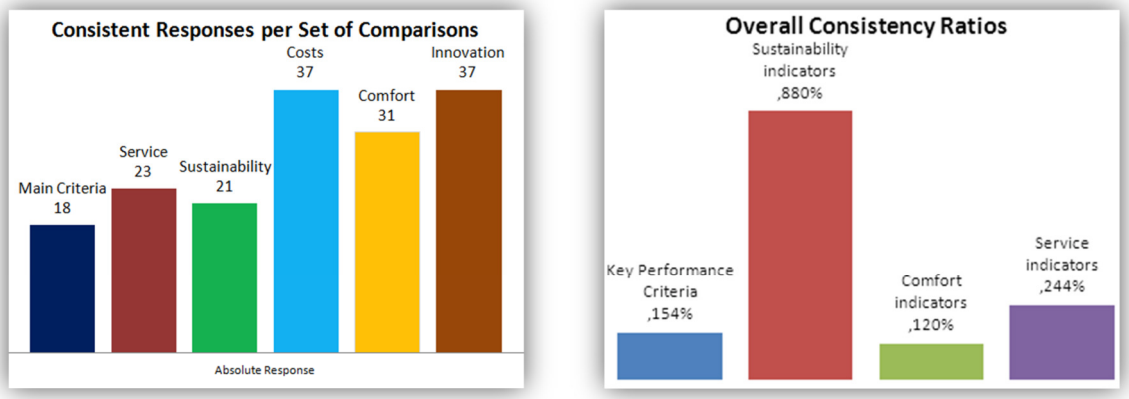


FIGURE 5-I: CONSISTENCY RATIOS

After the exclusion of individual inconsistencies, the general consistency ratio could be calculated. As can be seen in the right graphic of Figure 5-I the overall consistency ratios are low enough (below 10%) to guarantee reliable results.

5.1.5 RELATIVE WEIGHTS

Outsourcing to Energy Service Company shifts the responsibilities and risks to the other party. Outsourcing means that the ESCo needs to deliver a service objectively. The last part of the Analytical Hierarchy Process analysis result in the relative weights between the indicators that can be incorporated in an energy performance contract. The weighing factor per value indicates the relative importance of the indicator, derived from all respondents. Descriptions of all the key performance criteria are listed in Table 4-A. The relative importance of the indicators within the set of main criteria is graphically presented in Figure 5-J. The costs, comfort and service indicators are emphasized by the respondents in contrast to the sustainability and innovation indicators. Innovation and sustainability indicators are given less priority. The low preference for sustainability indicators is a surprising result since energy use and efficiency of installations are commonly used as KPI. The lower focus on innovation indicators is expected because these are inferior to the primary process most of the time. It might also be harder to decide when to grant a bonus or distribute a penalty on

the basis of innovation. The other three emphasized KPI are directly related to the wishes of a hospital and considered as evenly important.

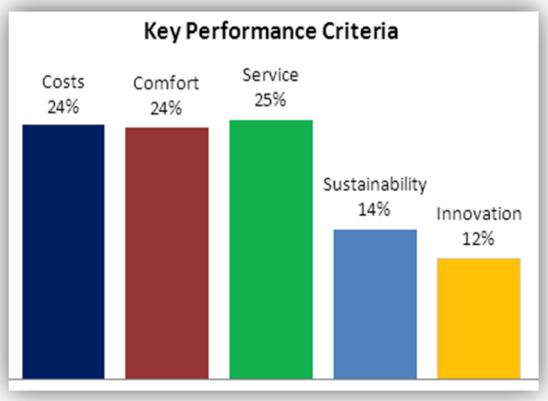


FIGURE 5-J: RELATIVE WEIGHTS KEY PERFORMANCE INDICATORS

The main criteria are divided in sub criteria. The service delivered by the ESCo can be established in terms of user-experience, malfunctions, status installations, response time and safety, as can be seen in Figure 5-K. Within the service indicators, safety (29%) is given the highest preference. The amount of malfunctions of an installation (22%) also proved to be important as an indicator. The indicators related to the functioning of installations and healthiness of the hospital is thus given the highest preference for a hospital. Response time (18%) seemed moderately important but can also be varied per type of installation which might improve the usability for this indicator. Service provisioning (16%) based on user experience is less important as an indicator. Implementing a questionnaire for users might be harder for hospitals than for healthcare facilities for example is my conclusion. The level of technical check (15%) is least important. This KPI might be neglected by the respondent because the Safety indicator is more encompassing.

For the sustainability indicators, the energy use (34%) and the installation efficiency (31%) are far more important than the energy label (18%) and certification(18%), as can be seen in Figure 5-K. This preference was already expected, the label and certification are probably too comprehensive and broadly as an indicator. The energy use and installation efficiency are dependent on each other but can both be used to give an indication of the sustainability.

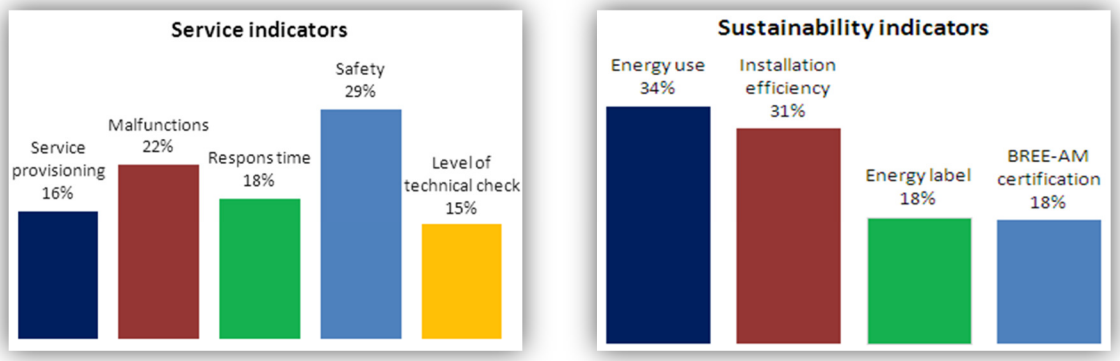


FIGURE 5-K: RELATIVE WEIGHTS SERVICE AND SUSTAINABILITY INDICATORS

Costs indicators have been divided in maintenance costs (56%) and energy costs (44%), graphically shown in Figure 5-L. The energy costs are overarching. A focus can be observed on the maintenance costs. This can be beneficial for energy service companies since maintenance costs can be influenced instead of energy costs. In addition the energy costs are compared with the energy savings as an indicator. When a client wants to focus on the deviation of a specific baseline, the energy savings as an indicator might be a solution. However the energy costs (60%) are preferred over the energy savings (40%), as can be seen in the right figure beneath.

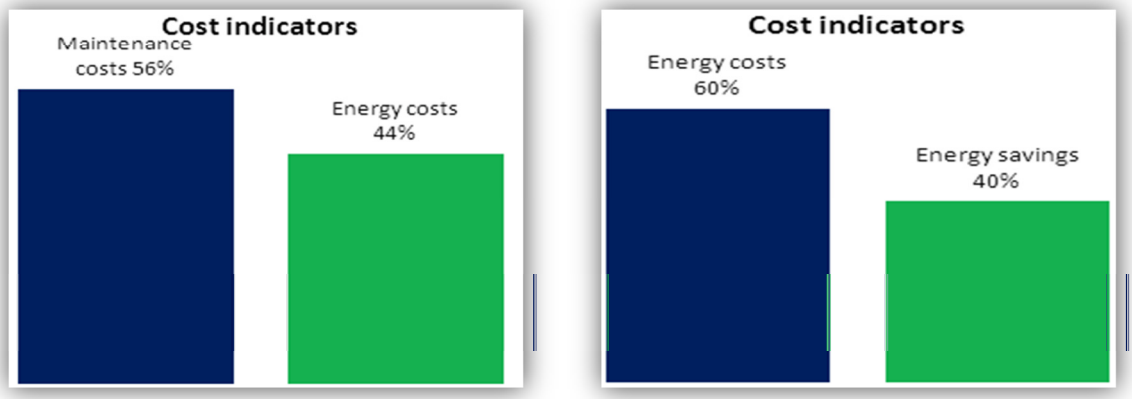


FIGURE 5-L: RELATIVE WEIGHTS COST INDICATORS

Within the comfort indicators the thermal indoor (28%) and air quality (30%) are more important than the lightning and scenic vision (19%) and acoustic indoor (22%), as can be seen in Figure 5-K. A strong correlation can be observed with the most important requirements in this case. The health of the patients might be more depending on air quality and temperature of a room than scenic vision and sounds. The renewal (56%) proved to be a bit more important than the availability of the revision information (44%), graphically shown in Figure 5-M. This was expected since the availability of revision information is only a minor documentation aspect. The renewal with the amount of improvement proposals is moderately important of the total indicators. It is highly dependent on the state of installations.

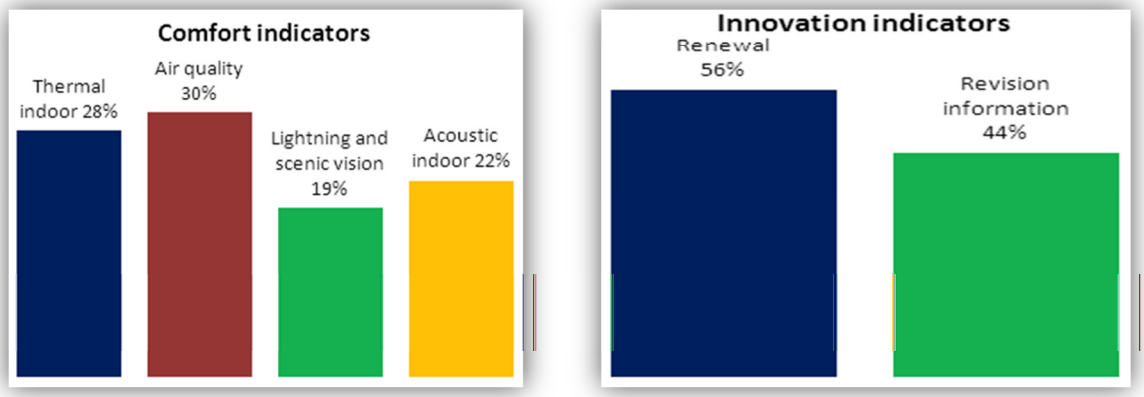


FIGURE 5-M: RELATIVE WEIGHTS COMFORT AND INNOVATION INDICATORS

5.2 PERSPECTIVES (FINANCIAL) DECISION-MAKERS

The hospitals that delivered 37 respondents completing my questionnaire were contacted again to get insight in the decision making on a more strategic level. Financial directors of hospitals within the board of executives are the final decision makers which have been derived from earlier interviews with hospitals. Since financial directors have a full schedule, it takes a bit more effort to get in touch with them. Almost all of the email addresses of the financial directors were obtained by calling the secretaries of the executive board. In the email financial directors were invited to cooperate in a small interview. In the end an amount of 7 financial directors were willing to cooperate.

Overall financial directors were unfamiliar with the concept of energy service companies in contrast to managers of technical- or facility services. According to financial directors the medical specialists do not have any influence on decisions made by the board of executives related to energy policy. Sustainability stands high on the agenda although a very broad definition is applied. In contrast to the respondents of the survey, financial directors view the organization from a broader perspective. The financial directors confirm that hospitals are currently in transition due to governmental influences. Since an increasing focus on health care can be perceived, implementing energy service companies might be a solution (for the future). The relevant structure of the organization is indicated by the structure of the departments of real estate, technical service and facility management. Before the privatization and liberalization of the cure market, real estate and operational costs were given less attention. Real estate was owned by the government. To my perception the transition towards energy service company might be hard due to the absence of real estate management within hospitals.

At first sight the academic hospitals had a high energy saving potential due to its large size, energy saving targets established in multiyear agreements and possibilities for clustering. However the incentive to implement energy service companies strongly relates to the wish for technical and financial outsourcing. In general these incentives play a little role for the semi-public academic hospitals. Overall the technical service of these hospitals are large in personnel with a broad expertise. Academic hospitals are rather able to invest in sustainable measures in contrast to regional hospitals. Thereby the opportunities for the large size and clustering do not hold because the different buildings of the academic hospitals are different in condition and age. This was confirmed by the outcomes of the survey where smaller sized hospitals were more willingly to implement energy service companies.

5.3 BUSINESS CASE ESCO

Due to the confidentiality of the specific business case, the outcomes and formulas of the business case are positioned in Appendix E. The Stock Flow Model (SFM) that has been used to simulate the business model is depicted in Figure 5-N, showing all the relations among the variables used for the model. The SFM is described below the figure.

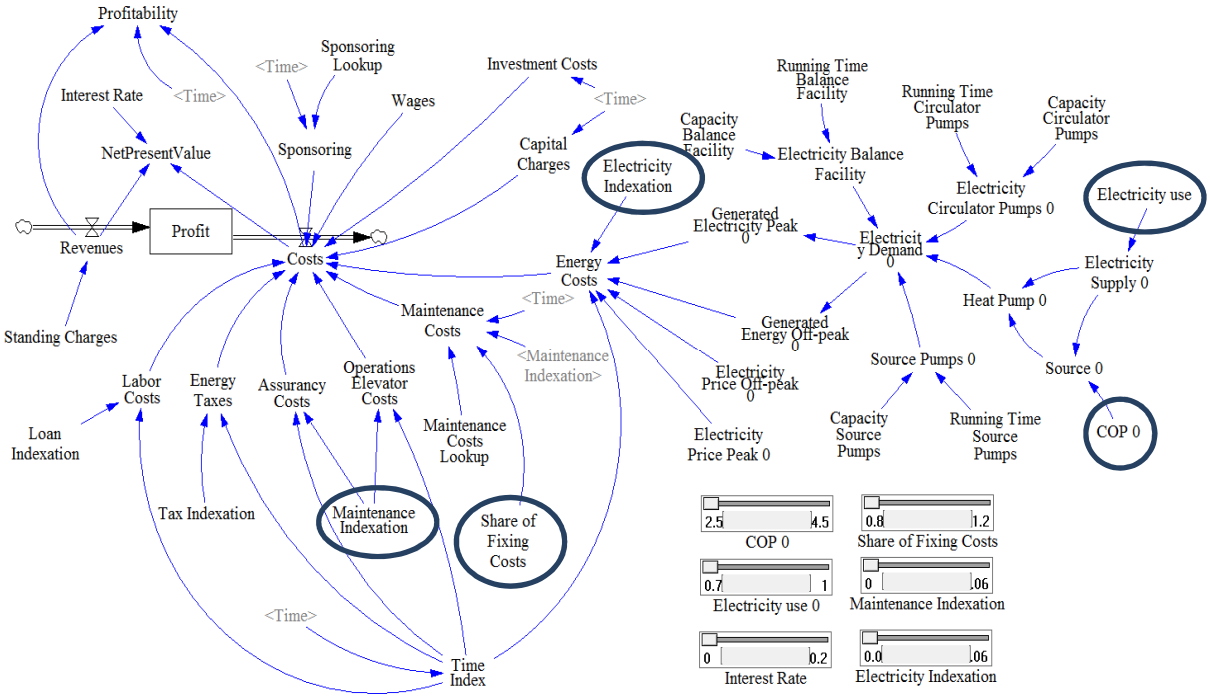


FIGURE 5-N: STOCK FLOW MODEL (DEVELOPED BY AUTHOR)

The input for the model can be found in Figure 4-C in Paragraph 4.3. The outcome of the model is the net present value based on the discounted cash flow and discount rate of 15%. A discount rate of 15% for a long-term project including risks is plausible. The cost items influencing the Costs flow have been determined for this specific business case in cooperation with Kuijpers. The investment costs, labor costs, maintenance costs and energy costs including energy taxes are always present in the business model of an energy service company. The maintenance costs are influenced by a yearly maintenance indexation and include a share of fixing costs. The energy costs consist of the generated energy peak and off-peak by the different installation systems and the energy price per kWh. The energy costs are subject to a yearly electricity indexation. The generated energy depends on the running time and capacity of the installations (Source Pumps, Heat Pump, Circulator Pumps and Electricity Balance Facility). The coefficient of performance of the heat pump and actual electricity use eventually affect the energy costs. The circled variables are the parameters that are varied, creating different scenarios. The bandwidth of these parameters for the different scenarios and Monte Carlo simulation is listed in Table 5-A. The results of the best case and worst case scenarios follow directly from the System Dynamics model. The graphical effects of these scenarios on the net present value have been generated by the System Dynamics model and can be seen in **Fout! Verwijzingsbron niet gevonden.** in Appendix E.

TABLE 5-A: SCENARIOS MONTE CARLO SIMULATION

Scenario	Parameters
Most expected	Increase energy prices 4%, increase maintenance costs 2%, fixing costs 100% of standard, demand 90%, COP 3,5
Scenario 1 Worst case	Increase energy prices 8%, increase maintenance costs 6%, fixing costs 120% of standard, demand 70%, COP 2,5
Scenario 2 Best case	Increase energy prices 4%, increase maintenance costs 0%, fixing costs 80% of standard, demand 100%, COP 4,5

In addition the Monte Carlo simulation provides a more holistic sensitivity analysis. The parameters for the Monte Carlo simulation are the same as the scenarios listed in Table 5-A. The worst and best case scenarios are used as minimum and maximum input for the simulation respectively. The expected values are the same as the values for the standard scenario. The simulation is completed after 50.000 calculation steps. The output of the simulation is represented by a histogram in **Fout! Verwijzingsbron niet gevonden.** in Appendix F. With the histogram a probability distribution is generated, representing the effect of the risks on the net present value. A bandwidth of the actual outcome with a certainty of 80 percent can be predicted for example. This business case proves to be sufficiently profitable to continue the collaboration. The outcomes of the best and worst case predicted by the system dynamics model alone are not predicted by the Monte Carlo simulation. This is due to the fact that the probability for the best and worst case is nearly zero. Monte Carlo simulation thus gives a better and broader estimation of the future.

The so-called tornado plot shows the individual risk contribution of the parameters. The plot is depicted in **Fout! Verwijzingsbron niet gevonden.** in Appendix F. It appeared that the risk contribution of maintenance indexation has the largest influence on the outcome followed by the fixing costs and coefficient of performance. The electricity indexation and actual energy demand have the least influence as a risk in this business case. Controlling and focusing on the maintenance costs is therefore recommended. It is favorable that the maintenance costs can be influenced, more than the energy costs since the energy costs can hardly be influenced. The maintenance costs can be controlled for example by monitoring and verification of performance or preventive maintenance.

6 CONCLUSIONS

Conclusions can be derived from the results described in the last chapter and the literature study. The research questions are answered in this chapter with which the research purpose is fulfilled. In addition a paragraph is devoted to my own optimal Energy Service Company based on the experiences and findings. The report closes with a discussion including recommendations and limitations of this research. The most important recommendations are summarized schematically in Figure 6-A which will be explained further in this chapter. The picture shows comparisons where the aspects related to the implementation of energy service companies in bold are preferred over the other.

FIGURE 6-A: FOCUS POINTS CONCLUSIONS

6.1 ANSWERING RESEARCH QUESTIONS

The research purpose is to align supply and demand in the energy service companies market for hospitals with a focus on the demand side. This research focused on the determination of the most important considerations for hospitals to engage in an ESCo collaboration. The structure of the organization of a hospitals proved to be of high relevance. Different stakeholders within the hospitals all have an influence on the process. With the conclusions in this research an energy service company should be able to anticipate the current cure market. The research purpose could not have been fulfilled without the preliminary research questions. This paragraph highlights the answers per research question, declaring the in-depth quality of the research purpose.

Contract types and options of energy service companies: Because of the broad definition of the concept of energy service companies, the options have been subdivided in terms of *depth, scope* and *method of finance* (Sorrel, 2007). The depth, indicating the contract type ,and method of finance proved to be most important for this research. The *scope* represents the number of useful energy streams and/or final energy services that are wholly or partially under the control of the contractor. The contract *depth* relates to the number of organizational phases required to provide the service or product that is under control of an energy service company. The following phases have been distinguished for this research: Staff training, monitoring, ownership, installation, energy purchase, financing, maintenance,

operations and engineering. The contract depth can be related to the contract type since the composition of the elements together form a contract type. Finance, Maintenance, Operations/Energy purchase and Monitoring appeared to be the most relevant phases to outsource for a hospital. Energy service companies should take this information into account in offering their products to the clients. The *method of finance* is another important aspect. The energy service company or hospitals might invest in sustainable measures themselves but a more considerable option for the cure market is Third Party Financing because of the general lack of financial capabilities. Third Party Financing can be subdivided in the shared savings concept and the guaranteed savings concept. The depth, scope and method of finance can be varied, generating multiple options for an energy service company.

Stakeholders and structure: The most important stakeholders are the energy service company, the hospital and financial institution. Energy service companies make use of energy performance contracts to guarantee energy savings. The distinctive characteristic of the concept for this research is that remuneration is directly linked to the amount of energy savings. Energy service companies need to add value to the current organization of a hospital. One essential element is offering technical expertise to the client. In my perception only the larger installation companies are capable of setting up a larger scale energy service company including all activities. Installation companies have the technical knowledge which is essential in taking over part of an organization.

For this research hospitals in the Netherlands were split into academic and regional hospitals. Hospitals are currently subject to several developments. Lately the financing structure changed. All activities and operations of the hospitals derive from the demand of the patient instead of fixed tariffs. Therefore energy cost savings directly benefit the quality of health care. The percentage energy costs of the total budget is low but within the budget of the facility management, the energy costs are substantial, especially when operating costs are taken into account. Low priority on the energy policy is given in general. Limited information on sustainability could be obtained from annual reports of hospitals.

Arranging finance remains one of the challenges in implementing energy service companies. Financial institutions are rather skeptical. Financial institutions have their own specific credit application valuation methods. A credit application is rated on the quality of the management, financial ratios, the business case and the execution value of the building. The creditworthiness of the client and the quality of the contract should be of high value to compensate for the uncertainty of the object.

The structure of the relations depend mainly on the *method of finance*, schematically shown in Figure 6-B. Within Third Party Financing the contact with the financial institution can either be arranged by the energy service company or the hospital. The difference is which party bears the credit risk. The shared savings concept is recommended for the cure market. With both the performance and credit risk a higher incentive to save energy (costs) for the energy service company is implied. Another motive is that hospitals feel the need to outsource financial risks because of a lack of financial capital. The suggested structure for the cure market is elaborated in the vision for the energy service company in the next paragraph any further.

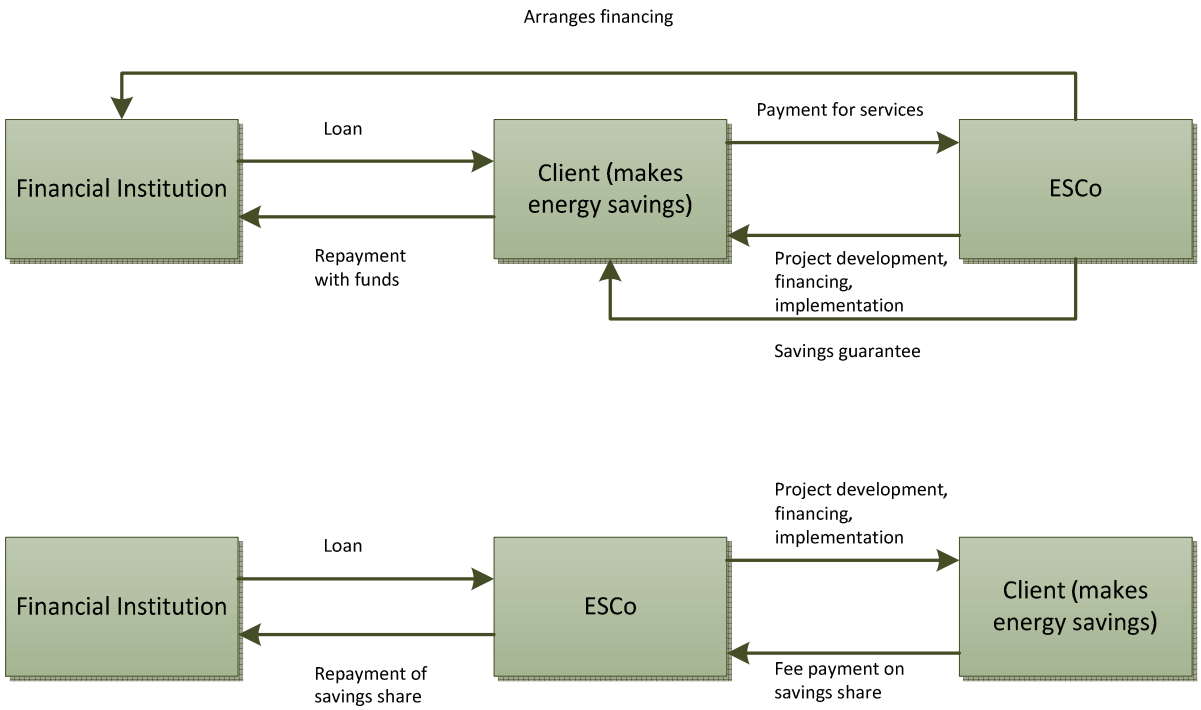


FIGURE 6-B: METHODS OF FINANCE ENERGY SERVICE COMPANIES (DEVELOPED BY AUTHOR BASED ON LITERATURE)

The governmental organizations influence the process as an external factor which should also be taken into account. The European guidelines for energy savings and application of sustainable measures set targets for governments on all levels. However most hospitals do not notice any enforcement of the environmental act of the municipalities, concluded from expert interviews.

Status, potential and the risks of implementing energy service companies for hospitals: The cure market is currently in transition because hospitals are subject to several governmental and societal developments. The most important developments that favor the introduction of energy service companies in hospitals are: the energy intensiveness resulting in a high energy saving potential, a growing privatizing and liberalizing market, lack of financial or technical abilities of hospitals and an increasing focus on health care within hospitals. These developments have the effect that a lot of hospitals are currently reorganizing. A lot of hospitals are currently in trouble with a lack of financial capital. Outsourcing the financial risks on energy might release hospitals. Technical outsourcing can be a strong motive because of the increasing complexity of installation techniques and aging of the Technical Service within a hospital. In the enforcement of the environmental act by municipalities lies great potential. Currently only a few municipalities maintain the target set by the national government. The beneficial tax arrangements EIA/MIA stimulate the implementation of energy service company because hospitals are not able to use it.

The resistance of implementing energy service companies mainly relate to the novelty of the concept. A wrong image, distrust towards energy service companies and a traditional way of thinking and tendering are all due to the unknown concept. For hospitals the perceived risks towards availability of the installations is especially dominant. The large payback periods lead to a perception of high risk for the new clients. Outsourcing also has consequences for

the organization itself, current job employment might be at risk. Some hospitals or organizations are more suitable than others. The adjustability and possibilities to renovate are important factors in this case.

Demand and supply in the energy service company market for hospitals can be aligned when the weaknesses and threats are elevated. The general lack of experience of the concept should be turned into high knowledge and experience by executing pilot projects to create trust and willingness. Opportunities should be seized by the energy service company by providing and guaranteeing energy savings and CO_2 reduction, using the technical knowledge and taking care of financial aspects.

Most important considerations of a hospital: The most important considerations and incentives of a hospitals to collaborate with an energy service company are listed in Figure 6-C. The considerations have been derived from literature and validated by interviews with experts from hospitals. The energy service company should approach the hospital with these considerations in mind. It can be seen as a checklist for the energy service company. Most of the incentives should be in favor of outsourcing for a project to succeed.

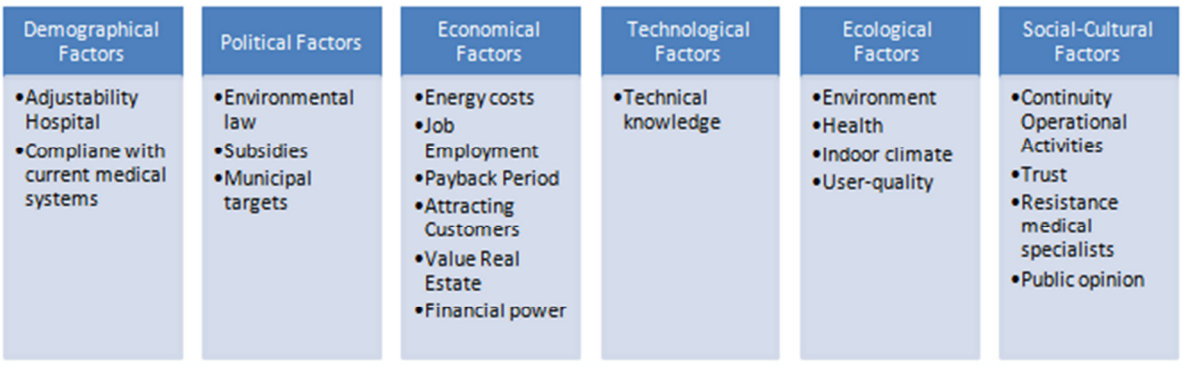


FIGURE 6-C: CONSIDERATIONS HOSPITALS (DEVELOPED BY AUTHOR BASED ON INTERVIEWS)

The two most important motives mentioned in literature; financial and technical outsourcing have also been incorporated in the survey. Financial outsourcing proved to be more of a reason than technical outsourcing. Half of all respondents are willing to implement energy service company in some form with different motives.

Differences between hospitals in the attitude towards energy service companies: The differences in the attitude towards energy service companies between hospitals were investigated in terms of *size*, *age* and *public* or *private*. The incentive to implement energy service companies strongly relates to the wish for technical and financial outsourcing. In general these incentives play a little role for the semi-public academic hospitals. Overall the technical service of these hospitals are large in personnel with a broad expertise. Thereby different buildings of the academic hospitals are different in condition and age, resulting in less opportunities for sustainable measures. This was confirmed by the outcomes of the survey where smaller sized hospitals were more willingly to implement energy service companies. Logically the willingness to outsource is higher for older hospitals since they are in more need of renovation.

Differences within organizations of hospitals in the attitude towards energy service companies: The attitude towards energy service companies within hospitals was analyzed by a survey among the facility management, real estate, technical services and contract management. Half of the respondents of the survey could be identified as head of technical service. The other half were respondents from the facility management of a hospital. For facility managers technical outsourcing is a stronger motive to outsource than for the technical service. The technical service might have a conflict of interest. This effect strongly favors the facility management in contrast to the technical service to approach as an energy service company. In case a real estate department is represented within the organization, they might be approached because the concept is in line with lowering exploitation costs. Facility managers might focus more on the availability of installations. They can then, in turn, positively influence the board of directives and the financial director.

In addition, financial directors cooperated by providing answers to my interview questions. Most financial directors are not familiar with the ESCo concept. However they were very interested in the principles of the concept. The wish to save more energy and apply sustainability in the broadest sense exists. The financial directors operate on strategic level and confirmed that their hospitals were currently in transition after the governmental interventions. An increasing focus on health care can be observed. All other processes are inferior. A lack financial capabilities and aging of technical service is perceived. Thus financial directors indicate that outsourcing energy might be a solution for the future. However trust in the other party is very important since it should not be at the expense of health care.

Most important key performance indicators: The key performance indicators (KPI) incorporated in the survey are listed in Figure 6-D. The practical implementation of the energy performance contract has been illustrated in Table 4-A. The relative importance of these key performance indicators that can be incorporated in an energy performance contract for hospitals was assessed by the method of Analytical Hierarchy Process. A focus of the different (levels of) KPI could be identified. The service, costs and comfort indicators are preferred over the innovation and sustainability indicators. The safety, maintenance costs, amount of malfunctions, energy use and air quality and thermal indoor within the comfort indicators proved to be the most applicable KPI according to the facility managers and technical service.

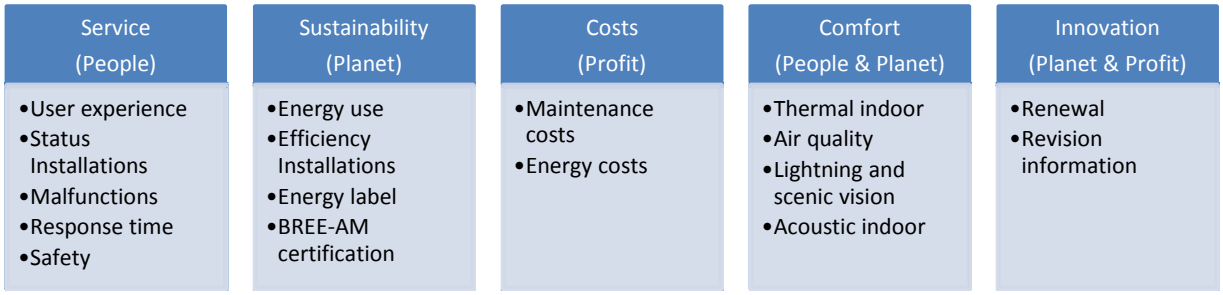


FIGURE 6-D: KEY PERFORMANCE INDICATORS (DEVELOPED BY AUTHOR BASED ON LITERATURE FROM AGENTSCHAPNL)

Effectiveness of System Dynamics and Monte Carlo simulation: Both methods proved to be effective and useful methods in estimating the bandwidth of key performance indicators and risks within the business model of an energy service company. The System Dynamics model created for the specific business case is a dynamic model showing all causal relations among the variables. The model can be generalized and applied to similar business cases. The model is dynamic in the sense that it shows the conduct of all included variables over the contract period. Five input parameters were established that were varied in the model, creating best- and worst case scenarios resulting in different gradients of the net present value.

The System Dynamics model is expanded with a sensitivity analysis using Monte Carlo simulation. Monte Carlo simulation proves to be an effective method in estimating risks in business models both for the energy service company as well as for the client. Five parameters were used as input for the a specific business case with the net present value as output. The histogram showed the bandwidth of the net present value with all risks incorporated in the business case. The most expected net present value can be derived from the histogram. The tornado plot showed the risk with the largest influence on the net present value. A focus on minimizing the maintenance costs together with the percentage fixing costs is recommended for this specific business case.

Monte Carlo simulation can be very useful in estimating the bandwidth of the key performance indicators. A bonus or penalty can be assigned depending on the percentage deviation of the expected value. In estimating the bonus or penalty, Monte Carlo simulation estimates the probability a certain deviation is expected. The energy service company is then able to underpin their bandwidth of the key performance indicator theoretically.

Responding to the considerations of hospitals: The most important considerations and requirements for a hospital to implement an energy service company have now been estimated. The structure of the organization of a hospital should first be explored before the concept of energy service company can be introduced. A strategy of market pull is preferred over market push because the most optimal form of energy service company for a specific hospital is highly dependent on the current situation and needs of the hospital. Answers to the following questions need to be identified at first:

- At which point of the transition is the hospital at this moment?
- How are the departments of technical service, real estate and facility management structured within the organization of a hospital?
- What are the technical and financial capabilities of the organization?
- Who is responsible for energy management, exploitation costs and the energy bill?
- What are the sustainability targets?
- What is the current state of installation techniques and condition of the building?

Otherwise the needs and considerations of a hospital can hardly be estimated. When insight has been gathered on these questions, recommendations can be given because each question is more or less related to the willingness of implementing an energy service company. The relevant answers to these questions and recommended strategies that suit the implementation of energy service company best, are summarized in Figure 6-A at the start of this chapter.

6.2 VISION ENERGY SERVICE COMPANY

This paragraph elaborates on my vision towards the perfect accumulation of supply and demand in the energy service company market for hospitals, answering the last research question. The main conclusion of this research is that the most optimal energy service company that can be offered to a hospital at this moment is highly dependent of the current demand and structure of the organization. Hospitals are in the middle of a transition, subject to several developments outlined in the literature study. Hospitals are currently trying to find their way to keep up with these developments. Implementation of energy service companies only succeeds when a hospital is ready for a new sustainable way of thinking supported by a large part of the organization. Although a lot of hospitals are not ready for implementation of energy service companies, a most optimal concept energy service company can be set forth for the future. However keep in mind that not all organizations need an energy service company per definition. The energy service company should always add value to the organization.

A lot of different forms of energy service companies have been distinguished in literature. One of the advantages of implementing energy service companies is neutralizing a split incentive. In principle the basic form of energy service companies neutralizes the split incentive to save energy among the different suppliers. In the current situation different suppliers are responsible for their own part within the energy supply chain. However flaws still exist within the concept where a hospital is completely outsourced on the field of energy by an energy service company. A portion of the consumed energy use for example is beyond the scope of influence for the ESCo or dependent of the user. Users of a building still have to cooperate for the benefit of energy savings. A penalty can be beneficial financially for the client. Clients should not be tempted to let energy service company exceed the established bandwidth according to the energy performance contract.

Special Purpose Vehicle: A way to optimize the unique selling points of energy service companies in my perception is to create a so-called special purpose vehicle, schematically shown in Figure 6-E. A new cooperation is established where all involved parties are jointly responsible. Shared responsibilities in which sustainability, optimization and proper maintenance are the mainspring. Both parties should have the incentive to save as much energy as possible. The members of the SPV are the energy service company, the hospital and a financial institution (in case the energy service company is not able to finance themselves). The client is asked to cooperate in the process in contrast to the basic ESCo form, where the client is completely outsourced. However the client is

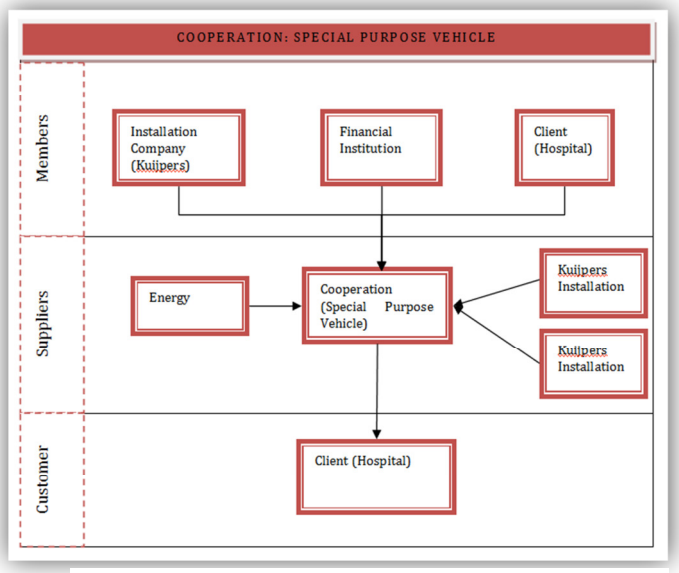


FIGURE 6-E: SPECIAL PURPOSE VEHICLE

also able to keep control which is in line with the precondition for hospitals: availability of the installations. Another conclusion from the survey in favor of the special purpose vehicle is the focus on the operations phase and energy purchase. Thereby a hospital is not able to make use of the energy investment deduction. The SPV as a new entity is also able to make use of the beneficial tax arrangements in the investment (EIA).

Bonus/Malus distribution: In addition, to decrease submerging responsibilities during the contract period by one of the parties is to make smart arrangements for profit sharing. Different percentages of share of profit between the energy service company and hospital should be agreed upon, depending on the actual savings. When an energy service company performs within the predetermined bandwidth of KPI the ESCo should be remunerated for its achievements. However agreements must be reached in case of over- or underperformance. In case of over performance the client should also share in the profits. This way the client and user are also motivated to save even more energy. The share of the client should even increase when energy performance increases. The same goes for underperformance, however energy service companies are more responsible for losses so should therefore also pay the largest portion of the losses.

An example of profit sharing based on the agreed bandwidth of a key performance indicator is depicted in Figure 6-F. The share of profit is plotted against the KPI percentage of expected energy savings. A target of potential energy savings should be estimated on which a percentage deviation should be agreed upon. In this case a bandwidth of 95% to 101% of the expected energy savings is acceptable where the ESCo performs as it should be. However when even more energy is saved, the client will have a 25% share of profits rising to 75%. This will stimulate both parties to save as much energy as possible. On the other hand, the client should also carry a little part of the burden for 25% of the losses in case of underperformance. The client and user are partly responsible for shortfalls of energy saving.

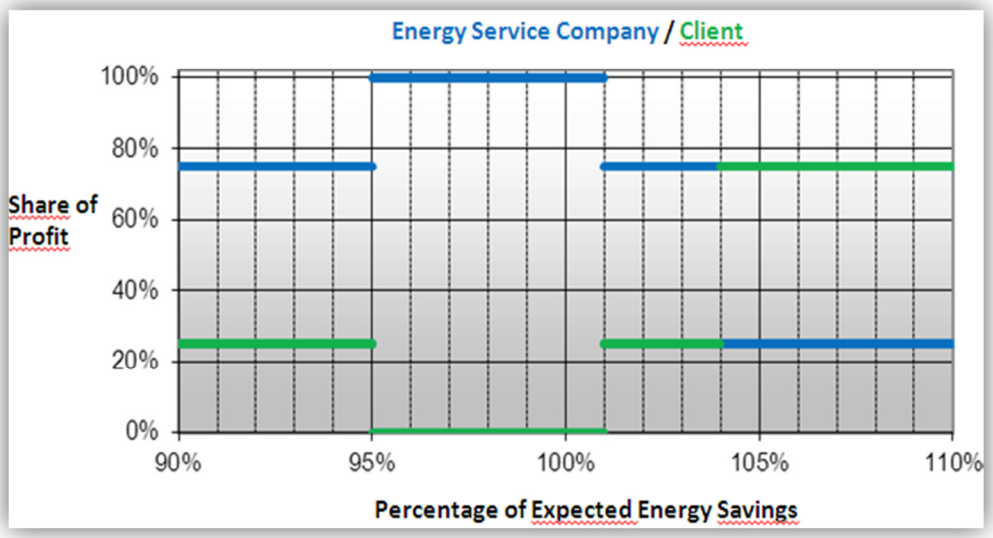


FIGURE 6-F: DISTRIBUTION OF PROFIT (DEVELOPED BY AUTHOR BASED ON KUIJPERS MODELS)

The height of the penalty and the time to enforce it should be estimated depending on the criticality of the problem. Because the availability of energy remains important for the

hospital an immediate stiff penalty for the energy service company is recommended in case emergency power facilities fail. When less critical problems arise, more time should be granted to the energy service company to recover.

The special purpose vehicle aims to create a long-term collaboration in which every party has the influence it comforts. The risks and savings should be distributed in line with each interest and responsibility.

6.3 DISCUSSION AND FURTHER RESEARCH

This paragraph values the base and reliability of this research. Research always creates discussion and new questions. Following from the discussion, recommendations for further research will be appointed.

One useful conclusion is that the implementation of energy service companies within the cure market is highly situation dependent. The most important needs and considerations of hospitals are provided in this research. An energy service company should first know about these considerations of a specific hospital before a product can be offered. Only then key performance indicators can be implemented where a good balance of trust and KPI within the contract should be found. Trust is an important prerequisite for a successful project, mentioned in almost all of the interviews with hospitals. However the key performance indicators are just as important. A good relationship based on trust is always also based on some boundaries.

➔ **Estimating key performance indicators in the practical field**

The practical implementation can be improved. A case-study at a hospital can be used to bring theory of this report into practice. Going through the tendering phase of sustainable measures for a hospital would be optimal. The energy performance contract with specific key performance indicators can then be elaborated in detail. The balance of trust and the amount of key performance indicators and flexibility of the contract remain an interesting field which should be focused in detail by a case-study.

➔ **More extensive theoretical underpinning**

The findings of this research can be strengthened in a quantitative and qualitative way. Well over forty respondents of different working fields within the organization of hospitals participated in this research. A more complete image of the cure market can be outlined with more data from hospitals. Also more in-depth data can be gathered when an extensive collaboration is engaged with a hospital.

➔ **Generalizing the System Dynamics model**

The System Dynamics model focuses on a specific business. Although it showed the usefulness of a dynamic model including a sensitivity analysis for a business case, the model should still be generalized for an ESCo business model. Expertise of the model and method is currently necessary to apply changes for another business case. A general model with a dashboard would be helpful to simulate prospective business cases which can be used by everyone. Thereby the business model of the client can be included in the business case when a special purpose vehicle is established. The distribution of profits between the client

and ESCo depending on the energy performance can be taken into account in the sensitivity analysis. This will make the model even more interesting, both for the ESCo as well as the client. The input parameters for the Monte Carlo simulation are based on past developments of prices and experiences of Kuijpers. More research would strengthen the basis of the future assumptions which will improve the sensitivity analysis.

➔ **Giving insight in the Health Care (real estate) transition**

The current health care market and real estate is subject to several (external) developments. How will the organizations of hospitals look like in the future? How will the real estate of health care develop over time? What will be the effect of sustainability on the value of health care real estate? Foreign countries already addressed these aspects in scientific research, however a total different structure of the real estate market in the Netherlands is implied. Interesting questions that need to be answered to respond to the cure market also in the future as an energy service company.

➔ **Giving insight in the possible financial (tax-)arrangements**

The choice for the method of finance is highly dependent on the potential tax arrangements for different kinds of organizations. In some cases financial outsourcing might be less relevant for a hospital. A lack of juridical knowledge still exist on this topic. In some cases hospitals are able to make use of beneficial tax arrangement as well in the application of sustainable energy measures with a loan from the municipality.

➔ **Investigating the application of Real Options Analysis (ROA)**

Within a long-term project of uncertainty the application of real options valuation becomes interesting. Real options are useful for identifying, understanding, valuing, prioritizing, selecting, timing, optimizing, and managing strategic business and capital allocation decisions (Mun, 2002). With real options valuation, new strategic investment decisions can be optimized by evaluating different decision paths under certain conditions. It times the effective execution of new investments. ROA might thus complement the business case of an energy service company.

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8 APPENDICES

8.1 APPENDIX A: QUALITY ASSURANCES

In this appendix the legal framework which should assure the quality of energy service companies is described. Most quality assurances are created and maintained by governmental organizations. Subsequently, the role of the governmental organizations as a relevant stakeholder will be reflected in this paragraph.

International Level

Within the 'Energy Efficiency Directive' composed by the European Union several guidelines have been determined to achieve energy saving targets by 2020, adopted in 2006. The conclusions of the European Council of 4 February 2011 emphasized that the 2020 20 % energy efficiency target as agreed by the June 2010 European Council, which is presently not on track, must be delivered. On 11 September 2012 a new Energy Efficiency Directive was debated. Under this provision, energy companies must deliver savings each year equivalent to 1.5% of their final energy sales. This 1.5% is cumulative, so in year one, savings of 1.5% must be delivered. In year 2, savings of 3% must be delivered. With the Directive, cost-effective energy efficiency improvements should be applied by providing financial and legal frameworks to remove market imperfections that currently obstruct the implementation of these improvements. Frédéric Melchior, Director Governmental Relations at the European Association of Energy Services Companies (eu.ESCO) welcomes this directive in setting framework conditions to improve the market for energy services. 'The success really now depends on the implementation by the Member States'. Stéphane le Gentil, eu.ESCO Chairman said: 'In order for EPC to really take off in the European Union, public bodies need to take the leading role. This has been the case in the United States and then the private sector followed', he explained.

Another guideline is the EU Climate Action and Energy Package, created in 2008 which commit member states to lower the greenhouse gas emission and to increase energy efficiency by 20% in 2020 compared to 1990. Also a level of 20% renewable energy in 2020 should be achieved. A lot of savings are gained in the construction sector since buildings use 40% of all the energy consumption. A specific Energy Performance of Buildings (EPBD) has been introduced in 2002 (2002/91/EC) which was updated in 2008 (2010/31/EU) based on the energy efficiency directive, inspired by the Kyoto protocol. This is the main legal framework for energy performance in buildings requiring member states to furthermore develop policies to create new nearly energy neutral public buildings by 2020. Member States ought to apply energy performance certificates for any building that is constructed, renovated or sold or rented out to a new user.

A rather unknown but important binding agreement is the effort sharing decision composed by the European union. This target determines annual binding greenhouse gas emission reduction targets for member states from 2013 to 2020. For the Netherlands this means a reduction of 16% by 2020 (Ministerie van Economische Zaken, Landbouw & Innovatie, 2011).

In certain Member States other than the Netherlands, white certificates have been implemented. These documents certify that energy producers, suppliers and distributors

reduced the final energy demand by taking energy efficient measures. A predefined annual energy deliverance is determined which has to be met, otherwise a penalty has to be paid. Producers, suppliers and/or distributors can use these certificates for their own by trading, selling to other parties that cannot meet their targets. This concept is quite related to the concept of emissions trading (ETS) (Steinhilber, Ragwitz, Rathmann, Klessmann, & Noothout, 2011).

National Level

Following the guidelines from the European Union the Dutch government set targets for greenhouse gas emission to a reduction of 20% and a 14% share of renewable energy in 2020. Several policy instruments are implemented to reach these targets by 2020.

The national government of the Netherlands implemented the Environmental Act to stimulate building owners in applying sustainable measures. According to the Environmental act, health care institutions ought to implement energy saving measures with a payback period less than six years or measures with a positive net present value in case of an internal rate of return of 15 percent. On practical grounds, the lower limit lies at approximately 800 square meters gross floor area. Hospitals are subject to these regulations by definition due to its approximate size. However this environmental law is not enforced and is thereby losing its impact. A high potential lies in increasing the energy efficiency by enforcing this law. By estimation an energy saving potential of 11 PJ by 2020 can be achieved (Volkers, Menkveld, & Sipma, 2010).

Another popular trend in the introduction of new concepts is the publications of white papers by authoritative organizations. AgentschapNL published some white papers on the subjects of energy service companies and its potential. Important players in the market are able to read these recommendations after which it can be implemented. Energy service companies are able to make use of this knowledge and standardization in implementing their own business model for the concept.

As a part of the Dutch climate policy, the Dutch government introduced the Energy Performance Coefficient (EPC) for new construction. All the newly built buildings have to meet certain energy performance standards reflected in the Energy Performance Coefficient. The European Union implemented similar standards in 2002 so the EPC can be seen as a Dutch target following the European EPBD targets. In the Netherlands the energy performance of buildings is established in an energy label. The measurement and assessment of the energy labels are conducted by BREEAM-NL, presented in September 2009. In the springtime of 2011, the BREE-AM certification has been introduced for the existing buildings next to new construction and renovation (DGBC). The national government set targets to new construction to meet at least label C.

Academic hospitals taking part in multiyear agreements (MJA3) target to achieve an energy efficiency improvement of 30 percent from 2005 to 2020 and an annual energy-efficiency improvement of 2 percent. They ought to compose their energy efficiency plan (EEP) every four year in cooperation with AgentschapNL which is checked every year by the same party by monitoring the results via the electronic environmental annual report (EMJV). They are obliged to apply energy savings measures with a payback period less than five years and

implementing a solid energy management system. However these targets are not met most of the time.

In the Netherlands the Energy Investments Deduction (EIA) might be beneficial for energy service companies especially in case of non-profit organizations as a client, who cannot use this tax arrangement. An investment in energy saving measures is the core business of energy service companies so they should be able to fully use this tax arrangement. In 2011 the total budget for the EIA was 151 Million Euros. On average, 10% of the investment can be retrieved. An implication is that the policy is changing often by the government.

Regional Level

On a regional level, municipalities and provinces exercise less power. However some municipalities took the initiative for energy saving measures by implementing and maintaining policy instruments on their own. The establishment of environmental and energy saving targets by the Rotterdam Climate Initiative (RCI) were a main motivator for the initiation of the energy service company project. Project manager Lex Keijser from the municipality of Rotterdam signed for a 50% reduction of CO2 pollution by 2020 comparing to 1990. The introduction of an energy service company would probably not be present when these ambitious targets were not established. The urgency for energy savings measures, imposed by the municipality, was a good motivator to carry through the ESCo project. This urgency implied by regulations and rewards is also present in foreign countries while it lacks in the rest of the Netherlands (Hansen, Bertoldi, & Langlois, 2009).

Generally, although these programs, targets and policy tools for energy efficiency are not focused specifically on Energy Service Companies, most of the quality indicators and targets indirectly stimulate the concept. Most of the determined targets are guidelines but not binding. The only binding agreements that should be maintained are the environmental law by the Dutch government and the effort sharing decision by the European Union.

8.2 APPENDIX B: TOTAL SWOT ANALYSIS

Strengths

- Effective and efficient maintenance
- Improving user-quality and comfort
- Knowledge on installations and energy saving measures
- Guaranteeing energy savings
- Neutralizing split-incentive
- Exposure (prestige project)
- Advantages of scale
- Reducing CO_2 emission
- Increasing rentability and value of real estate
- Increasing job employment
- Being ahead within the Energy Service Company market

Weaknesses

- Future uncertainty
- High transaction costs in the introductory phase
- Little experience
- Lack of financial capital
- Long-term contract

Opportunities

- Lack of sufficient knowledge on energy saving measures within hospitals
- Lack of technical manpower within hospitals
- Limited cyclical sensitivity healthcare real estate
- Lack of financing for hospitals
- Government as 'launching customer'
- Knowledge platform and standardization
- Change of funding system
- Reference/pilot projects
- Growing awareness for energy saving policies within organizations
- Subsidies/Green financing
- Multiyear agreements hospitals
- CO_2 reduction
- Evolution of energy prices
- Energy intensive sector
- Maintaining legal framework (Activiteitenbesluit)
- Certification (BREE-AM)

Threats

- Perception of risk (technical, financial, performance)
- Relatively unknown concept/wrong picture
- Distrust and begrudge of profits
- Fiscal arrangements in favor of insourcing
- Little experienced energy saving necessity
- Traditional (maintenance) contracts
- Current job employment in technical service
- Low ratio energy costs/total budget of hospitals
- Complex decision-making structure
- Potential lack of compliance with medical equipment
- Lack of renovation possibilities/adjustability hospital

8.3 APPENDIX C: TOTAL CAUSAL LOOP DIAGRAM

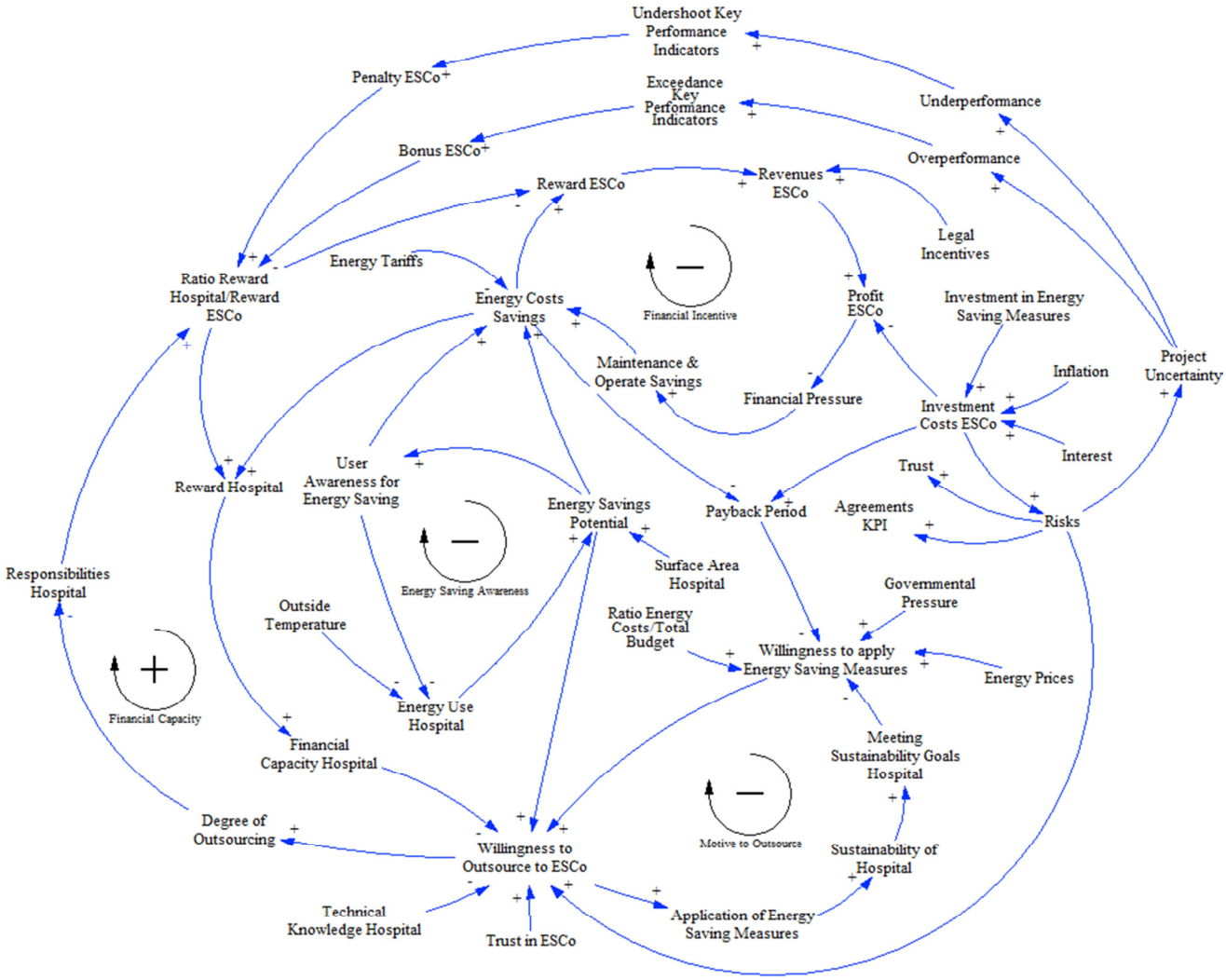

FIGURE 8-A: CAUSAL LOOP DIAGRAM

8.4 APPENDIX D: RESULTS ANALYTICAL HIERARCHY PROCESS

TABLE 8-A: KEY PERFORMANCE INDICATORS

	Weighing factor per value	Weighing factor of total	Total Respondents	Number of Consistent Respondents	Percentage of Constistent Responses	Overall Consistency Ratio
Service (people)	**25%**	**100%**	**37**	**18**	**49%**	**0,15%**
Service provisioning	16%	4%	37	23	62%	0,24%
Malfunctions	22%	6%	37	23	62%	0,24%
Respons time	18%	4%	37	23	62%	0,24%
Safety	29%	7%	37	23	62%	0,24%
Level of technical check	15%	4%	37	23	62%	0,24%
Sustainability (planet)	**14%**	**100%**	**37**	**18**	**49%**	**0,15%**
Energy use	34%	5%	37	21	57%	0,88%
Installation efficiency	31%	4%	37	21	57%	0,88%
Energy label	18%	3%	37	21	57%	0,88%
BREE-AM certification	18%	3%	37	21	57%	0,88%
Costs (profit)	**24%**	**100%**	**37**	**18**	**49%**	**0,15%**
Maintenance costs	56%	14%	37	37	100%	-
Energy costs	44%	11%	37	37	100%	-
Comfort (people & planet)	**24%**	**100%**	**37**	**18**	**49%**	**0,15%**
Thermal indoor	28%	7%	37	31	84%	0,12%
Air quality	30%	7%	37	31	84%	0,12%
Lightning and scenic vision	19%	5%	37	31	84%	0,12%
Acoustic indoor	22%	5%	37	31	84%	0,12%
Innovation (planet & profit)	**12%**	**100%**	**37**	**18**	**49%**	**0,15%**
Renewal	56%	7%	37	37	100%	-
Revision information	44%	5%	37	37	100%	-
Energy costs	60%	-	37	37	100%	-
Energy savings	40%	-	37	37	100%	-

8.5 APPENDIX H: SUMMARY KENWIB (EN)

ALIGNING SUPPLY AND DEMAND FOR ENERGY SERVICE COMPANIES IN THE CURE MARKET USING ANALYTICAL HIERARCHY PROCESS AND SYSTEM DYNAMICS

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23-07-13

ABSTRACT

Outsourcing to Energy Service Companies (ESCos) is an arising concept in the Cure market. Market supply and demand of Energy Service Companies should be aligned to benefit from energy savings and lowering energy costs. The research method of Analytical Hierarchy Process is used to give insight in the needs and considerations for a hospital in their decision to outsource and the relative importance of key performance indicators that can be incorporated in energy performance contracts. System Dynamics in combination with Monte Carlo simulation is used for a sensitivity analysis of a specific business case. The two methods proved to be useful in estimating risks influences and bandwidths of key performance indicators. Several expert interviews have been organized to verify and validate the results.

Keywords: Energy Service Companies, Health Care, Analytical Hierarchy Process, Monte Carlo simulation, Key Performance Indicators

INTRODUCTION

Implementing energy service companies (ESCos) is an arising concept and relatively new for the cure market. According to research from SBR, the building sector uses 40% of the total primary energy use, living and service together. Thinking and acting differently contributes to reducing the CO-2 emission and reduced energy pollution and costs (SBR). Gert-Jan Peeks states that the implementation of energy service companies involves a new way of thinking both for the supplier and the client. A precondition is that building owners leave their traditional way of thinking and tendering. This new way of thinking creates a lot of opportunities with which a lot of energy savings can be achieved (Peek & van Remmen, 2012). A few hospitals are starting to implement energy performance contacts, outsourcing to an energy service company. At first glance a lot of opportunities for hospitals to outsource exist. Overall hospitals lack the capacity to actively deal with energy savings. The user and maintenance company do not have sufficient knowledge and experience on the energy

subject (Builddesk, 2011). A lot of energy and money can be saved by applying sustainable energy systems and installations which can be implemented by energy service companies. According to van AgentschapNL and Heumen and Traversari, a healthier, safer working and living environment can thereby be created (van Heumen & Traversari, 2010) (AgentschapNL, 2010).

Problem Description

The priority for outsourcing is low and a lack of insight in the willingness and considerations of hospitals to collaborate with energy service companies exists while substantial and profitable energy savings can be achieved (NL Energie en Klimaat, 2010). The problem is that supply and demand are not aligned. On both the supply and demand side several misunderstandings, ambiguities and lack of trust are present (Builddesk, 2011).

Research Purpose

The goal of this research is to give insight in the consideration framework of hospitals in their decision to collaborate with an energy service company and the measures to be taken to respond to hospitals and/or financial institutions to cooperate in ESCo projects. The demand of hospitals for energy service companies should be clear but also the type of energy service company that can be put on the market. This research will therefore consist of a market analysis and business case. The importance and bandwidth of the most relevant KPI that can be incorporated in an energy performance contract should be found. Another obstacle that should be overcame is the risk perception of the client as well as the energy service company. When risks are incorporated in the business case, trust for both parties can be increased. Eventually the most optimal energy service company for a hospital will be outlined.

Research Questions

From the problem definition and research purpose the following main research question is created: How can we improve the implementation of Energy Service Companies in the cure market?

Research Boundaries

Although a wide network of stakeholders is involved in an ESCo project, this research focuses on the client, with the hospital in particular, the financial institution and the energy service company. For this research within the organization of a hospital, financial directors, facility management, technical service and the real estate department play a role.

According to ‘Stichting Kien’ the following considerations for further development of the ESCo are necessary (Te Boekhorst, 2012). This research focuses on the aspects in bold. Logically the aspects will be elaborated for the cure market specifically.

- **Covering financial and performance risks.**
- Governmental assurances and guaranteeing conditions
- **Developing financing constructions**
- Setting up a knowledge platform for all the stakeholders
- Standardization of performance contracts and ESCo-business models
- **Defining critical key performance criteria**

Research Design

The research design is depicted in Figure 9.

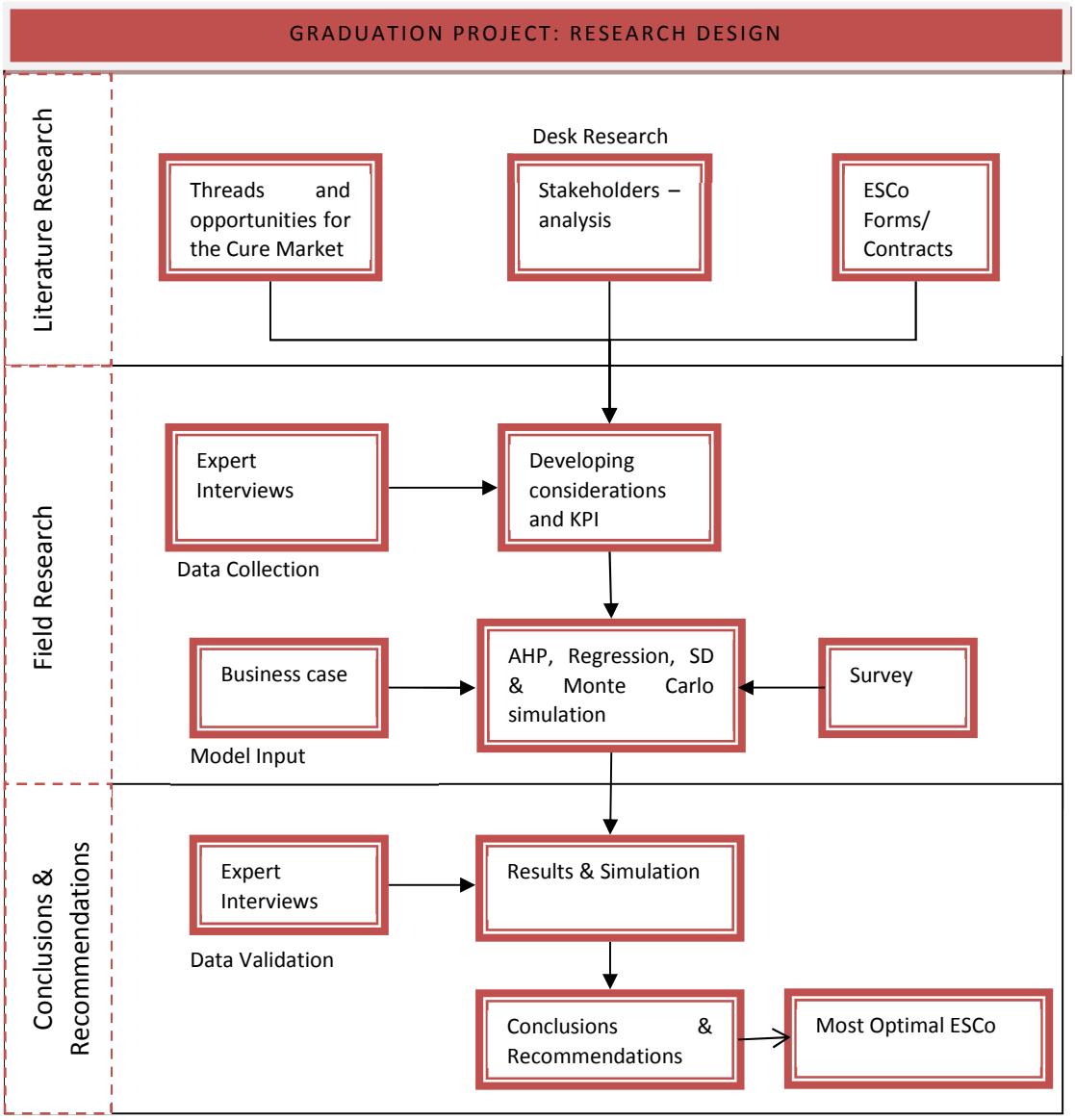

FIGURE 9: RESEARCH DESIGN (DEVELOPED BY AUTHOR)

METHOD

RESEARCH METHODS

At first, expert interviews in the field of hospitals and energy service companies and additional experience of Kuijpers should appoint the most important considerations of hospitals towards energy service companies. The pair-wise comparisons of Key Performance Indicators will be processed by the method of Analytical Hierarchy Process. Regression analysis will be used to identify interaction effects of variables incorporated in the questionnaire. System Dynamics is used to set up a specific business case. Monte Carlo Simulation incorporates the most important risks within this business case with which also the bandwidth of key performance indicators can be underpinned theoretically.

Regression Analysis

The method of logistic and multiple regression is used to interpret the data output of the questionnaire. Correlation indicates the interaction of two variables. However correlation does not tell anything about the predictive power of variables. The subsequent step is the regression analysis where one variable is predicted by another. Multiple regression seeks to predict an outcome variable from several predictor variables.

Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) is a decision-aiding method developed by Thomas L. Saaty in the late seventies. It aims at quantifying relative priorities for a given set of criteria on a ratio scale, based on the judgment of the decision-maker, and stresses the importance of the intuitive judgments of a decision-maker as well as the consistency of the comparison of alternatives in the decision-making process (Saaty, 1980).

System Dynamics

The System Dynamics method (SD) is used to understand complex issues by modeling it in a mathematical way. It represents real life problems with different scenarios and tests to realize an optimal result in the end. The public and private sector can be supported by system dynamics models with which policies can be designed. Dynamic systems characterized by interdependence, information feedback, mutual interaction and circular causality can all be modeled by using System Dynamics (Sterman, 2000). In this research System Dynamics is used to set up the business model with which a sensitivity analysis can be carried out using Monte Carlo Simulation.

Monte Carlo Simulation

Monte Carlo simulation is a technique used to understand the impact of risk and uncertainty in financial, project management, cost, and other forecasting models. Since energy service companies guarantee energy savings established in a contract over a long time, the project involves a lot of risks and uncertainties. These uncertainties should be incorporated in the business model of a project.

FINDINGS

Literature Study

Because of the broad definition of the concept of energy service companies, the concept has been subdivided in terms of *depth, scope* and *method of finance* (Sorrel, 2007). The *scope* represents the number of useful energy streams and/or final energy services that are wholly or partially under the control of the contractor. The contract *depth* relates to the number of organizational phases required to provide the service or product that is under control of an energy service company. The following phases have been distinguished for this research: Staff training, monitoring, ownership, installation, energy purchase, financing, maintenance, operations and engineering. The *method of finance* in terms of Third Party Financing can be subdivided in the shared savings concept and the guaranteed savings concept. The depth, scope and method of finance can be varied, generating multiple options for an energy service company which are also incorporated in the questionnaire.

The energy intensiveness resulting in a high energy saving potential, a growing privatizing and liberalizing market, lack of financial or technical abilities of hospitals and an increasing focus on health care within hospitals favor the introduction of energy service companies. Hospitals are currently subject to several developments. Lately the financing structure changed. All activities and operations of the hospitals derive from the demand of the patient instead of fixed tariffs. Therefore energy cost savings directly benefit the quality of health care. The European guidelines for energy savings and application of sustainable measures set targets for governments on all levels. However most hospitals do not notice any enforcement of the environmental act of the municipalities. The beneficial tax arrangements EIA/MIA and SDE+ subsidy stimulate the application of sustainable measures.

Expert Interviews

In Figure 3 the most important considerations for hospitals towards energy service companies are appointed. In interviews with different working functions of hospitals these considerations have been validated. Financial and technical outsourcing, trust and energy costs are the most important considerations for a hospital. The most important considerations for financial institutions to cooperate in an ESCo project are the creditworthiness of the client, quality of the energy performance contract and quality of the object to be leased.

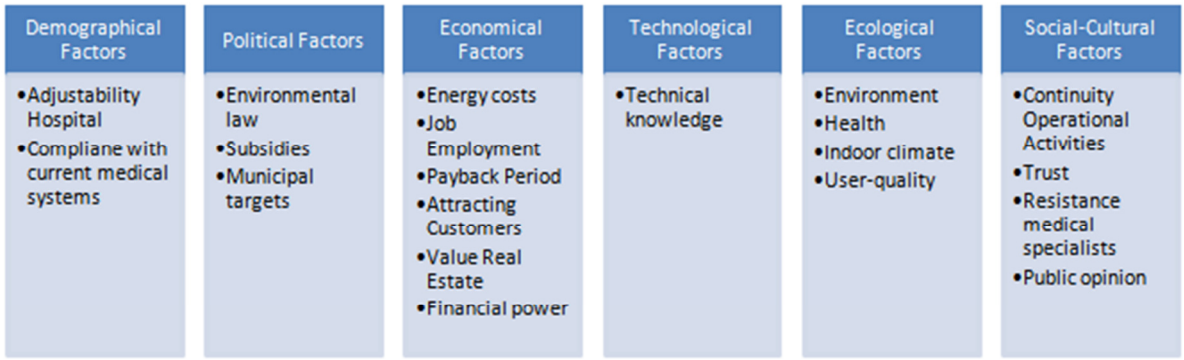

Figure 3:DESTEP Energy Service Companies in the Cure Market (Developed by Author)

Data Collection

The respondents of my questionnaire for the Analytical Hierarchy Process (AHP) and Regression Analysis had to be working in a hospital environment with a function related to energy and installation techniques or contract management. After phone calls and two reminders by e-mail, a total of 37 respondents of different hospitals completed my questionnaire. . Data for these methods is collected from employees of the Technical Service or Facility Management from different hospitals. In addition, perspectives from financial directors make the overall picture of the attitude of a hospital towards energy service companies complete. Eventually 7 interviews with financial directors were organized. The amount of expert respondents turned out to be plenty enough to be able to carry out the AHP analysis. Quantitative data for the business case has been obtained from Kuijpers.

Regression Analysis

Following from the questionnaire, financial outsourcing proved to be more of a reason than technical outsourcing. Half of all respondents are willing to implement energy service company in some form. Most of the respondents look for a solution in the middle. Finance, Maintenance, Operations/Energy purchase and Monitoring appeared to be the most relevant phases to outsource for a hospital. For facility managers technical outsourcing turned out to be a stronger motive to outsource than for the technical service according to the outcomes of the survey. The technical service might have a conflict of interest. This effect strongly favors the facility management to approach as an energy service company. In general the link between the facility manager and financial directors is also stronger. An interaction effect could be noticed between the willingness of implementing an energy service company and high age and low floor surface of a hospital.

Most financial directors are not familiar with the ESCo concept. The wish to save more energy and apply sustainability in the broadest sense exists. The financial directors operate on strategic level and confirmed that their hospitals were currently in transition after the governmental interventions. An increasing focus on health care can be observed. A lack of financial capabilities and aging of technical service is perceived. Thus financial directors indicate that outsourcing energy might be a solution for the future. However trust in the other party is very important since it should not be at the expense of health care. From these interviews also a difference between facility management and real estate is indicated. In general facility management focuses on the availability of installations while the real estate department aims to reduce operational costs. The new way of thinking is therefore in line with real estate management while the new concept is harder to understand for a facility manager. However notifying is that real estate is managed differently between hospitals.

Analytical Hierarchy Process

The key performance indicators incorporated in the questionnaire are listed in Figure 4 developed by author based on literatureFigure 6-D. The relative importance of these key performance indicators that can be incorporated in an energy performance contract for hospitals was assessed by the method of Analytical Hierarchy Process. A focus of the different (levels of) KPI could be identified. The service, costs and comfort indicators are preferred over the innovation and sustainability indicators. The safety, maintenance costs, amount of malfunctions, energy use and air quality and thermal indoor within the comfort indicators turned out to be the most applicable KPI within an energy performance contract.

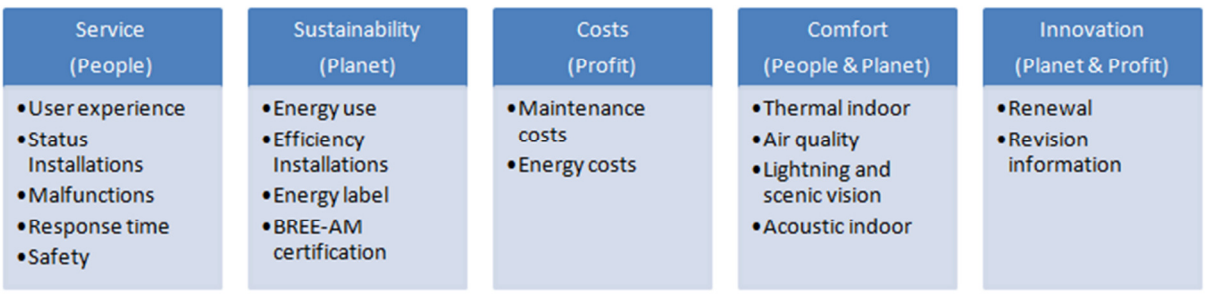

Figure 4: Key Performance Indicators

System Dynamics

The outcome of the model depicted in Figure 5 is the net present value based on the discounted cash flow and discount rate of 15%. A discount rate of 15% for a long-term project including risks is plausible. The cost items influencing the Costs flow have been determined for this specific business case in cooperation with Kuijpers. The investment costs, labor costs, maintenance costs and energy costs including energy taxes are always present in the business model of an energy service company. The maintenance costs are influenced by a yearly maintenance indexation and include a share of fixing costs. The energy costs consist of the generated energy peak and off-peak by the different installation systems and the energy price per kWh. The energy costs are subject to a yearly electricity indexation. The generated energy depends on the running time and capacity of the installations (Source Pumps, Heat Pump, Circulator Pumps and Electricity Balance Facility). The coefficient of performance of the heat pump and actual electricity use eventually affect the energy costs. The circled variables are the parameters that are varied, creating different scenarios used for the Monte Carlo simulation.

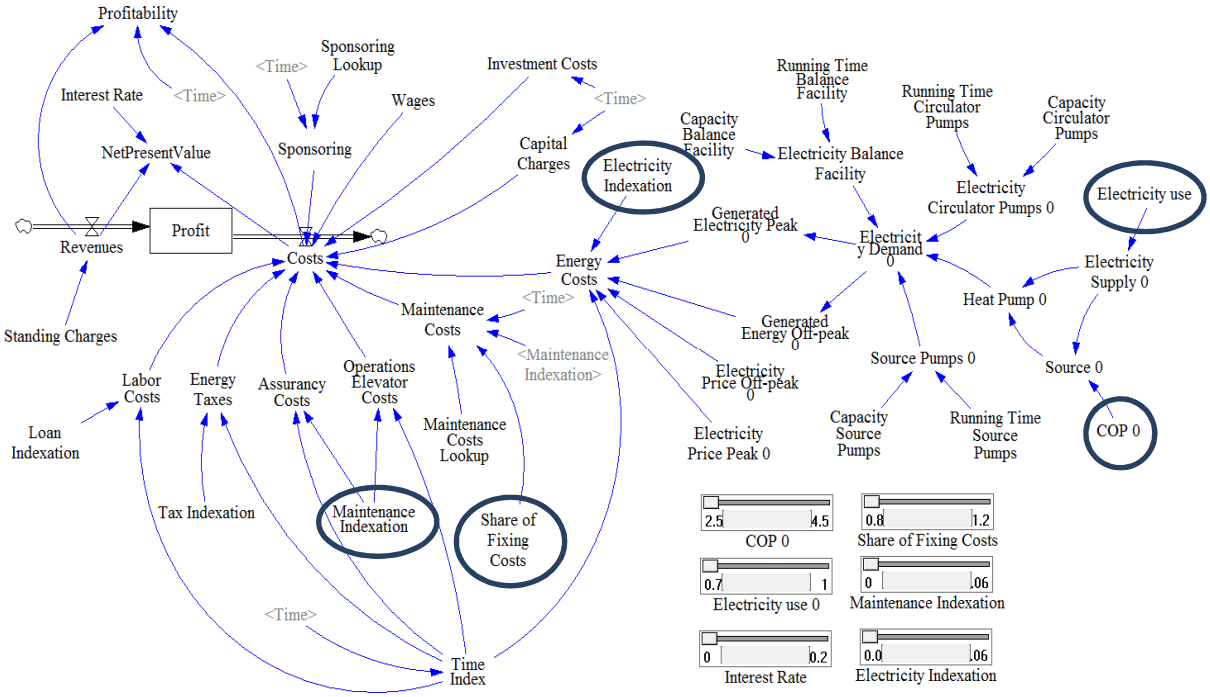

Figure 5: Stock Flow Model Business Case

Monte Carlo Simulation

Monte Carlo simulation is used for the sensitivity analysis of the business case in which five parameters are varied following a probability distribution. The specific business case for this research deals with an energy service company implementing a heat-cold storage installation. The uncertain parameters that could vary over time are listed in Table 8. 50.000 simulation steps were carried out following a PERT distribution.

Table 6: Parameters Monte Carlo Simulation

Dependent variable	*Unit*	*Affects the*	*Expected Value*	*Uncertainty range*
Indexation electricity	%	Energy costs	6%	4-8%
Energy usage	kWh	Energy costs	90%	70-100%
Coefficient of Performance	Dmnl*	Energy costs	3.5	2.5 – 4,5
Indexation maintenance	%	Maintenance costs	2%	0 – 6%
Percentage repair costs	%	Maintenance costs	100%	80 – 120%

Results of this business case are confidential and can only be found in the appendix of the full report. A bandwidth of the net present value with a certainty of 80 percent could be predicted. This business case proved to be sufficiently profitable to continue the collaboration. Thereby the individual risk contribution of the parameters have been estimated. It appeared that the risk contribution of maintenance indexation has the largest influence on the outcome followed by the fixing costs and coefficient of performance. Controlling and focusing on decreasing the maintenance costs is therefore recommended.

CONCLUSIONS

The main conclusion of this research is that the most optimal energy service company that can be offered to a hospital at this moment is highly dependent of the current demand and structure of the organization. The structure of the organization of a hospital should first be explored before the concept of energy service company can be introduced. The most optimal form of energy service company for a specific hospital is highly dependent on the current situation and needs of the hospital. Answers to the following questions need to be identified at first:

- At which point of the transition is the hospital at this moment?
- How are the departments of technical service, real estate and facility management structured within the organization of a hospital?
- What are the technical and financial capabilities of the organization?
- Who is responsible for energy management and the energy bill?
- What are the sustainability targets?
- What is the current state of installation techniques and condition of the building?

Otherwise the needs and considerations of a hospital can hardly be estimated. When insight has been gathered on these questions, recommendations can be given because each question is more or less related to the willingness of implementing an energy service company. The relevant answers to these questions and recommended strategies that suit the implementation of energy service company best, are summarized in Figure 8. The terms in bold are given preference over the other.

Market pull	-	Market push
Regional hospitals	-	Academic hospitals
Large hospitals	-	**Small hospitals**
Older hospitals	-	New hospitals
Facility management	-	Technical service
Facility management	-	**Real estate department**
Financial direction	-	**Real estate department**
Service, comfort, costs KPI	-	Sustainability, innovation KPI
Financial outsourcing	-	Technical outsourcing
Shared Savings	-	Guaranteed savings
Outsourcing	-	**Shared responsibilities**

Figure 8: Focus Points Conclusions

System Dynamics in combination with Monte Carlo simulation can be very useful in estimating risks within business models and the bandwidth of the key performance indicators. A bonus or penalty can be assigned depending on the percentage deviation of the expected value. In estimating the bonus or penalty, Monte Carlo simulation estimates the probability a certain deviation is expected. The energy service company is then able to underpin their bandwidth of the key performance indicator theoretically.

Most Optimal Energy Service Company

Flaws still exist within the concept where a hospital is completely outsourced by an energy service company. A portion of the consumed energy use for example is beyond the scope of influence for the ESCo or dependent of the user. A penalty can be beneficial financially for the client. Clients should not be tempted to let energy service company exceed the established bandwidth according to the energy performance contract. A way to optimize the unique selling points of energy service companies in my perception is to create a so-called special purpose vehicle in which a new cooperation is established where all involved parties are jointly responsible. Shared responsibilities in which sustainability, optimization and proper maintenance are the mainspring.

In addition, to decrease submerging responsibilities during the contract period by one of the parties is to make smart arrangements for profit sharing. An example of profit sharing based on the agreed bandwidth of a key performance indicator is depicted in Figure 9Figure 6-F. The share of profit is plotted against the KPI percentage of expected energy savings. A target of potential energy savings should be estimated on which a percentage deviation should be agreed upon. In this case a bandwidth of 95% to 101% of the expected energy savings is acceptable where the ESCo performs as it should be. However when even more energy is saved, the client will have a 25% share of profits rising to 75%. This will stimulate both parties to save as much energy as possible. On the other hand, the client should also carry a little part of the burden for 25% of the losses in case of underperformance. The client and user are partly responsible for shortfalls of energy saving. The special purpose vehicle aims to create a long-term collaboration in which every party has the influence it comforts. The risks and savings are distributed in line with each interest and responsibility in the most optimal way.

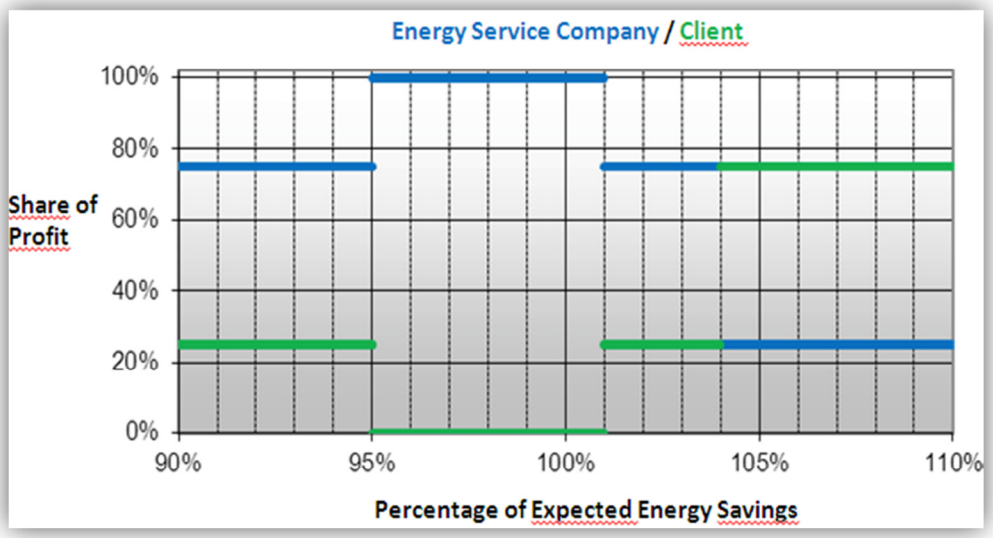

FIGURE 9: DISTRIBUTION OF PROFIT (DEVELOPED BY AUTHOR BASED ON KUIJPERS MODELS)

DISCUSSION

One useful conclusion is that the implementation of energy service companies within the cure market is highly situation dependent. The most important needs and considerations of hospitals are provided in this research. An energy service company should first know about these considerations of a specific hospital before a product can be offered. Only then key performance indicators can be implemented where a good balance of trust and KPI within the contract should be found.

The findings of this research can be strengthened in a quantitative and qualitative way. A more complete image of the cure market can be outlined with more data from hospitals. Also more in-depth data can be gathered when an extensive collaboration is engaged with a hospital. The System Dynamics method in combination with Monte Carlo simulation proved to be useful but can also be improved by generalizing the model and also taking the business model of the client into account.

Further Research

To sum up, the recommendations for further research resulting from the conclusions and discussion are the following:

- Estimating key performance indicators in the practical field
- Investigating the application of Real Options Analysis (ROA)
- More extensive theoretical underpinning
- Generalizing and extending the System Dynamics model
- Giving insight in the Health Care (real estate) transition
- Giving insight in the possible financial (tax-)arrangements

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K.J. (Koen) Hemink

Thank you for reading this summary of my graduation report. The graduation project was an inspiring time in which I learned a lot on the field of energy service companies, sustainable installation techniques and the health care sector. I hope I have contributed to an understanding of the health care sector and showed the potential of energy service companies within this sector with useful tools. I want to thank Kuijpers Ecopartners for giving me the opportunity to graduate on an interesting and topical subject and to experience with the scientific methods in the practical field.

2006 – 2011	Bachelor Innovation Sciences, TU/e
2010 – 2011	Board Ichthus Eindhoven
2012 – 2013	Certificate Technology Entrepreneurship, internship Hospitainer
2012 – 2013	Secretary/Vice-chairman Studytour committee China, of CoUrsE
2011 – 2013	Master Construction Management and Engineering, TU/e
2012 – 2013	Graduation Internship, Kuijpers Ecopartners

8.6 APPENDIX I: SUMMARY KENWIB (NL)

AFSTEMMEN VAN VRAAG EN AANBOD VAN ENERGY SERVICE COMPANIES IN DE ZIEKENHUISMARKT GEBRUIKMAKEND VAN ANALYTICAL HIERARCHY PROCESS EN SYSTEM DYNAMICS

Auteur: Koen Hemink

Afstudeerprogramma
Construction Management & Engineering

Afstudeerdatum
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Externe begeleider (Kuijpers)	ing. Bob Bloemers MBA
Externe begeleider (Kuijpers)	ing. Valentijn van Wanrooij MRE

ABSTRACT
Het concept Energy Service Companies (ESCos) wordt steeds belangrijker in de ziekenhuismarkt. Vraag en aanbod van Energy Service Companies in de ziekenhuismarkt zou op elkaar afgestemd moeten worden om energieverbruik en energiekosten te verlagen. Een enquête is afgenomen bij verschillende werkvelden binnen een ziekenhuis die inzicht geeft in de behoeften en afwegingen van een ziekenhuis in de keuze voor implementatie van een ESCo. De onderzoeksmethode Analytical Hierarchy Process bepaalt de relative belangrijkheid van kritische prestatie indicatoren (KPI) die kunnen worden opgenomen in een energieprestatie contract. System Dynamics in combinatie met Monte Carlo simulatie is gebruikt om een gevoeligheidsanalyse van een specifieke business case uit te voeren. Deze methodes zijn uitermate geschikt voor het bepalen van de risico-invloeden van een verdienmodel en bandbreedtes van KPI. Interviews met diverse experts verifiëren en valideren het onderzoek.

TREFWOORDEN: Energy Service Companies (ESCo), Gezondheidszorg (Cure), Analytical Hierarchy Process (AHP), Monte Carlo simulation (MCS), Kritische Prestatie Indicatoren (KPI)

INTRODUCTIE
Implementatie van Energy Service Companies is een relatief nieuw en opkomend concept voor ziekenhuizen. Volgens onderzoek van SBR draagt een andere manier van denken bij aan het verlagen van CO^2 emissie en energiekosten (SBR) (Peek & van Remmen, 2012). In eerste opzicht zijn er een hoop kansen voor uitbesteding van het energievraagstuk aan Energy Service Companies. De energie intensiviteit van de sector met een hoog besparingspotentieel, een groeiend privatiserende en liberaliserende ziekenhuismarkt, gebrek aan financiële middelen en een toenemende focus op de zorg binnen ziekenhuizen geven kansen voor ESCo-constructies (AgentschapNL, 2010) (Builddesk, 2011).

Probleemdefinitie
Implementatie van Energy Service Companies vraagt echter wel een omslag van denken voor het ziekenhuis. Prioriteit voor het uitbesteden is laag en er is een gebrek aan inzicht in de behoeften en afwegingen van het ziekenhuis terwijl aanzienlijke energiebesparingen gehaald kunnen worden. De Energy Service Company en het ziekenhuis komen niet dichter bij elkaar door misverstanden, onduidelijkheden en gebrek aan vertrouwen (Builddesk, 2011).

Onderzoeksdoel
Het doel van het onderzoek is om inzicht te verkrijgen in de behoeften en afwegingen van ziekenhuizen ter implementatie van energy service companies om daar vervolgens als energy service companies op in te spelen. Voor een succesvolle implementatie zijn er een aantal obstakels die overwonnen moeten worden. In een marktonderzoek wordt de vraag en relatieve belangrijkheid van kritische prestatie indicatoren vastgesteld. Met een specifieke business case inclusief gevoeligheidsanalyse wordt het nut van het concept in de praktijk en gebruikte methodes onderzocht.

Onderzoeksvraag
Vanuit de probleemdefinitie en het onderzoeksdoel is de volgende onderzoeksvraag geformuleerd: Hoe kan de implementatie van Energy Service Companies in de ziekenhuismarkt versnel worden?

ONDERZOEKSMETHODES

Het onderzoek start met een literatuuronderzoek. Tegelijkertijd zijn er interviews georganiseerd met experts van energy service companies and ziekenhuizen. Hierin zijn de verschillende vormen van energy service companies uiteengezet, is een stakeholders-analyse opgezet en zijn de belangrijkste kansen en bedreigingen voor de ziekenhuismarkt bepaald. Een enquête, ingevuld door de technische dienst en facilitair management van verschillende ziekenhuizen, bepaalt de belangrijkste afwegingen en behoeftes van ziekenhuizen ten opzichte van energy service companies. Regressie is toegepast om de interactie effecten te bepalen. Een onderdeel van deze enquête is het paarsgewijs vergelijken van de kritische prestatie indicatoren. De resultaten hiervan worden verwerkt met de methode Analytical Hierarchy Process. Deze methode bepaalt de relatieve belangrijkheid van verschillende criteria en subcriteria. Voor het opzetten van de business case is gebruikgemaakt van de System Dynamics methode. System Dynamics probeert complexe problemen begrijpelijk te maken door mathematisch te modelleren. De risico's van de business case zijn verwerkt met behulp van Monte Carlo simulatie. Monte Carlo simulatie wordt gebruikt om de impact van risico's en onzekerheid van bijvoorbeeld financiële modellen te bepalen. Voor dit onderzoek geeft de methode een bandbreedte van de NPV aan en stelt de risico's met de grootste invloed vast. Met deze methode kan ook de bandbreedte van de kritische prestatie indicatoren theoretisch worden onderbouwd.

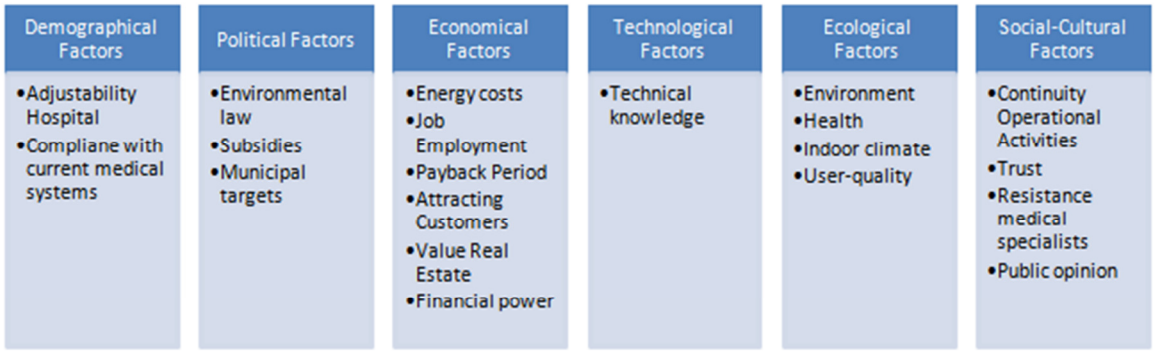
De business case betreft de exploitatie en het beheer en onderhoud van een WKO-installatie waarop zes gebouwen aangesloten zijn. De scenario's met vijf verschillende parameters die zijn meegenomen in de Monte Carlo simulatie zijn weergegeven in Tabel 1. Deze aannames zijn gebaseerd op eerdere prijsontwikkelingen en ervaringen van Kuijpers. Het verdienmodel is gemodelleerd in System Dynamics met de Net Present Value als uitkomst.

Tabel 1: Parameters Monte Carlo simulatie (samengesteld door auteur)

Scenario	Parameters
Meest verwacht	Elektriciteitsprijs indexatie 4%, onderhoudsindexatie 2%, reparatiekosten 100% van standaard, energie afname 90%, COP 3,5
Scenario 1 Worst case	Elektriciteitsprijs indexatie 8%, onderhoudsindexatie 6%, reparatiekosten 120% van standaard, energie afname 70%, COP-waarde 2,5
Scenario 2 Best case	Elektriciteitsprijs indexatie 4%, onderhoudsindexatie 0%, reparatiekosten 80% van standaard, energie afname 100%, COP-waarde 4,5

RESULTATEN

Vanuit de literatuur en interviews met verschillende werkgebieden binnen de organisatie van een ziekenhuis zijn de belangrijkste afwegingen vastgesteld, weergegeven in Figuur 1.



Figuur 1: DESTEP Afwegingen ziekenhuizen (samengesteld door auteur)

In de enquête, waaraan 37 respondenten hebben deelgenomen, zijn de afwegingen voorgelegd. Hieruit blijkt dat financiële en technische ontzorging, vertrouwen en het verlagen van energiekosten de belangrijkste motieven zijn voor implementatie van Energy Service Companies. Financiën, onderhoud, exploitatie en monitoring zijn de belangrijkste fasen die kunnen worden uitbesteed. De service, kosten en comfort indicatoren worden geprefereerd boven de innovatie en duurzaamheidindicatoren. Veiligheid, onderhoudskosten, aantal storingen, energieverbruik, temperatuur en luchtkwaliteit bleken de meest toepasbare KPI in een energie prestatiecontract.

CONCLUSIE

Belangrijkste conclusie van dit onderzoek is dat de meest optimale Energy Service Company dat kan worden aangeboden sterk afhankelijk is van de huidige situatie en structuur van de organisatie van een ziekenhuis. Onderzoek binnen een specifiek

Market Pull	-	Market Push
Regionale ziekenhuizen	-	Academische ziekenhuizen
Grote ziekenhuizen	-	**Kleine ziekenhuizen**
Oude ziekenhuizen	-	Nieuwe ziekenhuizen
Facilitair management	-	Technische dienst
Facilitair management	-	**Vastgoedafdeling**
Financiële directie	-	**Vastgoedafdeling**
Service, comfort, kosten KPI	-	Duurzaamheid, innovatie KPI
Financiele ontzorging	-	Technische ontzorging
Gezamenlijke besparingen	-	Gegarandeerde besparingen
Outsourcing	-	**Shared responsibilities**

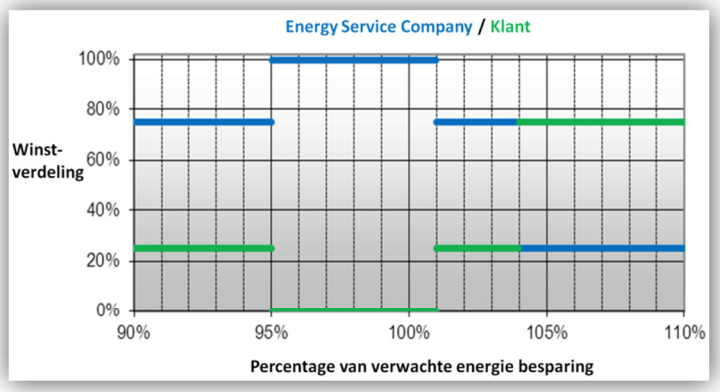
Figuur 2: Aandachtspunten (samengesteld door auteur)

ziekenhuis is dus vereist voor het introduceren van een product. De belangrijkste aandachtspunten, vet gedrukt, die de implementatie van Energy Service Companies versnellen en volgen uit dit onderzoek zijn samengevat in Figuur 2.Het benaderen van een vastgoedafdeling of facilitair management verdient de voorkeur boven de technische dienst en financiële directie. Afwegingen hierin voor succesvolle implementatie zijn doelstellingen voor het verlagen van exploitatiekosten en een breed draagvlak zonder belangenverstrengeling.

De precieze resultaten van het System Dynamics model en Monte Carlo simulatie zijn vertrouwelijk en alleen toegevoegd in de bijlage van het totaalrapport. De business case bleek gunstig uit te pakken waarin een NPV bandbreedte is vastgesteld ten gevolge van de risico's. De onderhoudsindexatie en reparatiekosten bleken de meeste invloed te hebben waarmee een focus op deze kosten aan te bevelen is. De methodes hebben hun nut bewezen in het verwerken van de risico's in een ESCo verdienmodel en het theoretisch onderbouwen van de bandbreedte van kritische prestatie indicatoren.

Meest optimale Energy Service Company voor ziekenhuizen

Een manier om de Energy Service Company te optimaliseren, waarin iedere partij risico's draagt in lijn met zijn of haar invloed, is het opzetten van een zogenaamde Special Purpose Vehicle. Zo is het ziekenhuis in staat de regie te blijven houden. Een voorbeeld van winstverdeling op basis van voorafgestelde bandbreedte van het percentage verwachte energiebesparing is schematisch weergegeven in Figuur 3. In dit geval is een bandbreedte van 95% tot 101% een acceptabele prestatie waarin de ESCo presteert zoals het moet presteren. Wordt er nog beter gepresteerd, gaat de klant ook meedelen in de winst, oplopend tot 75% van de winst. Anderzijds is de klant ook medeverantwoordelijk voor slechte energieprestaties en dient daardoor ook voor een klein deel de lasten te dragen. Zo zijn de risico's en besparingen optimaal verdeeld tussen de klant en ESCo naar de invloed en verantwoordelijkheid in het proces, stimulerend voor beide partijen om energie te besparen.



Figuur 3: Verdeling van winsten (gemaakt door auteur gebaseerd op Kuijpers modellen)

Referenties

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