



**LUND UNIVERSITY**  
School of Economics and Management

# Resource Allocation within an R&D Environment

- The Agency Theory Conundrum

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## Abstract

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<b>Keywords</b>	Agency Theory, R&D, Resource Allocation, QlikView
<b>Purpose</b>	Investigating and minimizing the effects of agency problems in the R&D resource allocation within Arandee as well as evaluate and improve the analysis of the resource and planning process.
<b>Theoretical perspectives</b>	Agency theory within internal capital markets.
<b>Methodology</b>	Case study and action research, data collection through observations and interviews.
<b>Empirical Foundation</b>	The employees at the Business Control department and selected program and line managers within division 1 at Arandee as well as internal documentation.
<b>Conclusions</b>	Agency problems affect the resource planning and analysis, but not the allocation of resources to the R&D programs. The problems can be solved changing the data recorded and by introducing benchmarks, audits and changes to the compensation scheme. The analysis of the resource allocation, performed by the Business Control department in Excel, was inefficient. The introduction of the business intelligence software QlikView improved the analysis greatly.

## List of Abbreviations

R&D	Research and Development
BC	The Business Control department at division 1
HC	Headcount

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# 1 Introduction

## 1.1 Background

Arandee is an R&D-intensive firm; the R&D personnel constitute 85% of the employees. The R&D within the company is divided into three main divisions, 1, 2 and 3, each with an own Business Control (BC) unit. One of the functions of the BC units is the resource planning and analysis for the R&D. This resource allocation function consists of monthly analysis of the present and future resource need and resource availability for the various R&D projects. The results of the analysis are formalized into reports and subsequently used for the actual allocation decision (M.B. 2011).

The resource need is decided upon in a more decentralized manner. Each project manager requests resources for a specific task within a specific line (examples of line categories are software and productification). This is named the ‘when and what’ part of the process. The individual line manager then either approves the requested amount, meaning that the request is equal to need for completing the task, or adjusts it, meaning that fewer or more resources are needed. This is named the ‘how and who’ part of the process. Given that there are no restrictions in terms of capital and that the established need is equal to the true need, all projects would always be allocated resources up to this need. (M.B. 2011)

### 1.1.1 QlikView

Created by a company from Lund, QlikView is a business intelligence computer software that facilitates visualizations and analysis of large, complex, datasets. The program is configured to extract data directly from multiple databases and through automated processes create a user interface that is driven almost solely by mouse clicks. The charts, graphs and tables displayed in a constructed interface (henceforth called cockpit) can therefore be customized to visualize practically any combination of the data without essentially requiring anything other than a mouse. The two main advantages of the software are the ability to quickly find and uncover new important aspects in the data and the time savings made in producing reports and analysis

material. There is also the added benefit of the more widespread usage and analysis made possible by the ease of operation.<sup>1</sup>

## 1.2 Problem Discussion

Being a young R&D firm which has just finished a transformation process, with substantial R&D not yet ready for market release, internal funds are scarce. Seeing as the company is not yet producing a positive bottom line, i.e. that the sales generated is not enough to provide the R&D with sufficient funds to achieve its objectives, efficient use of the available resources is vital.

This allocation of resources depends on the analysis made by the business control unit, which in turn depends on the accuracy and truthfulness of the resource need established by project and line managers. In the current situation, all projects do not have full allocation relative to the need. Project managers are aware of this limitation in resources, leading to a theoretical motivation for requesting more than their perceived need. Line managers should be independent of the individual projects and thus serve as a controlling entity that establishes the true need. However, under the current conditions, there is considerable pressure to complete certain projects on time and it can easily be imagined that no line manager wants his/her line to be a bottleneck in those projects, giving him/her incentive to approve a higher resource need than the true one. If this is the case, line managers no longer behave in the best interests of the firm as a whole. Because the program and line managers jointly have sufficient knowledge to establish the true need, the potential problem at hand is ascertaining that they fulfill their duties and behave in the interest of the BC, senior management and the company as a whole.

In the financial literature, the problem presented above is discussed within the agency theory framework. More specifically, it is discussed within agency theory in internal capital markets. In the agency theory terminology, the current process has two levels of agency problems. Starting from the top, which is the level where line managers are the agents and BC is the principal. BC wants the line managers to establish correct program needs so that the analysis and resource planning is accurate. To do so, the second level of agency problems has to be mitigated by the line. In this second level the program manager is the agent and the line manager is the principal.

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<sup>1</sup> More detailed information on QlikView is found in appendix 3.

The line manager wants the program manager both to request truthfully the amount of resources needed and to pass on all relevant information so that the establishment of the program need and subsequently the allocation is optimal.

Hence, there are 5 scenarios possible in the allocation process.

1. The program manager requests more resources than the perceived need and it is mitigated by the line manager.
2. The program manager requests more resources than the perceived need and it is not mitigated by the line manager.
3. The program manager requests resources equal to the perceived need, but not equal to the true need, and it is mitigated by the line manager.
4. The program manager requests resources equal to the perceived need, but not equal to the true need, and it is not mitigated by the line manager.
5. The program manager requests resources equal to both the perceived and the true need.

In scenarios 1, 3 and 5, the established need will be accurate whereas in scenarios 2 and 4 it will not. As is seen, when the line managers do not act as required, the program need becomes faulty. On the other hand, when line managers fulfill their obligations, the program need is accurate. There are two basic reasons why the line manager would fail to establish the true program need: either because the program manager withholds important information not available to the line manager or because the line manager is shirking in some way.

Since it is assumed by BC that the established need represents the true need, untruthful, too high, established needs result in faulty analysis and in extension to overinvestment in the concerned programs and underinvestment in other programs. At the present, it is never questioned which of the scenarios above is the dominant. It is, therefore, not known from which level the agency problems originate. Neither is there any effort spent on increasing the truthfulness of the program needs, such as by contracting the outcomes of the managers' behavior or through increasing the managers' reporting.

The sheer amount of data processed by BC each month requires a substantial amount of time for constructing easily understood visualizations to be included in the reports. Presumably, if the data processing time is decreased, more time and effort can be put into the analysis, thereby making it

more flexible. Furthermore, if the input is more structured and more easily overviewed when it reaches the employees in the BC unit, the quality of the analysis should logically be increased. The data processing is currently done in the Microsoft program Excel and without considerable programming there can be no improvements in either time consumption, flexibility or quality.

### **1.3 Statement of Purpose**

The primary purpose of this study is to investigate, from the viewpoint of the Business Control, the existence and the implications of agency problems in the resource allocation process. Having evaluated the current process, it is the aim to suggest improvements that mitigate any agency problems. The suggestions will be derived through literature studies, observations and interviews.

The secondary purpose of this study is to improve the data processing and reporting by introducing a business intelligence computer program called QlikView. The aim is to configure and implement the software in such a way that Excel becomes superfluous and the amount of manual labor is kept to a minimum in the analysis process, meaning that the bulk of the data processing is automated. The end goal is a senior management “cockpit” with simple, graphical representation of key data, providing a simple way of increasing the understanding of resource allocation.

### **1.4 Delimitations**

Although in the general field of internal capital markets and capital allocation, this study will neither study nor conclude how the resources should be distributed.

### **1.5 Confidentiality**

Since the R&D projects in the pipeline in a company such as Arandee are confidential, the authors of this paper have signed a non-disclosure agreement. The most notable result of the agreement is the use of a pseudonym when referring to the firm. Furthermore, the paper does not present any sensitive internal information. This has the implication that parts of both the empirical- and the conclusions chapters will be kept more general than what might be required to

get full understanding of the issues. At times, the authors have also taken the liberty to present a distorted picture of the information gathered.

## 1.6 Thesis Outline



**Figure 1 Thesis outline**

Figure 1 above displays how the thesis progresses from this point. In chapter 2 the methodology used in the study is presented, followed by the literature review and theoretical framework in chapter 3. In chapter 4, Empirical Investigation, the relevant observations made and a summary of the results from the interviews are presented. In the subsequent chapter 5, that which was presented in chapter 4 is discussed and analyzed in relation to the theoretical framework. Chapter 6 comprises the authors' suggestions for change in the process. In the final chapter, Conclusions, the conclusions and areas of interest for future studies are presented.

## 2 Methodology

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*In this chapter an overview of the methodologies applicable to the thesis as well as the research approach taken are presented.*

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The main focus of this paper is to evaluate the R&D program resource planning and analysis at the Business Control department and suggest improvements to the process. In order to do so proper methodologies and strategies necessary for the analysis need to be selected. The different research strategies and methods used in this paper are introduced in this chapter.

### 2.1 Strategies

When it comes to ways of defining the object being studied in this paper, there are several different research strategies that can be applied in order to solve the research problem. Among them are case studies, surveys and actions research. Each of these strategies will be discussed below.

#### 2.1.1 Case Study

The use of case studies has become extremely widespread in social research, particularly with small scale research. These studies are used when the focus is on just one or few occurrences of the thing that is being investigated. The focus should, therefore, be on the individual occurrences rather than the wide spectrum. The logic behind concentrating efforts on one case rather than on many cases is that there may be insights to be gained from looking at the individual case that can have wider implications and would not come into light through the use of a research strategy that tried to cover a large number of instances. The main aim of this study is to get an in depth understanding of the processes, actions and relations that are present and to illustrate a general phenomenon through one specific case. The study takes place in a natural occurring environment and the case that forms the basis of the investigation is normally something that already exists. The researcher can, therefore, not manipulate the environment to isolate the effect of a specific variable. (Denscombe 2007)

Case studies tend to deal with holistic rather than isolated factors by focusing on the relationship between the actors in the case, as well as how the process works. The real value of the study is that it offers the opportunity to explain why certain outcomes happen, more than just finding out what those outcomes are. (Denscombe 2007)

One of the advantages of the case study is that it allows the researcher to use a variety of sources, types of data and research methods as a part of the investigation. Among other, the benefits of this study method are:

- It focuses on one or a few instances which allow the researcher to deal with the subtleties and intricacies of complex social situations
- It is suitable when the researcher has little control over events.
- It can fit in well with the needs of small scale research through concentration effort on the research site. (Denscombe 2007)

However, in recent years there has been extensive criticism of the case study method, claiming that it is not rigorous enough, since it allows equivocal and biased findings and conclusions to be presented by the investigator. These are properties that lay in the investigators' ability to execute the study and are difficult to govern. It can also be argued that this is evident in other more frequently used study methods, e.g. surveys, though more prominent in case studies. Another concern is that there is no ability to generalize from a single case. In contrast to surveys, case studies cannot be generalized to a population, but like experiments it still can be generalized to a theoretical proposition. (Yin 1994).

### **2.1.2 Survey**

Surveys have in recent years emerged as one of the most popular and commonplace approaches to social research. According to Denscombe (2007) surveys have three major characteristics, which are as follows

- They can be used as a research strategy when the scope of the research is wide. In principle, they should take a panoramic view of things and take everything into account which centers around the research
- Their purpose should be to bring things up to date by attempting to provide snapshots of

how things are at the specific time at which the data was collected.

- As a research strategy it encourages empirical research.

Surveys can be carried out in several different ways; as postal questionnaires, face-to-face interviews, telephone interviews, documents and observations. The best known kind of survey is the one which involves postal observations. The survey strategy is most commonly used to research large number of instances over a wide scope.

The sample used by the researcher must be carefully selected, since it is impossible to collect data from everyone in the population, if there is to be any confidence that the findings from the sample are similar to those among the rest of the category under investigation. The sampling techniques can be divided into probability and non-probability sampling. Probability sampling is based on the notion that the people or the events that are chosen as the sample are chosen because the researcher has some idea of the probability that they will be a representative cross-section of people or events in the whole population being studied. Non-probability sampling is conducted without such knowledge about whether those included in the sample are representative of the overall population. Further, when the survey strategy is applied to small-scale projects and to collect qualitative data, non-probability sampling is generally used. (Denscombe 2007)

According to Denscombe (2007) surveys have four major advantages, the first being that they emphasize on producing data which is based on real-world observations. Secondly, the surveys can incorporate both large-scale research covering many people and events, and small-scale qualitative research projects. Thirdly, they lend themselves to quantitative data, meaning that researchers using quantitative data will be inclined to using surveys. And lastly, surveys are relatively cheap compared to other research strategies and can produce a mountain of data in a short time.

There are, however, a couple of drawbacks to surveys. One problem is when researchers neglect the significance of the data. Another problem stemming from the use of surveys is when the data produced from the surveys are likely to lack much by the way of detail or depth on the topic being investigated. The biggest problem is, though, that the researcher is unable to verify the accuracy and honesty of the responses. (Denscombe 2007)

### 2.1.3 Action Research

Action research can be classified as a close relative to case studies, with the most notable difference being that in action research the researcher assumes the role of change agent. While a traditional researcher is detached, an action scientist is deeply involved. In the context of business organizations, the actions scientist conducts academic research while being either a consultant or an employee. (Gummesson 2000)

The involvement is meant to facilitate research in the sense that the personnel and the researchers find solutions cooperatively and use the knowledge that each party has to increase their competence. This leads to new decisions which in turn lead to new issues to study. The research process therefore becomes cyclical. (Gummesson 2000)

Susman and Everend (1978) presented *The action research cycle* (Figure 2) in which the general action research process is visualized.

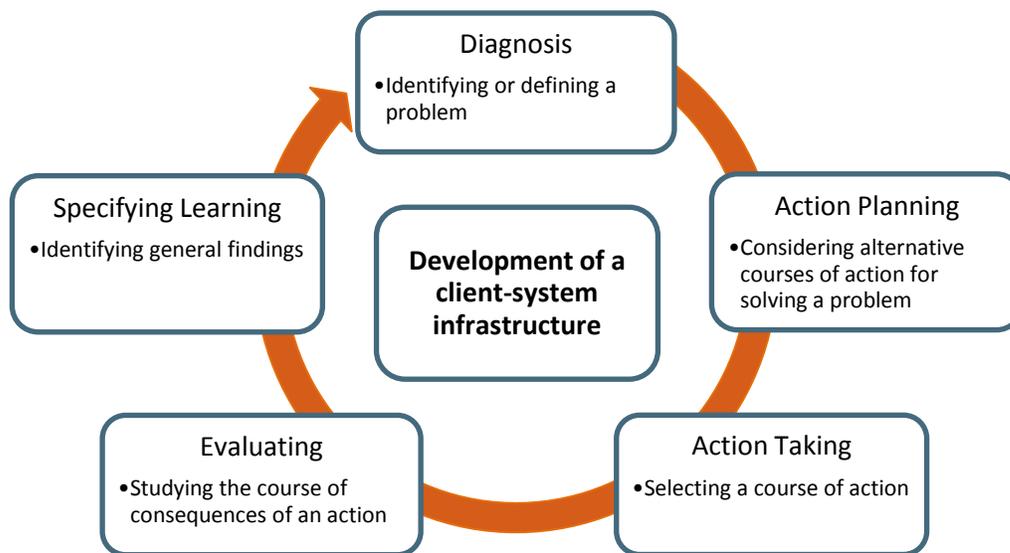


Figure 2 The action research cycle

At the heart of the methodology lies the notion that a researcher involved in the firm acquires extensive knowledge of the change process. Examples of this are the ability to understand verbal and non-verbal cues as well as the informal structures (Baskerville and Wood-Harper 1996). This notion also implies that action research is situational in the sense that the researcher does not base

the appropriate action solely on previously documented relationships of action-outcome, but also on the behavior of the actors involved (Susman and Everend 1978). Gummesson (2000) emphasizes that the researcher has to have genuine knowledge of the corporate environment and the business conditions. It should not, however, affect the investigation or research; instead it should be used as a resource to utilize in the change process. The methodology can be qualitative or quantitative and use multiple methods of data collection, the added dimension in action research is the involvement of the researchers and their influence on the change process.

In contrast to case studies, where only a few factors are studied in detail, action research focuses on the bigger picture of the problem. However, in order to be able to take action, the research has to be simple enough to engage the affected personnel (Gummesson 2000). In the words of Argyris et al., the research strategy is to be “optimally incomplete” (Argyris et al., 1985, p. 78).

The most notable drawback of an action research approach is the duality of the aim. It puts a strain on the researcher’s personality as he is attempting to unite research practice with the actions of a consultant without letting either become dominant. Meeting the objectives of the client while still producing a report of scientific value inevitably leads to conflicts and contradictions. (Baskerville and Harper-Wood 1996)

Gummesson (2000) proposes that the dual aim can be met by extending the research scope beyond the extent requested by the client. In practice, this implies that at the same time as the change agents meet the demands placed on the role of consultant, they also try to meet the requirements of the research community by carrying out certain additional work.

## **2.2 Research Approach in the Study**

The focus of this thesis was set on evaluating how human resources were allocated among different projects at Arandee and to suggest possible improvements to this process. This was done by working at Arandee throughout the study period. The authors of this paper had no influence or ability to change the environment. Data was collected from several different sources of information along with using several different methods to extract this data. This all agrees with using the case study approach, but due to the authors’ practical involvement in creating an analysis tool and since case study work needs to be conducted in an independent environment

where the results are just observed and not influenced, an action research approach seems more applicable. The research strategy used in this paper can, therefore, be said to be a combination of case study and action research.

The current resource allocation process was assessed by gathering data through literature studies, interviews, and observations. Interviews were carried out internally, and were either unstructured or semi-structured interviews. The decision to not have structured interviews was motivated by the belief that unstructured interviews could adapt more easily and because it was not known beforehand which area of information was of the most interest for each individual. The unstructured interviews were mainly held with personnel employed at the Business Control department. The purpose of these interviews was to get an understanding of the process as a whole and the fundamental ideas behind it. The semi-structured interviews were conducted by interviewing both program managers and line managers in division 1 at Arandee in an attempt to evaluate whether there existed any agency problems when it came to allocating resources between projects/programs. The interviews with program and line managers were used to collect qualitative information. Observations were also made on a daily basis by the researchers by participating in the everyday work at the division.

Drawing from the interviews, observation and literature studies, suggestions were made on how division 1 could improve its allocation process.

Another aspect of the allocation process evaluated was the analysis performed at the BC department. This evaluation, and the suggestions for improvement, were performed and generated by creating a new analysis model in the computer software QlikView. The end goal of the model was a senior management “cockpit” with simple, graphical representation of key data, providing a simple way of increasing the understanding of resource allocation on the financials which thereby improves the influence over actual decisions. The cockpit represents the most action research-like part of the study. Firstly, the current analysis was examined and evaluated and secondly the QlikView cockpit was set up in such a way that all the previous output could be produced. Once the cockpit was functional, the action research cycle was followed; problems were identified, solutions implemented and outcomes evaluated. Going through the cycle

whenever a problem was identified should ensure that the allocation decisions and analysis is as efficient as they can be.

## **2.3 Validity and Reliability**

Validity and reliability are two integral aspects when designing or assessing the methodology of a study and therefore need careful consideration.

### **2.3.1 Validity**

Thanasegaran (2009) purports that a measure is valid if it measures what it claims to measure, and measures it cleanly. To the type of study undertaken, there are three types validity relevant: construct validity, internal validity and external validity (Mullen et al. 2009).

Construct validity is the degree to which the variables and items measured corresponds to the theoretical constructs, or concepts, studied (Mullen et al. 2009). Achieving high construct validity in this study did not pose a problem; the literature on the subject of agency problems is clear on what aspects should be studied.

Internal validity is the validity with which one can describe the causal relationship, or lack thereof, between two variables (Muller et al. 2009). Being present throughout the allocation process, the authors had the possibility to observe and analyze on what basis the decisions are made. This means that there was ample opportunity to both find and describe any relationships (and the directions of them).

External validity, or generalizability, is a measure of how generalizable the results are (Saunders et al. 2006). In other words, it is how applicable the results are in other settings, such as a different firm. Naturally, external validity is hard to achieve in case studies and action research (Saunders et al. 2006). Arandee in its entirety is unlike any other firm, which means that the results cannot be assumed to be directly applicable to any other firm. Instead, care was taken by the authors to as accurately as possible explain the results in this unique setting in order for future research to test the robustness of the conclusions in similar settings and in that way validate the results.

### **2.3.2 Reliability**

Reliability is the degree to which a data collection technique yields consistent findings. Saunders et al. (2006) bring forth 3 questions to ask oneself when evaluating the reliability of a study:

1. Will the measure yield the same results on other occasion?
2. Will similar observations be reached by other observers?
3. Is there transparency in how sense was made from the raw data?

Due to the nature of this study, ensuring reliability is close to impossible. Observations made by the authors are likely to be different on any other occasion, not least because of the action research approach being taken. In addition, the firm itself is not in a steady state, which by definition means that it is constantly changing. Repeating the observational process and the interviews would therefore not give the same results, it would rather provide an evaluation of the changes suggested and/or implemented by the authors.

The second question raised by Saunders et al. is, in the view of the authors of this study, easier to comply with. Although the interviews were not fully structured, they were fairly standardized in terms of the questions asked, reducing the risk for observer errors.

Ensuring transparency in the analysis of the raw data is by far the hardest to comply with because of the confidentiality. Great care has been taken by the authors to be both unbiased and critical when interpreting the answers. The risk of participation bias, where the interviewees answer what they think their managers would like them to say, has constantly been considered. Unfortunately, the degree to which the authors have been successful in ensuring transparency is unobservable for any outsider without access to the confidential data.

## **2.4 Criticism of Sources**

For firm-specific data primary sources have been used. Due to the nature of the investigation the authors have collected data on specific issues from multiple sources. Each of these sources has been evaluated in terms of subjectivity. Finding agency problems is complicated since there are incentives for those who are misbehaving to not reveal anything that identifies them. Therefore, to limit the bias and subjectivity of the data, the interview answers are not evaluated individually,

but in light of all the answers from all the different participants. In essence, it is not the single answer that is used as basis for the conclusions; it is the overall picture that emerges. This critical view is facilitated by the use of well-known and credible sources when building the theoretical framework and subsequently evaluating the results. For the theoretical framework, mainly secondary sources have been used and they have mainly been in the form of articles published in journals.

### 3 Literature Review

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*This chapter presents the literature relevant to the purpose of the study and establishes the theoretical framework.*

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In research and development organizations human knowledge is the most important and by far the scarcest resource. Allocating the accurate human resources to a project is, therefore, essential to all organizations. The more the number of projects involved and the more specific knowledge that is needed in every project, the more important, but more difficult, is the allocation process. (Hendriks et al. 1999). As a result of human capital being such a scarce resource, firms face capital rationing since their capital budget is insufficient to fund all profitable projects. This makes the decisions on capital allocation made by the organization the most important ones. The choice of projects and the level of investment are, however, not only critical to the stakeholders of the organization but also for the economic well-being of the society as a whole. (Harris and Raviv 1996). When it comes to allocating the scarce resources among different divisions and projects within the same firm one theory in the business literature stands out. This is the theory surrounding allocation in internal capital markets. The following section of the paper describes in theory, based on previous literature, how internal capital markets are affected by asymmetric information and offers possible solutions to the agency problems that arise with this short coming. It begins, however, with a description of the concepts of information asymmetry and agency problems.

#### 3.1 Information Asymmetry and Agency Problems

Although the theories of the effects information asymmetry has on the market for publicly traded goods were first formulated in the economics literature, the importance of their application to financial markets was quickly recognized (Ogden, Jen and O'Connor, 2003). This discussion, therefore, begins with the pioneering theoretical analysis of information asymmetry in the economics literature. The concept of asymmetric information was first introduced by Akerlof in 1970 when he provided a theoretical analysis of the implications of asymmetric information in the market for used automobiles. Below follows a synopsis of his analysis.

Suppose that there are four types of cars. There are new cars and used cars. Both types of cars can also be either good or bad. When individuals buy new cars they do not know whether they are buying a good or a bad car. After owning the car for a specific length of time they can form judgments of the quality of their car. Now, assuming that the owners of some cars wish to sell them an asymmetry in available information has developed, since the sellers of the cars have more knowledge about the quality of the car than the potential buyers. Since it is impossible for a buyer of a used car to tell the difference in quality between a good car and a bad car, the sellers have an incentive to exaggerate the quality of their cars. Telling the truth about the quality of their cars would limit the proceeds from the sale and make them difficult to sell. The sellers of bad quality cars can put their car in a condition that mimics the condition of better quality cars, and then claim that the car is of good quality. Consequently, prospective buyers of this model will be unable to distinguish the bad cars from the good cars among all the cars that are for sale in the secondary market. Hence, bad cars and good cars must sell at the same price. All prospective buyers face the hazard that they will unwittingly purchase a bad car rather than a good-quality car.

Information asymmetry can be extended to take all goods into account. Asymmetric information simply entails that the seller of a good has more information about that good than the potential buyer. He, therefore, has an incentive to pass out untruthful information about the quality of that good in an attempt to increase his own benefits at the expense of the buyer. Although the effects of asymmetric information, as presented above, were first formulated in the economics literature, it was soon realized that their effects could be extended to take financial markets into account. According to Leland and Pyle (1977), information asymmetries are particularly prominent in financial markets. Borrowers usually know their collateral, industriousness, and moral rectitude better than the lenders do. Entrepreneurs possess inside information about the quality of their own projects for which they seek financing. Lenders would benefit from knowing the true characteristics of both the borrowers and the entrepreneurs. Moral hazard, however, hinders the direct transfers of information between the market participants. It cannot be expected that borrowers be entirely honest about their characteristics, or that entrepreneurs be truthful about the quality of their projects, since both parties might gain substantial rewards for exaggerating

positive qualities. Verifying the true characteristics by outside parties can be extremely costly, or even impossible.

The difficulties that arise under the condition of asymmetric information have become known as agency problems. The origins of agency theory dates back to the 1960s and early 1970s when economists like Wilson (1968) and Arrow (1971) explored risk sharing among individuals or groups. Their literature described the risk-sharing as a problem that arose when cooperating parties had different attitudes towards risk. Jensen and Meckling (1976) and Ross (1973) broadened the agency theory literature by including the agency problems that occur when cooperating parties have different goals and division of labor. According to them, agency theory is directed at the agency relationship in which one party (the principal) delegates works to another party (the agent) who performs that work. The principal, however, does not know what the agent has done, whether he has carried out the work as promised or not. Given the self-interest of the agent, the agent may or may not have behaved as agreed. The agency problem arises because the principal and the agent have different goals and the principal cannot determine if the agent has behaved appropriately since it is both difficult and expensive to verify what the agent is doing. This problem stems from moral hazard; the agent lacking effort in carrying out the work assigned to him and reporting truthfully about the quality of that work since it is believed that the agent has superior information about the work. Eisenhardt (1989) states that the main focus of the principal-agent literature is on identifying situations in which the principal and agent have conflicting goals and then describing the governance mechanisms that limit the agents self-serving behavior. According to her the principal has two options if he is unable to observe the agents behavior. The first option is to discover the agent's behavior by investing in information systems such as budget systems, reporting procedures, board of directors and additional layers of management. Such investments would reveal the agent's behavior, and the situation becomes one where there is complete information available to the principal. The second option is to contract the outcomes of the agent's behavior. Such an outcome-based contract motivates behavior by coalignment of the agent's goals with those of the principal.

Within the context of internal capital markets, agency theory is one of the most widely used theories to explain the organization of relationships within multinational corporations (O'Donnell 2000). Within multinational corporations, headquarters delegates decision-making responsibilities

to the divisions. This establishment of hierarchy creates a principal-agent relationship within the firm. The agency theory problems arise whenever the division's own interests are different from those of the headquarters. To put it differently, the division will act to pursue its own interests, even when they deviate from those of the organization as a whole. Monitoring is the most commonly recommended solution to this kind of agency problem, with the level of the monitoring determined by the extent of the deviation of interest between headquarters and the division. It is, therefore, the severity of the agency problem that dictates the level of monitoring (Mudambi and Pedersen 2007). Over the past decades, several other attempts to solve the agency problem have been proposed, such as using an internal audit system (Harris and Raviv 1996 and 1998), compensation contracts (Ogden, J. P., Jen, F. C. and O'Connor, P. F. 2003), capital rationing (Zhang 1997) and introducing a rotation policy (Stein 2003). These devices will be further discussed in chapter 6.

Multinational organizations like Arandee are multi-divisional firms, and in this context the agency approach has been best developed in the financial literature on internal capital markets. According to this literature, the headquarters of a multi-divisional organization re-allocates resources from poorly performing divisions to successfully performing divisions (Stein 1997 and Mudambi and Pedersen 2007). Since the divisions possess superior information they have an incentive to selectively provide information to headquarters in order to maximize their resource allocation. When the resource allocation within the firm is not linked to divisional investment opportunities it can be both inefficient and value destroying as more resources are being allocated to poorly performing divisions. These inefficient and value destroying allocations stem from the agency relationship between divisional managers and headquarters (Lamont 1997).

The discussion about agency problems can, of course, be extended to take external capital markets into account. Although this paper is not explicitly interested in external capital markets, they deserve a mentioning in order to make the agency theory foundation more complete. The discussion below, therefore, focuses on the attempts to address agency conflicts and information asymmetry problems simultaneously within the external capital markets framework.

Noe and Rebello (1996) developed a theoretical model that simultaneously examines the effects of asymmetric information and managerial self-interest on a firm's financing and dividend

policies. In their analysis a firm, which is initially owned by a large inside shareholder and managed by an incumbent manager, seeks funding for an investment opportunity. The shareholder and manager have private information about the firm's prospects. Although the firm has some internal funds at its disposal, these funds are not sufficient to meet its investment needs. To acquire outside financing, the firm must issue a mixture of both debt and equity. According to their results, shareholders always view debt financing as optimal in the presence of either asymmetric information or managerial self-interest. When both of these problems are simultaneously present, however, issuing equity can become an optimal signaling mechanism. Restricting dividends followed by equity financing and lastly under pricing securities is the most preferred signaling mechanism of shareholders. Managers, however, prefer the signaling mechanism to be the other way around.

Restricting dividends as a means of reducing agency problems seems counterintuitive when taking financial literature into account. It is argued that shareholders can limit managers' abilities to pursue self-serving behavior by restricting the free cash flow available to them. Dividends, therefore, mitigate agency problems of managerial discretion by disgorging excess cash. Dividends can also be used as a signal of the firm value in an asymmetric information context. On the other hand, higher dividends tend to increase the firm's need for external financing, which is extremely costly given the adverse-selection problem. This last problem is the reason why Noe and Rebello (1996) suggest that shareholders would want to restrict dividend payments (Ogden, J. P., Jen, F. C. and O'Connor, P. F. 2003).

Harris and Raviv (1991) introduced a theoretical model where debt could be used to simultaneously offer investors information about the firm and to discipline managers for engaging in self-serving behavior. By taking up debt the company is forced to make payments of both principal and interest in a timely fashion or face the probability of default. This disgorges the excess cash while also providing investors with information about the future prospects of the firm, i.e. that it has the ability to make future payments.

In the following section the agency problems of asymmetric information in internal capital markets will be discussed more thoroughly and previous literature on the subject will be presented.

### **3.2 Internal Capital Markets**

Williamson (1970) was among the first to realize that multi-divisional organizations could operate an internal capital market for allocating resources to capital projects. The question which remained was, however, to what extent does capital get allocated to the right investment projects? This has been one of the most frequent and fundamental questions asked in corporate finance these past years. In the perfect world envisioned by Modigliani and Miller (1958), where capital markets are frictionless, funds are able to flow in such a way that the marginal product of capital is equated across every project in the economy. However, in the real world capital markets are far from frictionless. There are a variety of distortionary forces that prevent capital from flowing in such an efficient manner. Taxes and transaction costs are examples of such frictions. But perhaps the most persistent and important distortions influencing the efficiency of corporate investments are those that arise from informational asymmetries and agency problems (Stein 2003). Modern finance theory recommends allocating capital based on the net present value rule. The net present value rule does, however, not provide any role for details of the internal allocation process. The internal capital allocation process must, therefore, account explicitly for asymmetric information and incentive problems (Harris and Raviv 1996). Using the net present value rule becomes problematic if senior management, which is in charge of the capital allocation, has to rely on information about future cash flows provided by better informed divisional managers. Assuming that the divisional manager enjoys private benefits from controlling more capital, reflecting his preference for empire building, greater perquisite consumption and the reputation that comes along with running a larger business; he will have an incentive to overstate the project quality. Since senior management is unable to verify his report they might allocate resources based on the information provided by the divisional manager. This can lead to both under- and overinvestment problems for the firm as resources are allowed to flow from high quality projects to weak quality projects since in most instances it is the managers in weak divisions that exert the most effort in

reporting untruthfully (Scharfstein and Stein 2000). The firm could, therefore, reject projects with positive NPV and invest too heavily in projects with negative NPV. If the senior managers must provide incentives for the managers to mitigate this moral hazard problem and report project quality truthfully, the firm might find it optimal to allocate capital differently than described by the net present value rule. Recent literature on the internal capital market allocation is presented below.

Wulf (2009) finds evidence suggesting that information problems lead to inefficient capital allocation in multi-divisional firms. To the extent that division managers prefer larger capital budgets, they have incentives to engage in costly influence activities to skew capital budgets in their favor since headquarters base their capital allocation on the information provided by the managers. Wolf uses a standard moral hazard model to argue that the divisional managers of large, established businesses can influence or bias the private information received by headquarters about the investment prospects of smaller divisions. Since headquarters is unable to observe the divisional managers' actions, the capital budget allocation might be inefficient, resulting in less profitable projects receiving more capital at the expense of more profitable projects. In order to address the incentive disparity between headquarters and division managers, he suggests that the internal capital market should be eliminated by either breaking up the firm or instituting policies which limit the role of headquarters in allocating capital. Wolf suggests another less extreme and potentially more practical approach to mitigate this problem; incorporating incentive contracts into the capital budgeting process to control and influence activities by divisional managers.

Bernardo, Cai and Luo (2001) use a simple model to illustrate the information, moral hazard and incentive problems within a multi-division firm. In these kinds of firms capital is allocated to investment projects based on reports by division managers who have access to private information about the project quality. The firm, however, is not able to verify the managers' reports and monitor their actions. This can result in underinvestment problems as resources are either allocated away from efficient projects to inefficient projects or not allocated by the firm to the managers. The authors of the paper, therefore, suggest that the firm must provide incentives to ensure truthful information flow and efficient use of the resources. They identify that the firm's problem is designing managerial compensation contracts and capital allocation schedules

that encourage honest reporting. Without an explicit incentive scheme, the divisional managers will always report the maximum project quality in order to get the greatest possible capital allocation. In the model they provided managerial compensation contracts that are linear in every division's cash flows. They also suggested that the firm provides more capital, greater performance-based pay and a lower salary when to managers when they report (honestly) that their project is higher quality. A lower salary combined with higher performance-based pay effectively encourages truth-telling by making the managers "purchase" shares in the firm when they are very optimistic. It is, therefore, likely that by offering managers powerful incentives in the form of compensation schemes such as shares in the firm or stock options, headquarters can mitigate the moral hazard problem and managers will report their private information honestly.

In their paper, Zanibbi and Pike (1996) show how capital investment decision making becomes difficult when lower level managers have different goals to senior managers and where the latter are unaware of such differences. The problem is that senior management bases their allocation on the information provided by divisional managers. Senior managers, however, possess far from complete knowledge of how the divisional managers generate and appraise capital projects. Since the resource allocation is based on the information provided by the divisional managers, they must invest a lot of time in convincing senior managers that their projects are worthy of their support. This is done by engaging in both formal and informal communications which can be counted as an expensive transaction cost. In order to align the goals of senior and divisional managers and reduce the transaction cost by reaching speedier allocation decision, the authors suggested that senior management adopt various control strategies such as instituting and monitoring training, investment criteria and procedures to be pursued that are consistent with senior management capital budgeting behavior.

Scharfstein and Stein (2000) developed a two-tier agency model that showed how rent-seeking behavior on the part of division managers could subvert the workings of an internal capital market. Rent-seeking is when divisional managers have superior information about certain projects compared to the senior management and use these advantages to make personal gains without making any contributions to productivity. Based on their superior information, the divisional managers take great effort in reporting untruthfully about the quality of their projects in an attempt to get a higher resource allocation, since it is assumed that the divisional managers

have preferences for empire building. By taking part in rent-seeking, division managers are able to increase their bargaining power and extract greater overall preferential capital budgeting allocations. They found out that rent-seeking is more of a problem with managers of weaker divisions. The reason being that the opportunity cost to such managers of taking time away from productive work to engage in rent-seeking is lower. This results in internal capital market inefficiencies as strong divisions typically wind up subsidizing weak ones. A possible solution to this problem is to get more senior managers involved in the allocation process. By giving each senior manager a specific role within the allocation process the firm might be able to take advantage of this specialized expertise in decision making. If someone is only responsible for a certain action of the allocation, he is more likely to become more informed about the divisions capital needs. However, as pointed out by the authors, dividing the authority in this way might increase the scope for inefficient “favor-trading”. One example of this is when a senior manager approves the capital allocation to a certain division out of favor. A more cutthroat approach described by the authors would be to remove the weak division from the firm.

In their paper Harris and Raviv (1998) focus on the extent to which headquarters allocates a given amount of capital across projects to a divisional manager. Headquarters seeks to design an incentive compatible capital allocation scheme to trade off the distortion due to asymmetric information and managerial preferences for empire building against the cost of auditing. In particular, headquarters chooses an audit strategy and capital allocation, as a function of the manager’s request for capital, to maximize the value of the residual claim, given the constraints implied by private information and the manager’s preference for empire building. The authors suggest that an optimal allocation scheme should involve an initial capital spending limit imposed on divisional managers that can be negotiated upward. The manager can either accept this capital allocation or request additional capital above the spending limit. These requests for additional capital by managers may be ignored, partially granted without investigating the managers’ projects or it may be fully granted based on a careful audit that reveals that the request was fully justified. The extent to which managers can negotiate the initial allocation depends on whether audit costs are low, medium or high. According to the authors, managers will request additional capital when the audit cost is low. As the audit costs increase, requests are more often ignored and less often fully granted. If the audit reveals that the projects productivity levels fully justify

the higher level of capital requested by the managers, headquarters will allocate this amount. If the audit reveals that the projects productivity levels do not justify the higher level of capital requested by the managers, no capital will be allocated to the project.

Zhang (1997) considers a model of moral hazard where divisional managers with unlimited access to capital have an incentive to understate project quality for the purpose of lowering the production level to disguise shirking. In order to control such shirking behavior, the senior managers need to offer high compensation to the divisional managers for high levels of production, which results in high compensation cost. Zhang suggest that by introducing capital rationing, managers would start competing for the limited capital. The term capital rationing refers to a voluntary restriction on investment activity in the form of a predetermined fixed budget, which will lead to the exclusion of some profitable projects. By forcing managers to compete for capital, each managers is now less tempted to understate the project quality since by doing so would result in him being compared unfavorably with his counterparts and thus less likely to receive capital. Credit rationing will, therefore, reduce managers' ability to extract rent and makes it less desirable for them to shirk. This comes, however, at some cost. The introduction of credit rationing will force the firm to forgo some projects, thereby resulting in under-investment. Zhang shows that when the profitability of the potential projects is sufficiently low, the benefit from incentive improvements outweighs the lost profit of foregone projects.

## 4 Empirical Investigation

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*In this chapter the results of the observations and interviews are presented. Initially, the current allocation process is explained, followed by a summary of the answers received in the interviews. The chapter ends with a description of the analysis currently performed in Excel and its limitations.*

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### 4.1 The Current Allocation Process

The resource allocation process at Arandee is quite similar to the internal capital allocation processes described in the finance literature. There are, however, two main differences between these processes. Firstly, internal capital markets allocate funds between the projects based on NPV calculations while at Arandee the allocation is centered on human capital. Although the processes differ in the form of capital being allocated between the different projects, both processes can be assumed to follow the same principals since the ability of a firm to allocate human capital among the different projects is based on the funds available. Allocating human capital is therefore equivalent to allocating funds. Secondly, the organizations described in the financial literature on internal capital markets are two layers. The top layer is headquarters that allocates funds to the bottom layers which are senior managers. Arandee is, however, a three layer organization with headquarters on top, line managers in the middle and project managers on the bottom. Although the allocation process at Arandee deviates from standard internal allocation theory by adding the extra layer, basing its allocation process on the internal capital market allocation theories is the most straightforward way since both processes give rise to the same agency problems due to asymmetric information. In what follows, the resource allocation process at Arandee will be described. Due to a confidentiality agreement the numbers chosen to explain the process are not actual numbers but some random numbers chosen by the authors.

Let's assume that Arandee has a number of programs, or projects, in the pipeline. Each of these projects has its own program manager. In order to meet the plans and successfully launch the projects on time, the managers need human capital allocated to their projects. All the project managers will, therefore, request human capital so that their projects will be functioning properly. When it comes to requesting the human capital each project managers must make requests from

specific line items. These line items are basically the skills of the human capital. There are several line items and none of them are the same, i.e. the human capital possesses different skills depending on which line it represents. So each project manager requests human capital from several different lines depending on the projects needs. The request process is best described in the matrix structure seen in Figure 3.

		Sectors/Lines						
		A	B	C	D	E	F	Program Requests
Programs/Projects	1	8				15	10	33
	2		50	15			30	95
	3	5	10	20	15	15		65
	4	5	20		35	60	70	190
	5	1		2	5	5	10	23

Figure 3 Resource Allocation Process – Requested Resources

Each line has a manager which can either approve the requests made by the project managers if he believes that the project really needs that amount of human capital to run smoothly or he can assign a different amount of human capital if he believes that the project does not need as much human capital as requested. As soon as the line managers have approved the requests made by project managers, or decided on the changes to the requests, a program need is said to be established. Figure 4 illustrates this part of the process. The program need is essentially what the line managers believe is the amount of human capital the projects should get allocated in order to run properly. At any given time there are always several project managers who are requesting human capital allocation from several line managers. However, since Arandee is a research and development organization human capital is the most important and most scarce resource. The program needs are most often greater than the human capital available at the corporation, so the projects must compete against one another for the scarce resources. Allocating the right human capital to a project is, therefore, vital. So how do the line managers allocate the human capital among the different competing projects? The allocation is based on a ranking system. The project

which receives the highest ranking has the highest priority when it comes to allocating the resources. The ranking is done by a business counsel at Arandee and is based on the NPV of the projects. So basically, the project that has the highest NPV should receive the highest resource allocation, relatively speaking. Line managers attempt to allocate, starting with the top prioritized program and moving down the list, enough resources to fulfill the goals of each program without risking breakdown in any of them. In the current situation, this means that the top prioritized programs have close to full allocation compared to the need, while the bottom programs operate on the bare minimum. There is a dialog between line and program managers to solve any critical issues arising as a result of the allocation. The final allocation is most often lower than the program need, as illustrated in Figure 4.

	Sectors/Lines						Program Need	Review Board	
	A	B	C	D	E	F		Allocated Resources	
Programs/Projects	1	10 8				15	10	35 33	33 30
	2		50	30 15			30	110 95	95 80
	3	5	10	20	20 15	15		70 65	65 50
	4	5	25 20		40 35	70 60	70	210 190	190 160
	5	1		2	5	5	10	23	23 20

Figure 4 Resource Allocation Process – Program Need and Allocated Resources

After the allocation has been decided there is a review board that has the final approval about the allocation of the resources. Examples of members on the board are the director of all programs, major sector directors and the head of the business control. The board takes into account both the rankings made by the business council and the issue reports filed by program and line managers. Although the review board has final approval, it does not have sufficient knowledge to question the decisions taken by line managers, meaning that the allocation is practically taken for granted. In fact, the main task of the board is to analyze the gaps between the need and either the allocation or the forecasted resource availability (henceforth called gap analysis). The purpose of

the gap analysis is resource and project planning; by examining the current and forecasted gaps, the review board can decide on the room for starting new projects in the future and the necessity of scrapping current or planned projects. Based on the gap analysis, the review board and the management team make alterations to the rankings and directives for the line managers, changes which will affect the next resource allocation cycle.

## **4.2 Interviews**

In order to evaluate the current allocation process and make inferences, interviews with program and line managers were conducted. The main advantage of using interviews to evaluate the process is that they do not require any advanced technical resources. However, their main disadvantage is that they take time to conduct and even more time to analyze. In this research, eight managers were interviewed, with the interviews lasting between 30 minutes and up to an hour. The sampling technique used in this paper is probability sampling. The sample chosen includes managers ranging from low to high level programs and should, therefore, provide a representative cross-section of the managers in the whole population being studied. All interviews conducted were semi-structured, meaning that they had some prepared questions but they also allowed the respondent to comment on things they found relevant to the topic. The question guidelines used for the interviews are presented in appendix 1.

Some program managers who were interviewed stated that they did not fully understand the allocation process, or that it was very unclear due to the lack of transparency. The main issue was that they did not see the use of the gap analysis. Although the resources requested by program managers are approved by line managers they will probably end up with an allocation which is much lower than the need. Program managers found it frustrating that they could get a high program need approved but only receive a limited allocation. Another important issue which they pointed out, was that line managers sometimes change the program need without discussing it with the program managers. These issues resulted in their inability to make comments on whether they would like to see changes made to the allocation process, other than making it more transparent, since they do not fully understand how the process works.

Other program managers seemed to understand the process perfectly but stated that, due to frequent changes being made to it and its short life, they understood why some might find the process complex and hard to understand. The short age of the current allocation process means that not all implementations have come into place but it will gradually become more efficient. Higher level managers seem to have a better understanding of the process while mid- and lower level managers do not have perfect understanding of the process.

Line managers, on the other hand, understand the process perfectly and do not want to see any changes made to it. They regard the process as being easy since they only have to allocate the resources they have at their disposal. They, however, agreed with the program managers' view that the process is quite complex and maybe quite heavy due to the lack of transparency.

Both parties agreed that the current process is quite efficient when it comes to allocating resources. With that being said, everybody stated that the resources allocated were insufficient, resulting in project delays and the loss of quality testing. This problem was, however, not that pressing for the top prioritized program since it seems that although they do not receive all the resources requested, they have the ability to influence the allocation decided by the line managers. So, if that program is likely to face delays or lack testing they will get additional resources allocated, pending on the motivation offered by the program manager. Other program managers, who have lower prioritized programs, stated that they do not believe escalation of issues will influence the allocation. However, they admitted that their programs might get additional allocation if it is close to a crisis situation. If this is the case then they might get resources reallocated from other programs. Line managers, to some extent, agreed with this view, acknowledging that the top prioritized program always gets resource allocation which is close to the program need, implying that they can run smoothly, while others programs receive almost minimum allocation. According to them, program managers cannot influence allocations after they have been made unless there is a great threat of program delays and customer unrest. When deadlines are closing in, line managers are willing to allocate additional resources to the program managers.

Line and program managers meet on a constant basis to discuss the resources needed to complete certain programs. These meetings take place both prior to and past the allocation. However, prior

to requesting resources, program and line managers have specific meetings to discuss the program need. Based on these meetings line managers either approve or disapprove the program need. Program managers will then request the resources which have been categorized as program need. Although the line managers have approved this program need they will almost definitely allocate fewer resources to that program. This is simply due to the fact that line managers only have a limited amount of resources available, due to the financial status of Arandee.

Program managers take neither the financial status of the firm nor the availability of resources into account when requesting resources. However, they contradict themselves by stating that if more resources were available, they would request more. Line managers are also under the impression that program managers would request more under that scenario.

When it came to incentive schemes all managers have the same general setup. Aside from the fixed salary there is a bonus scheme that is divided into three layers. The top layer is tied to the overall company performance. The second layer is based on the program performance while the third layer is based on individual performance. Receiving a bonus in a layer is contingent on the layer above being successful. The organization failing to meet the performance goals will result in no bonuses being received in the second and third layer.

The majority of the interviewees were under the impression that program managers overstate the program need in order to boost the allocation since they have no incentives to report truthfully about the project need. It was also pointed out that there are no penalties for overstating the need. In their view, program managers will, therefore, request more resources than needed in order for their program to survive. They know that there is a limited amount of resources available and by overstating the program need they might receive more resources than they otherwise would. Program managers will also try to lobby for a higher allocation. Managers of lines with few projects to allocate to state that they have sufficient knowledge of the programs to spot any over-requests made by program managers; dishonest requests made by program managers therefore have no effect on allocation. Other line managers, although not as confident, were also of the belief that over-requesting by program managers could be spotted. However, as is discussed below, this view changes as the horizon looking forward is extended.

Several problems regarding the process were raised in the interviews. The first problem is that line managers are unable to know the exact program need looking into the future. Program managers, however, make requests on a continuous basis which reflects both current and future need. Line managers have no problem allocating resources based on the current need but when it comes to future need, they have no knowledge of how many resources the program will actually need. So allocating resources to programs based on the future need might result in a distorted picture of the future situation.

Another important problem is that the process does not take overtime into account when allocating resources. Every program manager stated that they were forced to issue overtime in order to meet deadlines and keep the programs running in an effective manner. The fact that overtime is not taken into account in the allocation process also gives a distorted picture of the true allocation process since overtime can, to some extent, be taken to represent additional resources.

The last problem presented by some managers is that the process is not followed by everyone involved in it. The communication channels are not as they should be, requests are not made in a timely fashion, i.e. are made after deadline and requests made do not follow protocol. This problem might have risen due to program managers not fully understanding the process.

### **4.3 The Current Resource Allocation Analysis**

The existing resource allocation analysis is, as mentioned, done in Excel. The analysis is mainly used for the review meeting and for reporting the conclusions of the meeting to the management team. The supply chain of the data starts in the internal resource planning tool, Pluto, from where data is extracted to an Access database and eventually loaded into an Excel pivot table. All data can be viewed in the pivot table, given that the appropriate settings and sorting is applied. The majority of the reporting output stemming from this data is in graphical form, and often it is one single type of chart, i.e. the same variables on the axes, with variations only in the programs or sectors included. A typical chart is shown in Figure 5. In the chart, each color represents the established program need as it changes over time and the black line shows the forecasted

availability of resources. This chart is then varied by removing or adding programs or sectors and changing the line to show the actual allocation instead of the forecasted HC.

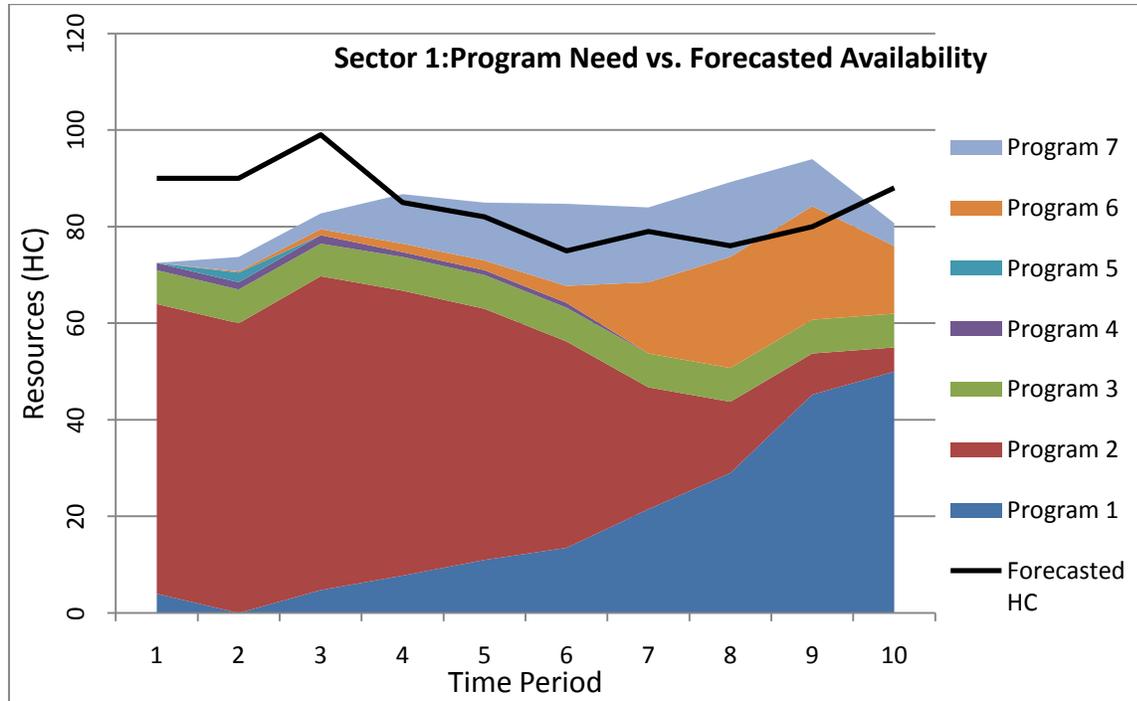


Figure 5 Typical Excel output chart

Customizing the charts is cumbersome work in the existing setup; each new variation requires a new chart to be built from scratch. This becomes even more of a drawback when it is taken into consideration that it cannot be known what variations are to be included in the final output before they have been created and examined. In other words, Excel does not offer the ability to screen the various variations graphically and, therefore, the likelihood of oversights increases.

Due the high time consumption, the analysis does not extend beyond these types of charts. There is a multitude of variables of interest not being considered, the clearest example being the research site. For example, in Figure 5, the total program need is higher than the forecasted HC for the periods 4 through 9, meaning that the programs will be understaffed. To investigate this it would be of interest to look first at the different programs individually to see if there are any large discrepancies (gaps). Secondly, with only the programs with the largest gaps shown, it would be of interest to show program need broken down by site (location) instead of program. This breakdown would then show if there are any sites with significantly less (or more) resources

than what the research at that site needs. The analysis can be continued by breaking the data down into sub-program projects or into sub-sector competences. Going through the above steps would in Excel mean that the chart has to be changed more than ten times, each time the pivot table has to be altered and the data reselected. Naturally, this type of analysis is never performed.

As was shown in the interviews, the analysis output is not distributed downwards in the organizational hierarchy. The rationale for this is that the gap-analysis should not affect any of the decisions taken by either line or program manager; it is solely for project portfolio planning purposes.

## 5 Analysis

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*In this chapter the results are discussed and analyzed in relation to the theoretical framework. It is split into two parts; The Allocation Process and The QlikView Cockpit.*

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### 5.1 The Allocation Process

Evaluating whether or not agency problems are inherent in the resource allocation process builds on the information gathered through observations and interviews. By working at Arandee throughout the study period the authors have been able to observe the process and gather a detailed understanding of how it works. Discussions have also been held with the employees at division 1 which shed further light on the process. However, in order to make a sound judgment on the process, interviews were carried out with those who are most involved with the process. Interpreting and analyzing those interviews is not solely based on the answers and comments submitted by the line and program managers but also by observing facial expressions and gestures while answering the questions posed. Body language sometimes says more than a thousand words.

Based on the answers submitted and through observations there seem to exist agency problems in the current allocation process. The fact that all managers are under the impression that program managers overstate the true project need pretty much sums up the problem. In addition, since the program managers admit that their requests would increase if the amount of resources available increased, it is apparent that the requests do not reflect the true program need. Since the program managers have greater information about the quality of their projects than the line managers, they have both an incentive and an opportunity to report untruthfully about the true program need. There are basically three reasons why the program managers may participate in dishonest reporting.

1. The program managers, who enjoy private benefits from controlling more resources, reflecting their preference for empire building, greater perquisite consumption and reputation that comes from running a larger division, will have an incentive to overstate the project need.

2. The program managers are aware that there exists capital rationing and that they must, therefore, compete for the scarce resources. Knowing that the line managers might, therefore, only allocate resources partially to their projects, they have an incentive to request a greater number of resources than they actually need in order to get a sufficient allocation.
3. Part of the program managers' salary is tied to the performance of their projects. By acquiring a greater number of resources than is actually needed, project managers can launch their projects quicker than anticipated and reap the rewards.

If line managers are truly unable to verify the information about the true program need, they might allocate resources based on the false reports provided by program managers. This might result in inefficient resource allocation as resources are allocated away from high quality projects to weak quality projects, resulting in an underinvestment problem.

Although program and line managers have recurring meetings throughout the life cycle of a project to decide on its resource needs, program managers do, as noted above, have superior information about their projects compared to line managers. They know for instance what the need will be in the future whereas line managers have limited information on the future need. Being able to request resources for future usage presents program managers with incentives to overstate the true need since line managers are unable to make any sound judgments as to whether this is the true program need or not. There are two problems stemming from these information asymmetries. First, future allocation might not reflect the true program need, meaning that the resources available are inefficiently allocated. Secondly, the gap analysis is biased. The second problem has large implications when considering that the gap analysis is used for program planning; if the need is overstated, the ability to start new projects is underestimated.

The fact that program managers can influence line managers' decisions, through escalation, after they have been made reflects program managers' incentives to participate in rent-seeking behavior to boost their allocation. If program managers make enough noise, they might be able to get additional resources allocated. Put differently, the line manager does not want to be the individual that causes a breakdown in a program. A logical implication of this is that the overall efficiency is decreased; those program managers who are proficient in lobbying will find it

profitable to invest time in convincing line managers that there are critical issues when there are not. Obtaining these resources enables the program managers to engage in a kind of risk shifting. Although line managers mainly allocate according to the priorities received from above, they also have to ascertain that all the programs can be continued. Therefore, when a program manager is successful in his or her lobbying, the line managers does not allocate according to the company objectives.

Taking into account the current availability of resources, program managers' incentives to overstate the program need is increased since they are dependent on getting sufficient resources allocated to their programs. Basically, program managers' do not face any consequences when they overstate the program need. They do not get penalized and over-allocated resources are not extracted since line managers do not monitor the efficiency of their allocation. Hence, when a too high program need has been established, it is likely that it will persist through future allocation cycles. Another consequence of the low availability of resources is that not all needs are truthfully established. As shown by the interviews, there is little incentive for line managers to scrutinize the requests made by program managers from un-prioritized programs. The allocation for those programs does not depend on the established needs; it is simply the resources left after the prioritized programs have received their allocation. There is no effect on the output of the R&D, but there is an effect on the gap analysis and therefore on the planning of new projects.

It should not be neglected, however, that the resource allocation process has gone through a series of changes. The current process was established in January and has only been running for four months. Not all implementations have come into place so it lacks in transparency, making it more difficult for line managers to detect agency problems. As the current process evolves through time and implementations come into place, it will become more transparent. This transparency increase will mean that managers have a greater understanding of the preferred outcome and its advantages, leading to an increase in the efficiency of the bonus systems. The latter would, in turn, lead to lessened agency problems.

In the view of the authors, it is naive to believe that agency problems can be completely mitigated; every process will have inherent agency problems. In this light, the authors would regard the process in place as being close to optimal. Although it is clear that program managers

request more resources than they need (an agency problem indeed), having the line manager as a controlling entity mitigates most of the adverse impact. Furthermore, the resource constraint functions as a kind of credit rationing, decreasing the risk of over-investment due to agency problems with both line and program managers.

The success of the current allocation process, therefore, depends on the behavior of the line managers. The line managers, who are independent of the individual program, also face an incentive problem. If they are not provided with sufficient incentives, the agency problems relating to program managers overstating the program need will not be mitigated. Without sufficient incentives line managers might engage in shirking behavior by spending their time on other activities that they deem more important than scrutinizing the program managers' requests.

Another pressing problem which deserves mentioning in the context of line manager incentives is that their task is to serve as a controlling entity that establishes the true program need. Within the organization, there is always considerable pressure to complete certain projects on time and as such no line managers wants his line to be a bottleneck in those projects, giving him incentives to approve a higher or lower resource need than is the actual one. If this the case, line managers no longer behave in the best interests of the firm as a whole. Since it is assumed that the established need represents the true need and since there is no additional function that audits the decisions made by program and line managers, untruthful established needs result in faulty analysis and in extension to under- or overinvestment.

If and when the time comes where the resource availability is larger than the need, the process will be less optimal. At that time, there will be no gaps between need and allocation and thus removing, from the BC point of view, one the main advantages. Furthermore, since the incentives to over-request are increased the monitoring workload of line managers is increased even more.

## **5.2 The QlikView Cockpit**

Needless to say, the agency problems in the allocation process affect the values in the analysis in QlikView, but as those problems have already been discussed above they are disregarded under this headline. The rest of section 0 will therefore not consider the accuracy of any analysis.

The authors see only a few potential improvements in terms of the data; almost all data that is needed is produced. The separation of the Program Need, Allocation and Forecasted HC, provides excellent ability to get snapshot views of the level of stress the different programs are under as well as the possibility to evaluate the effects of discontinuing projects or programs. In addition, the sheer number of variables the data can be broken down by is staggering.

In the view of the authors, the most important area, or variable, not included in the analysis is overtime. As was shown by the interviews, the programs utilize their resources more than regular working hours. Since this is the equivalent of having more people working regular hours, overtime needs to be considered when comparing allocation. It could possibly be that all programs log the same amount of overtime, in which case overtime does not need to be considered, but that possibility can be regarded as highly unlikely.

The most severe issue with the analysis performed in Excel is the time consumption. This problem is the root from which most other problems branch out. The most significant problem coming from the time issue is the analysis *not* performed. Instead of browsing or screening the data for aspects needing highlighting, more or less the same charts are prepared each allocation cycle. The latter does not propose a problem in itself; those charts prepared are the most important. However, when no screening is performed, important causal relationships can be missed.

Another problem is the transparency down the organizational hierarchy. The interviews showed it to be unclear what the program need and the gap-analysis is used for. It is reasonable to assume managers would be better off if they could see how their current situation is analyzed; it would increase their understanding of the process and therefore the effectiveness of the process. In addition, at present, managers obtain information on neither the allocation nor the program need for other managers' areas. Having knowledge about the need and allocation across the company could increase the understanding for the current financial situation and hence align the managers' behavior. With the existing setup, the appropriate charts would have to be constructed by either the staff at BC or by the managers themselves. The first alternative is not feasible since it would add very time-consuming tasks to the agenda (well above 20 charts would have to be made), and

the second alternative requires more knowledge of the data structure than most managers have. Thusly, it is simply not feasible with the current setup.

## 6 Implementation

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*This chapter begins with recommendations for changes to the allocation process and concludes with a discussion of the implementation of the QlikView cockpit.*

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### 6.1 The Allocation Process

Through literature studies, observations and interviews it has become evident that the resource allocation process at Arandee is one which faces several agency problems due to asymmetric information. This paper introduces several possible improvements to the process with the hope of mitigating the problem. The suggestions are all based on the theories of capital allocation within internal capital markets discussed in the literature review. Each concept, and possible implementation, is first discussed in a more general setting. These implementations can, thus, be generalized to other companies which deal with a similar allocation process. Each general discussion is followed by an Arandee-specific discussion of the suitability of the suggestions and how they would be implemented. The section ends with a presentation of the recommended changes, summing up the preceding discussions.

#### 6.1.1 Benchmarking

This strategy focuses on the resource needs and allocations made to historical projects. Historical projects are treated as benchmarks when it comes to future allocation. When line managers receive requests from project managers demanding resources, the line managers will decide whether to approve the request or make changes based on what allocations similar projects received in the past. Requests which are below the benchmark should be approved while request above the benchmark should be adjusted to align with the benchmark. This strategy would increase the transparency as project managers know the benchmark. It should also reduce the amount of time line managers spend on deciding on the allocation.

This strategy has one significant shortcoming: setting a correct benchmark. Setting a benchmark which is too high will induce project managers to request resources above the project need. Further, the historical projects which are treated as benchmarks might have faced agency problems and, therefore, received a higher allocation than actual need. This will result in the

benchmark overstating the project need. Analogously, setting a benchmark which is too low will result in an allocation which is too low. One reason for setting a benchmark which is too high/low is that the financial situation is different from when the benchmark was set.

Another shortcoming is the availability of suitable benchmarks. R&D projects are typically on the frontier of current technology, meaning that they are not necessarily similar to previous projects. If the tasks performed in the new projects cannot be directly compared to previous ones, benchmarking is superfluous. It is reasonable, however, to assume that some tasks are performed in all programs, in which case benchmarking is useful.

In the context of Arandee, benchmarking can be of considerable use. Firstly, it provides the line managers with a tool with which they can more easily audit the requests made by program managers. By comparing current requests with similar historical projects' requests, line managers can quickly identify overstated requests. Secondly, benchmarking can be used as a means of monitoring the line managers' behavior. By comparing established needs for historical projects to those of the current projects, instances where the line managers engage in shirking behavior can be found.

For the benchmarking to be successful, the program requests must be recorded. This would entail formalizing the communication between program and line managers prior to the establishment of the program need.

### **6.1.2 Credit Rationing**

Credit rationing exists whenever a firm's capital budget is unable to fund all projects. Although firms may face capital shortages due to their inability to raise funds when facing severe market conditions, some firms voluntarily limit the capital available to a predetermined fixed level. Line managers would only have a limited amount of resources available to allocate each project. By limiting the resources available, project managers are forced to compete for the scarce resources. This would increase the quality of their reporting and reduce the need to offer high compensation for honest reporting. Project managers, who offer reports of the highest quality and best motivations as to why they should receive a specific amount of resources allocated, should receive the highest allocation.

Credit rationing is similar to what the managers at Arandee currently face. It does lead to an efficient allocation; line managers are forced to both follow the rankings provided by headquarters and to make sure all programs function properly. It does, however, also decrease the line managers' incentive to establish true program needs, resulting in a biased gap analysis.

### **6.1.3 Audit**

Managers rely on the information passed on by the project managers when it comes to capital allocation. One way of forcing the project manager to report truthfully about the quality of his project is to introduce the possibility of audits into the capital allocation process. Under this strategy an optimal scheme would involve an initial capital allocation made to the project manager. The manager can either accept this amount or request additional capital. If the manager requests a larger amount, the line managers can either allocate a compromised amount of capital (somewhere between the initial amount and the amount requested) or they can audit the project and discover the true quality of the project. The probabilities of conducting an audit decrease with its cost but increase with the amount of capital being requested. For low audit costs, the project manager can request additional resources. For high audit costs, the project manager is held to the initial allocation regardless of the true quality of the project. If the audit reveals that the additional capital requested is acceptable, this amount should be allocated. Otherwise, no additional capital should be allocated to the project.

For Arandee, this would mean that the program managers, as opposed to line managers, are given an initial resource allocation. Requesting additional resources could lead to an audit if line managers deem the request as being overstated. In this scenario line managers use the benchmarking procedure discussed above as a means of detecting whether the requests are overstated and deserve being audited. The audit could then result in some form of penalties for overstated requests, such as lowered bonus, decreased future initial allocation and increased scrutiny of future requests.

This procedure has certain benefits. Introducing the threat of audits should at least mitigate the possibility of program managers overstating the program need and, therefore, reduce the agency problems. It could also decrease the time spent on allocation by line managers, and give them more time for optimizing labor.

Another scenario for using audits would be to in a setting where program needs established by line managers' is benchmarked, as discussed in section 6.1.1. The audit would be conducted by an unbiased and knowledgeable individual and the outcome would affect the line manager's compensation.

#### **6.1.4 Compensation**

As has been mentioned, managers have incentives to give dishonest information about the quality of their projects because of their preferences for empire building and capital accumulation. In order to mitigate the information and incentives problems within multi-divisional firms, such as Arandee, capital budgeting and managerial compensation contracts can be jointly designed. This would involve providing more capital to program managers and increase their performance based wages when they truthfully report that their project is of high quality. Offering lower fixed wages combined with higher performance based pay encourages managers to report truthfully about their projects quality. The role of the compensation contracts is to align the interests of the managers and the organization. The performance based pay should be contingent to a greater extent on the organization's performance as a whole. Managers who do not report truthfully should not get the resources requested and not receive the performance pay.

At Arandee, program managers' compensation would to a greater extent be dependent on the overall performance of the organization instead of the performance of the program, therefore removing the incentive to overstate the requests. Similarly, given that the line managers understand the importance of the gap analysis, they would have incentives to always establish accurate program needs.

The cost of redesigning the salary and compensation packages for the whole organization to take into account the agency dilemma has to be considered and weighed against the benefit of mitigating any agency problems.

#### **6.1.5 Rotation**

This strategy is based on an allocation process currently being used in General Electric, which is widely viewed as one of the most successful diversified conglomerates. General Electric pursues a strategy of rotating its senior managers across different divisions on a regular basis. There are

two distinct benefits of following such a strategy. First, managers' incentives to request for a lot of resources in any given division will be reduced since they will be leaving the division soon. Secondly, a job-rotation strategy might prevent managers from accumulating a great deal of specific expertise and political capital in a given division, thereby reducing their bargaining power relative to that of the CEO (Stein 2003).

Applying this strategy to Arandee would imply either rotating program managers across different projects or rotating line managers across different lines on a regular basis. This strategy is undesirable due to the program/line specific knowledge each manager has. Rotating the managers could result in hurting the organization more than helping it. Although this strategy might have the effect of mitigating agency problems, it will most likely result in even less accurate program needs.

### **6.1.6 Recommended Implementations**

Taking into account the current situation at Arandee and the fact that the process is believed to be close to optimal, only a few changes are recommended. First of all, since the current process has only been in place for a few months, all the implications have not yet been observed. Therefore, it is the authors' belief that the current process should be given time to evolve fully before any significant changes are made to it.

Nonetheless, the following recommendations for change are made:

- Recording the program requests

The major issue found in the analysis is making sure the line managers successfully monitor the program managers, ensuring that truthful information is passed on, and establish accurate program needs. It is therefore of interest to change the process so that the line managers can be monitored as well. By recording the requests made by the program managers, agency problems can be more easily detected with the use of benchmarking.

- Benchmarking

As shown in Figure 6, the current gap between a program manager's request and the established need should be compared to a corresponding suitable historical gap, chosen as

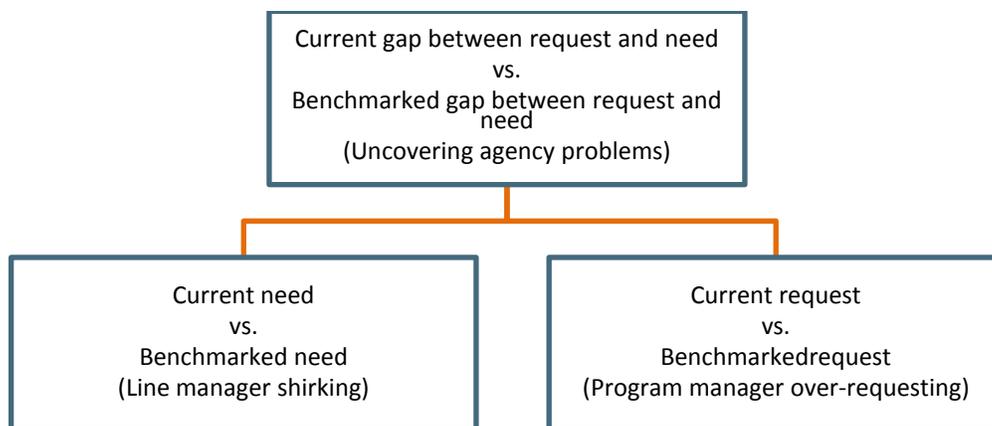
a benchmark. If there is a notable difference it is an indication of agency problems. In order to discover where the problems are originating, program and line managers need to be investigated separately. If the current need is not similar to the benchmark, the line manager might be shirking. On the other hand, if the current request is not similar to the benchmark, the program manager might be overstating the program need. Once the probable source of the discrepancy has been discovered, an audit is performed.

- Audit

An audit is performed by an unbiased and objective individual, assigned by the review committee. If the audit reveals that either the line or the program manager has participated in self-serving behavior, the compensation of that manager is affected and future scrutiny is increased

- Compensation

The manager who has shirked/over-requested would forego a certain portion of the bonus. The size of the portion is set by the review board, or an equivalent of it.



**Figure 6 Agency problem hierarchy**

Following these steps, agency problems can be discovered more easily. Since managers will be aware of this, and of the possible repercussions, they are less likely to engage in self-serving behavior. This would result in line managers monitoring the program managers more closely and establishing the program needs more thoroughly, mitigating the agency problems and leading to an accurate gap analysis.

When, in the future, the resource availability has increased to a state of abundance there will be additional changes needed. Firstly, since the natural credit rationing currently inherent in the process will have disappeared, the risk of over-allocation increases. The most feasible solution would be to reintroduce credit rationing. In contrast to the current situation, however, a decision has to be made as to what size the rations given to each line manager should be. According to what has been found in the investigation, and in the literature, line managers are likely to try to increase their rationed resources, which increases the monitoring needed. Secondly, when there are sufficient resources available, there is a more direct result for a program manager when he or she succeeds in obtaining an overstated program need; increased program need is equal to increased allocation. Therefore both the incentive for the program managers to over-request and the monitoring needed is increased.

## **6.2 The QlikView Cockpit Implementation**

The action research approach followed when evaluating the analysis made at BC has meant that the finished QlikView cockpit has been constructed and implemented bit by bit throughout the authors' time at the organization. The cockpit has therefore been re-evaluated and changed numerous times. In an attempt to keep the following text succinct, only the final state of the cockpit, and its results, are discussed. A snapshot of how the cockpit might look is found in appendix 2.

The largest issue found with the analysis performed was the large time consumption. Introducing QlikView has decreased the time consumption for generating the graphical representations significantly and the authors feel confident that the employees at BC now have as much time as is possible to perform the actual analysis. In chapter 5 it was stated that many of the problems stem from the time issue, and from observations made after the cockpit was made operational it has been proven to be so. More time has been made available for screening and examining into further detail, which equals an increased ability to find important causal relationships and issues. Furthermore, the transparency has increased since it has become easier and less time-consuming to customize what data should be viewed, meaning that individuals both up and down the hierarchy can quickly display the figures relevant to them. It is believed that this improvement

will enable a wider distribution of the performed gap-analysis and consequently make the allocation process clearer to program and line managers.

As previously mentioned, the data going into QlikView is supplied by an internal resource planning tool called Pluto. At present, Pluto is not implemented globally. This means that the whole organization cannot, as of now, utilize the QlikView cockpit. There is, however, an internal goal that states that Pluto should be globally implemented in the near future. Once the goal has been reached, it will also be possible to utilize QlikView company-wide. In the views of the authors, one of the consequences of the wider use would be that the different locations and areas will become more aligned in terms of adopting the process. In turn, this would lead to an increase in the consistency and the accuracy of data for the analysis.

Regarding the agency problems in the allocation process, there are a few perks when using the cockpit. The foremost advantage is a result of the decreased time consumption and the increased usability; line managers can quickly benchmark current projects against suitable past projects to uncover over-requesting by program managers. The cockpit is therefore also useful in potential audit procedures. As shown by the interviews, this type of benchmarking is currently only performed at higher levels in the organization, and as such, mainly concerned with forecasting how programs progress through time.

There are also a few problems with the analysis at the BC that could not yet be solved by introducing the cockpit. Firstly, overtime could not be taken into consideration. The resource planning tool, Pluto, is what the name suggests; a planning tool. Hence, in order to investigate the actual man-hours spent on a given project, a completely different database has to be accessed. Without further adjustments, this data cannot be included in the cockpit. Naturally, the effects of the overtime on the gaps are yet unstudied and remain an uncertainty. Secondly, the program requests cannot be visualized (which is one of the changes recommended in section 6.1). In order for the requests to be visualized, they would first have to be recorded in Pluto.

Although all data available in the Excel-performed analysis is available in the cockpit, the cockpit cannot completely replace Excel in all respects. One such respect is data tables. For the most detailed analysis, graphical representations are often not enough; tables are needed. The tables in the cockpit corresponding to the pivot tables used in Excel do not offer the same level of instant

customization. This has the implication that the Excel-sheets have to be maintained in order to not lose quality in the analysis.

Overall, the QlikView cockpit has increased the efficiency of the analysis of the program need and allocation, i.e. the gap analysis. It may also, in longer term, increase the accuracy of the data. Although it does not directly mitigate any of the agency problems identified, granted that the program managers' requests will be recorded, the cockpit will become a vital tool for identifying possible agency problems.

## 7 Conclusions

From the perspective of agency theory within internal capital markets, the authors have used literature studies, interviews and observations to evaluate the resource allocation process at Arandee. It was concluded that agency problems do pose an issue for the resource and program planning. These agency problems stem from self-serving behavior by the program and line managers. Program managers have incentives to overstate their need for resources while line managers do not have incentives to refrain from shirking. As a result, the analysis performed by BC is based on inaccurate input. The consequences of the faulty analysis are overestimation of the future resource need for the ongoing projects and underestimation of the ability to initiate new projects. It was also shown, however, that the actual resource allocation is close to being optimal; the allocation is improved to a great extent by the limited resource availability. Phrased differently, the scarcity of resources has the side effect of being a capital rationing function.

To mitigate the agency problems, the authors recommend that the resource requests made by program managers, from which the program need is established, are recorded and that both the requests and the program needs are benchmarked against suitable historical projects. On the basis of the benchmarking, audits whose outcome can affect the managers' compensation should be performed. Looking forward, the authors see potential problems arising in the allocation process when the resource availability increases; even more effort has to be spent on mitigating agency problems. One suitable change would be to re-introduce capital rationing.

The authors have also evaluated and improved the analysis performed by Business Control. By introducing the computer software QlikView the authors has decreased the time consumption and increased the usability, leading to increased transparency and therefore accuracy. In addition, if all the recommended changes are implemented, the QlikView cockpit will also become a vital tool in uncovering agency problems.

### 7.1 Suggestions for Further Research

As this paper has shown the overall unawareness of agency problems in a specific R&D organization, it would be of interest to investigate whether it is a general problem. Furthermore,

since the mitigation of agency problems is mainly a theoretical discussion, the authors would like to see research on the solutions' relative costs for an organization. This, in turn, could promote a discussion of the trade-offs of mitigating agency problems.

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## **8.3 Verbal Sources**

M.B., R&D Business Control (Arendee)

## 9 Appendix

### Appendix 1 – Interview Guideline Questions

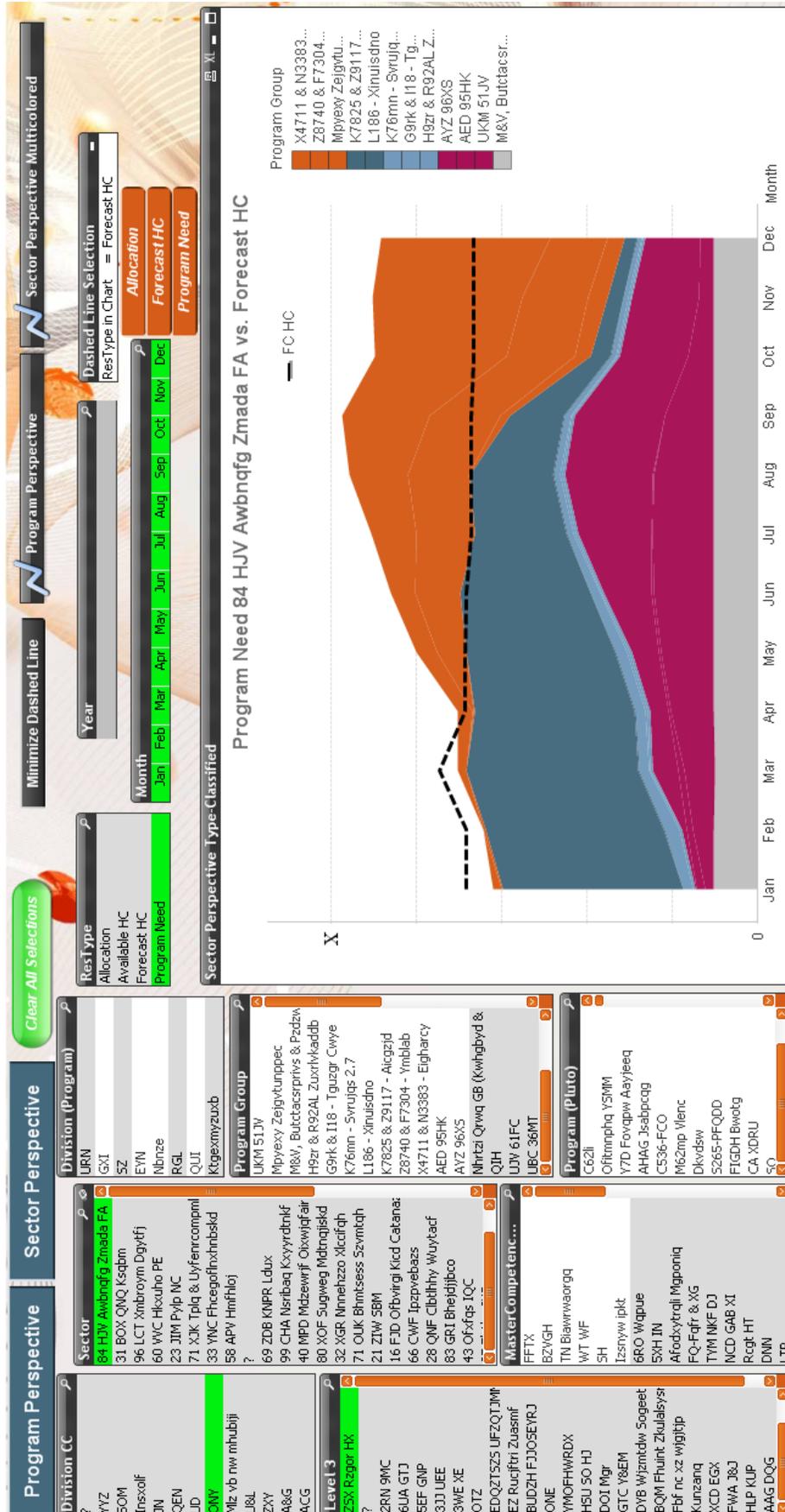
Program Managers:

- What is your general view of the current allocation process?
  - What and how would you like to change?
  - Do you agree with the usage of program needs?
- Do you monitor the other programs' allocations?
- In your view, is the allocated resources sufficient (overall) for your program?
  - If no, why not? What are the implications?
  - What would the improvements be if you would be approved the full program need?
  - Historically, have you had enough resources to run the programs smoothly?
- If there were an endless supply of resources, would you request more?
  - i.e. do you take into consideration the current pool of available resources in the firm when requesting resources?
- To what extent can you influence/change a program need decision made by a line manager?
  - How well is the escalation working?
- How much information do you pass on to the line managers?
  - How much info does the line managers request?
- Do you evaluate the efficiency of previously allocated resources?
  - Benchmarking against finished, similar, programs/tasks?
- Do you believe that program managers request more resources than they need in order to boost allocation?
  - If yes, does line ever approve higher needs than the true needs?

Line Managers:

- What is your general view of the current allocation process?
  - What and how would you like to change?
  - Do you agree with the usage of program needs?
- Do you monitor the other lines program need decisions?
- By what criteria do you decide the program need?
  - Do you take into consideration the amount of available sources?
    - Would you approve higher needs if there were no financial/resource constraints?
- To what extent do you take in to account appeals made by program managers?
  - How well is the escalation working?
- How much communication do you have with the program managers?
  - How familiar are you with the respective programs?
  - Do you get the info you need? Full/adequate/minimum amount of info?
- Do you evaluate the efficiency of previously allocated resources?
  - Benchmarking against finished, similar, programs/tasks?
- In your view, is the allocated resources sufficient (overall) for the programs?
  - If no, what are the implications?
  - What would the improvements be if the programs would be approved the full program need?
- Do you believe that program managers request more resources than they need in order to boost allocation?
  - If yes, does line ever approve higher needs than the true needs?

## Appendix 2 – Snapshot Example of the QlikView Cockpit



## Appendix 3 – QlikView Fact Sheet

QlikView's unique, patented in-memory associative technology is the foundation of our next generation business intelligence (BI) platform. It virtually eliminates problems and complexity plaguing traditional disk-based business intelligence tools - an inability to rapidly create analyses, slow access to limited data and data sources, and reliance on IT to create and change analysis. QlikView's in-memory analysis solution empowers users to consolidate disparate data sources, search associatively, and visualize and analyze answers to critical questions.

QlikView's in memory approach eliminates the dependence on rigid, pre-built data models. This allows users true self-service, so they can easily create their own dashboard view of the data, allowing IT to focus on managing capacity and deployment rather than servicing an endless queue of analysis report change requests.

### **All Your Data**

Because QlikView operates entirely in memory it can combine business intelligence data from any number of sources with high performance, regardless how those sources perform on their own. This in-memory technology provides the fastest way to gain insight into how different parts of a business relate. QlikView achieves this by associating data into memory from any source such as: transactional systems like Oracle, SAP®, salesforce.com; traditional disk-based data warehouses like Business Objects, Cognos, Hyperion; databases like SQL Server, Oracle, MySQL that power your custom applications; and local data in Excel and flat files. And, because the business intelligence data is held in memory, it eliminates disk-based cube limitations, making all your data quickly accessible.

### **Associative Search**

QlikView allows users to search and interact with their business intelligence data in the same way they think - associatively. Users can instantly see connections and relationships between data residing in different applications, systems, organizations, and regions, all by themselves. For instance, a car dealership chain could load maintenance data and vehicle lease trade-in history data into the QlikView in-memory solution regardless of where it is and instantly see relationships between maintenance records, lease trade-in timelines and car value, allowing them to predict which customers are likely to trade-in leases, and which customers are most profitable.

### **Visual Analysis**

The human ability to visually perceive relationships in business intelligence data is our most powerful analytic capability. QlikView's in memory technology gives users the ability to see information in charts, graphs and tables, as well as the ability to interact with those visual analytics in real time. Everything in the QlikView in-memory reporting can be clicked on, and every click provides a new view of the underlying business intelligence data instantly.

### **Simplicity**

QlikView's associative analysis allows you to see explore relationships that go beyond the linear and obvious. Never seen or used a QlikView application before? You can go and try one right now at [demo.QlikView.com](http://demo.QlikView.com). In just a few minutes, you'll not only see charts, graphs and numbers, but how associative analysis lets you ask any question, test any hypothesis, explore any angle, and share what you find.

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<http://www.qlikview.com/us/explore/products/in-memory-advantage>