The design of an ABC system In theory and at DSB



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Preface

The subject for this master thesis is the Activity Based Costing system, with the specific purpose of analyzing and discussing the models theory and comparing this to the practical application of this model at the Danish National Railroad (De Danske Statsbaner (DSB)). The thesis puts a heavy emphasis on the various errors that can arise in the system, which can bring the desired precision of the model in to jeopardy. Discussing the implications of these error, the model also seeks to discuss the strategic benefits that the models output gives to DSB and how DSB utilizes the model compared to its theoretical purpose.

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The reason for the subject has been a natural interest in the Activity Based Costing model which the author was acquainted with while writing his bachelor project, and because of a position as student assistant at DSB, it was made possible to write a thesis using their ABC model as empirical material.

The thesis is written by Anders Dall Madsen, cand.merc.ASC. student at Copenhagen Business School and Bsc.BA. from the University of Southern Denmark. The thesis was written with Carsten Rohde as supervisor, professor at the department of accounting and auditing at Copenhagen Business School.

Executive Summary

In order to correctly manage a company it is a necessity to be fully aware of how its output consumes its various inputs, which is to say, how the products of the company generates cost. For a large company such as DSB that produces an intangible product with a small proportion of the costs being direct, it is especially important to be able to come up with an acceptable allocation of the various indirect costs that these products generate.

In order to allocate these costs, DSB has employed the ABC model, invented by Robin Cooper and Robert S. Kaplan, which is a refined cost allocation system that in its theoretical framework, functions by adopting an activity based view of the various actions of the company

DSB has adopted and modified this model in order for it to fit the company's unique agenda of both explaining DSB's allocation of public compensation to external auditors, and to provide the company with important information for internal strategic purposes. For example the company has expanded the traditional resource and activity stages to include stages within the stages, thus allowing for greater detail in the allocation. Furthermore the model that DSB has created is a full cost model, also actually allocating both the direct costs and the revenue to the cost objects. While direct costs are not normally allocated, per their nature of being direct, the cost objects of DSB are of such a nature that this is necessary.

In its analysis the thesis finds that DSB has taken several steps to correctly design the ABC model, and thus finding a feasible trade-off between the sources of errors that can arise in a too simplified model, and the cost and size of a too complex model, which can also bring errors into the system. The data that DSB gains from the model is then used for ranged of strategically decisions, such as analysis concerning their capacity, to calculate the costs of a potential new route in connection with bids and general data to benchmark DSB against other train operators.

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1. Introduction

When managing a company, a natural concern is to be able to observe and understand how and why a company generates costs. Companies are under increasing pressure to optimize their processes and keep their cost to an absolute minimum in order to be able to compete with a global market. Meanwhile companies in the western world have also shifted from a profile of mostly production companies towards a larger service sector, where the companies are often faced with a lesser degree of direct production costs, and therefore a larger degree of indirect costs. Since these overhead costs stem from actions that are hard to trace to a single product or customer, they provide the company with the difficult task of assigning these costs. Cost allocation has under traditional systems been treated as a secondary task, something that was necessary to perform but the precision of the allocation left a lot to be desired, especially for companies with large proportions of indirect costs divided over many different products with varying complexity. For these reasons, efforts have been made towards inventing refined cost systems, which seek to offer a better insight into a company's products generation of indirect costs.

Activity Based Costing is one these refined cost allocation system, invented by Robin Cooper and Robert S. Kaplan in the late 80's, which has been getting a lot of attention. The system adopts a unique activity perspective, grouping various actions, which are driven by a common cause and effect factor, into activities, and funnels the company's indirect costs through these activities to the chosen cost objects, based on the cost objects use of the individual activities. By doing so, the system works on the assumption that some costs are not generated by the physical production of products, and as such should not be allocated based on this, but instead based on other drivers. Due to the complexity of such a system, it is necessary to make a large amount of decisions regarding its design, which can open the system up to errors and pitfalls, just as it is necessary for the designers of a model to be clear on how complex an ABC model they wish to create, since the larger the model becomes the more resources it consumes itself. The Danish railroad company DSB is a company as mentioned above, being a service company in nature and a large proportion of their total costs consists of indirect costs that are difficult to assign to specific cost objects. With this as one of the reasons, the company has chosen to adopt an ABC model in order to understand how their resources are being consumed, and for this thesis, it offers a unique opportunity to examine how the theoretical framework of the ABC model is used in a practical setting, and if the possible errors of the model can be overcome in order to use its information for strategic benefits.

2. Problem statement

While it is certain that the degree of accuracy that an ABC model offers is greater than that of a traditional costing system, it is important to be aware of the risks of errors when designing such a model. The main reason for using an ABC model will often be the increased accuracy of the cost allocation and these errors pose a threat to the precision, and therefore to the reason for the system to exist. In order to design the most optimal ABC model, it is therefore necessary for a company to be aware of the various errors than can arise, and seek to balance these errors while still keeping the model from consuming too many resources, so that it does not cause more harm than good. Since the information that the company obtains from the model is often used for strategic decisions, the struggle to identify and reduce errors becomes especially important, since strategic decisions made on a false basis can be catastrophic.

While DSB did not originally adopted the model for its accurate allocation of indirect costs, it has become a much more prevalent use of the model over the last years, and the information that it gives about the company's complex cost structure and their intangible products are unique compared to what other systems can offer. It is therefore very relevant to examine the model and how the designers of the model have dealt with the threat of errors, in order to secure the accuracy of the information and thereby strengthen the strategic decisions that the information provides a base of knowledge for.

2.1 Problem formulation

As stated above, it is necessary to be aware of the various types of errors that might arise when utilizing an ABC model in a company such as DSB. The company needs to structure their model correctly in order to create a model that is not filled with errors, or a model that is overly complex and therefore too expensive. Based on this issue, the final problem statement of this thesis can be formulated as such:

> "How is the DSB ABC model designed compared to the theory, how is the model structured in order to obtain a feasible trade-off between possible errors and the complexity of the model and how does DSB utilize the information obtained through the model for strategic purposes"

In order to answer this problem statement, the thesis will conduct an analysis of the theory surrounding an ABC model and the Time-Driven ABC extension, including how it is structured, what strategic purposes it can be used for and what errors which can arise when utilizing the model. The analysis of the errors will be in-depth in order to show how the errors arise in the various stages of the model. Following this theoretical discussion, the model that DSB has designed will be analyzed and the thesis will show how and if the practical application differs from the theoretical framework. The DSB model will be analyzed in order to show if issues with errors arise and if they do, how they are dealt with. Lastly the thesis will take a look at the various uses that DSB has found for the information that the model delivers.

3. Delimitation

This thesis has made several delimitations in its scope in order to be able to fit the thesis within the given boundaries. First and foremost the thesis does not discuss the nature of certain types of costs,

such as flexible and committed costs, that pertain to the variability and the reversibility of costs. These concepts are used in the later discussion of the DSB model, and the explanation of these cost traits where not found to be significantly relevant, and it is as such implied that the readers understand these concepts beforehand.

When it comes to the model of DSB, a significant delimitation is the fact that no actual numbers from the model is used, only the framework and the design of the model is used, which is a deliberate choice since DSB is not interested in giving out sensitive information regarding their internal business processes. This desire is therefore respected by the author of this thesis, and the delimitation is not seen as a hindrance to the completion of the thesis, since it is more concerned with the structure of the model, than the data within the model.

4. Method and disposition

The thesis will be composed first of a three chapters based in theoretical articles, with chapter 5 focusing on the ABC model and its structure, chapter 6 focusing on the strategic uses that the model has and lastly chapter 7 which contains an in-depth analysis of the various errors that can arise in the model and the consequence that they have for the model. The first chapters are based off of articles by the original creators of the ABC model, Robin Cooper, R. S. Kaplan and S. R. Anderson who was a part of creating the Time-Driven ABC extension, while the chapter concerning errors use other authors in order to gain a critical view of the model as well.

Following these theoretical based chapters, the thesis will focus on the practical application of the ABC model found at DSB over 4 chapters, with chapter 8 introducing the company, chapter 9 analyzing the model and its design, and chapter 10 containing an analysis and discussion of the issues that the model faces concerning errors. Chapter 11 contains an analysis of how DSB is utilizing this model for internal strategic purposes.

Finally the sources used in the thesis is considered in chapter 12, while chapter 13 contains the conclusion of the thesis. Chapter 14 contains a few ideas for further research on the model that DSB is utilizing.

The method used to write the part of the thesis based on empirical information, is a series of 6 interviews over the course of 3 months with the chief of the department tasked with modelling DSB's ABC model, Mikael Oxager. These interviews have been conducted 1-2 weeks apart, with the initial two interviews taking the form of individual lectures where Mikael Oxager has explained the model's history, its structure, its issues and how DSB utilizes it. The following four interviews have been more critical in nature, where the author of this thesis has narrowed down specific areas of interest and asked critical questions in order to obtain the information needed to answer the problem statement. During the course of these interviews the author of the thesis has seen the model in action, how it produces information and how it is able to assist DSB in various ways. Additionally Mikael Oxager has made several presentational materials available, which has contributed three figures to the thesis. The interview method used has consistently taken a critical point of view in order to challenge the model and the choices that has been made, so that a prober analysis could be conducted despite the absence of actual numerical data from the model.

5. Cost allocation and the ABC model

The art of allocating the costs of producing the output of a company is at the core of the process of understanding how a company uses its resources. As the general output of most western societies have evolved from being mainly primary and secondary in nature, to tertiary, the concept of allocating the production costs of products have also become far more complex. This complexity has posed a challenge to the systems that companies use to allocate their costs, and has exposed the flaws of the traditional ways of allocating costs. In traditional cost allocation systems, the main focus is to trace the direct costs such as labor and materials relatively effortlessly to products or production units. The reasoning behind this focus on direct costs is, that direct costs is presumed to make up a proportionally large size of the variable costs of production, and that the remaining indirect variable cost, is correlated with the rate of the direct costs. These presumptions that used to hold true for most companies, are no longer sure to hold up, as the products that companies have been producing for the last 30-40 years have become far more focused on private consumers and the growing service industry. (Robin Cooper & Robert S. Kaplan (1988), p.96)

This development has led to a shift in the nature of costs that companies incur, so that a proportionally larger part of the total costs are indirect costs, and the variable indirect costs are no longer likely to be tied to the direct costs, but instead, to other indirect costs. The development as already said, is in part due to the fact that the proportion of businesses based on pure service products have grown rapidly, but the various production companies that remain have gone through rapid development in technology which has led to the production equipment being able to produce a much larger amount of products. To avoid having surplus capacity on these machines, the companies have instead turned to producing more alternative products, which leads to a more complex product mix, which makes the allocation of costs even more difficult. The drive for a more complex product mix, has besides the increase in production technology, also been caused by an increasingly enlightened and hard to satisfy customer base, who are not afraid to pose demands, and expects the products to be tailored just for them. The complex product mix can have several effects on the combination of costs that a company incurs. As already mentioned, it leads to more products being produced on the same machinery, but these products can have different procedures going through the production machinery, with different processes taking more or less time. Other reasons for an increase in the amount of indirect costs could be that some products require a larger amount of research and development before being launched and produced. The production personnel might also be moving freely between working on the process of producing various products, making it

difficult and costly to track the time they spend on individual products (Robin Cooper & Robert S. Kaplan (1988), p. 97-98).

The output of a company can range from physical products to incorporeal services or a mix of these. Traditional costing systems will seek to allocate the indirect costs of these outputs, by measuring the degree to which the outputs use factors that have a direct correlation with the amount of products produced. This means that the traditional system uses a volume based cost allocation, to allocate the indirect costs of a company. This allocation is therefore based on the individual outputs use of factors such as the number of direct labor hours, the number of machine hours, the number of units produced and so on. However, the amount of products that are produced or sold, which will lead to an inaccurate cost allocation since the use of a volume based cost driver will make the allocation distorted.

As shown, the traditional costing system does not measure the precise usage of the company's resources, and therefore poorly reflect the precise costs that are incurred as a result of this usage, in connection with the production of a given product or a given service to a customer. This is the core of the problem that leads to the fact that it might be profitable for a company to change its costing system, so that it can become aware of the various outputs heterogenic use of the company's resources. A possible solution to this problem can be found in a more refined costing system such as the Activity Based Costing system (ABC). The core the ABC system lies in the mechanism where indirect costs are allocated to the output based on the outputs usage of various activities, and not on the amount of a given volume based unit. This is the reason why this type of resource allocation can be more profitable for companies with proportional larger amounts of indirect costs (Robin Cooper & Robert S. Kaplan (1992), p. 97-98).

The ABC system was, as earlier mentioned, developed by Robin Cooper and Robert S. Kaplan with the purpose to deliver a more precise method to allocate the indirect costs caused by support functions to the various processes, products, services and clients. The fundamental idea is to view the costs of the company as a result of its actions on all levels, meaning that it takes the hierarchy of factory operating expenses into consideration. This hierarchy operates under the notion that many activities undertaken by the company are not necessarily done to further the physical production of a product, but rather to supply a stream of support function needed to produce a wider array of products and to service a wide group of customers. This is for example activities such as building maintenance on the facility-sustaining level, research and development on the product sustaining level or setup of production machinery on the batch level. The idea of activity based costing is than when you view these various actions on a level that is sufficiently disaggregated, you will be able to see groups of actions that accrue costs in a proportional fashion, correlated to a specific driver. To make the system more manageable, these actions are grouped into what is called activities. Activities are therefore grouping of actions that are undertaken sequentially and in the same amount, meaning that when one unit of activity has been performed, one unit of each action has been performed and within a short period of time (Robin Cooper & Robert S. Kaplan (1991), p. 131-132). This is to make sure that there is proportionality between the costs and the level of activity. This also ensures that it is possible to use the amount of costs accrued by one unit of an activity, as a standard in determining the cost of products that the company wishes to have an exact costing of. By following this method, the costs of a unit of output can be calculated by summing the costs of the units of various activities that are required to produce one unit of said output.

The ABC system is built around these activities, which is the first item that must be identified in order to construct such a system. The second step is to identify the total costs of the various actions that are a part of performing a given activity. The system designers would then need to come up with an estimate for the expected amount of activities that are to be performed within a given period, the resource driver. By doing this, it becomes possible to come up with the cost of resources per unit of the given activity under the given capacity to perform the activity. This cost per unit of activity is then used as the earlier mentioned standard to determine the costs of a given cost object (Robert S. Kaplan & Antohny A. Atkinson, (1998) p. 97).

As previously described the use of a traditional costing system can often be undesirable, since the system does not account for the heterogenic use of resources that various outputs can have, but simply allocate the indirect costs based on a volume based driver. In the ABC system the costs are allocated in a two-step process, first, as just described, from the total pool of indirect costs to the various activities, the so called activity pools, and from there to the company's output. As can be seen, this is a more refined costing system, which identifies individual activities as the fundamental cost objects, which is more precise that the traditional system, which often utilizes cost centers as their cost objects, that often consists of more than one activity. The ABC system also achieves a stronger correlation between the cost objects and their usage of resources since an activity is defined as a collection of actions that have a homogenic usage of resources. To sum up, the two steps of this process is:

- The total indirect costs, also called overheads, is pooled in a single pool. From there the overheads associated with each different action is put into a pool for the activity that said action belongs to. These pools are called activity pools. An estimate of the total capacity of each activity needs to be made, so that a rate can be determined for the cost of each unit of the activity.
- 2. The second step is to allocate the costs from the activity pools to the output. This is done based on the usage that each product has of the individual activities. To determine this, the designers of the system needs to come up with an activity driver, which has a satisfying correlation with all of the actions within the activity. Each time that one unit of this activity is

performed in the process of creating a unit of a given output, that output is allocated the rate that was determined in step one.

As is evident in the above description of the mechanics of an ABC system, there is a lot of choices to be made regarding activities, drivers and estimates of capacity, which all influence the effect and usability of the system. When implementing such a system, it is therefore important to consider the level of precision that is desired, since there is a clear relation between the level of detail in the system, and the cost of implementing and maintaining it. The system needs to be tailored to both the requirements of the company and the costs that they are willing to bear and, so that the value of the systems is not completely offset by the cost of it. This is an important and delicate balancing act. A part of the discussion of the precision level of the system is the amount of activities that the company wishes to group the various actions into. It is clear that the more activities that the company chooses to specify, the more precise the system will become, due to the various actions that end up together, will have a stronger correlation with each other. What is also clear, is that more activities means a higher system cost, due to the amount of activity drivers that need to be tracked in order to allocate the costs from the various activities. The company needs to perform a cost-benefit analysis, which is able to weigh the higher costs and sharper precision of a more complex ABC system against less complex system that requires less resources.

The decisions surrounding the level of detail of a system and the cost of it, is one of the problems of the ABC system. An ABC system will always be an expensive choice for a costing system, and in the case of many companies it will be very expensive to utilize. In order to meet its full potential, the system first of all needs to be implemented correctly, which can be costly, and secondly it needs to be regularly maintained and updated, by consistently determining the cost pools associated with each activity, and the capacity of each activity which are the two deciders for the piece rate for a unit of a given activity. This level of maintenance can often lead to the system costing the company more resources that it saves it. Another issue regarding the ABC system lies in the way that activities are used, since they are very one dimensional. This comes from the fact that an activity is based on a standard rate that is supposed to represent all uses of the activity. Only determining one rate for a given activity, can work to give an initial idea of the cost, but in practice, an activity will vary in cost, depending on circumstantial factors, that makes the predetermined rate less accurate. The system is not geared to grasp an activity that contains levels of complexity, which creates an inaccuracy in the system, since different units of the same activity might have different costs, but are allocated the same cost. This can lead to distortion in the costing of output, which can the lead to more distortion in the price that a company would charge for a product, or the services that they would charge to a client.

As shown the ABC system has problems regarding the lack of tools to handle varying complexity and the issue of high costs of implementing and maintain the system was one of the main topics of debate when the systems was first introduced. These weak points led many to believe the ABC system too heavy and costly to actually be able to generate value for a company. While this notion might have some truth to it, other solutions exists, besides rejecting the ABC system completely. With the goal of correcting the apparent flaws of the ABC system, and thereby prove the value of the activity based school of thought, Robert S. Kaplan and Steven R. Anderson developed an extension of the ABC system called Time-Driven Activity Based Costing.

5.1 Time-Driven Activity Based Costing

As the name indicates, Time-Driven Activity Based Costing (TD-ABC) has a specific focus on the aspect of time, which the original ABC system did not have. In the TD-ABC system, the designers of the system must have a clear picture of the maximum capacity that the employees of the company have available to perform various activities. From this maximum capacity, they must make an estimate of what is known as practical capacity, which is the amount of time that the employees actually have available to work, since it is reasoned that the employees will "waste" time doing other things. In the original ABC system it was indirectly assumed that employees spend 100 % of their time on productive activities, which will inevitably lead to an incorrect allocation. Generally speaking, the practical capacity is said to be at 80-85%, meaning that the employee spends 80-85% of his time efficiently on work related activities. The remaining 15-20% of the employee's time is spend unproductive work related activates, such as starting up a machine or shutting it down, or non-work related activities, such as lunch, bathroom breaks, talking to coworkers and similar things (R. S. Kaplan & S. R. Anderson (2004) p. 133).

After the estimation of the practical capacity, the basic components of the TD-ABC system must be calculated. As has been stated, the focus in TD-ABC is on the aspect of time, in the sense that cost is allocated based on the length of time that activities take to perform. Therefore, the next step is to calculate the cost per unit of time, which is done by determining the amount of time units that a company or department has available in a given period, based on the estimation of the practical capacity. The cost per time unit is now calculated by dividing the total overhead costs, the fixed and variable indirect costs, with the total amount of available time units. This number represents the cost of a time unit spent on any given activity, which is why it is a reasonably local rate, in the sense that the cost per time unit will vary between different departments within a company. The next step is to determine the time consumed per each individual activity. Kaplan and Anderson places this task with the managers, who through researching and testing the various activities and employees can determine a correct rate of time used for one unit of each separate activity. When this last step has been performed, it become possible to calculate the rates the cost driver by multiplying the time used for an activity with the cost per time unit. The cost of performing a unit of a specific activity has then been found, and the continuing tracing of the costs related to said activity can be done by simply measuring the amount of times the activity is performed, since this will show the amount of time consumed, which will has become correlated with the overhead costs related to the activity (R. S. Kaplan & S. R. Anderson (2004) p. 133).

Besides the aspect of time, TD-ABC has another important improvement, which is the implementation of time-equations which makes it possible for activities to account for varying complexity. The concept of time-equations is based on the basic estimate that a given company or department has made for the time consumption of each activity. Besides this base, the company can estimate the cost of time for various extensions of the given activity, so that in the case that a specific unit of an activity has taken longer time than a basic unit of the same activity, this deviation can be explained by the extensions that has been added, and because the time used can be directly translated to additional costs, the complexity of the activity is handled correctly. An example for this could be the production line that produces a large number of different toys, with employees constantly working on different products. If a car toy is normally produced with just a single color, the standard amount of time spent on the activity will reflect this, and therefore this will be reflected in the cost of the activity. If a special order comes in for a car painted with two different colors, it would be possible to calculate the time that this extension of the original activity took, and thereby, the extra cost. As can be seen, the company has the possibility of increasing the complexity cost system, and still correctly reflecting the costs, due to the allowance for many different scenarios. By adding more or less time equation options to the various activities the company can decide for themselves how detailed they want the system to be (R. S. Kaplan & S. R. Anderson (2004) p. 135).

As stated above, the TD-ABC model has been given some clear improvements compared to the old ABC model. It is obvious that the two creators of TD-ABC actively sought to make the improvements that met the criticism that the old ABC model suffered from. First of all to equip the ABC system to become able to handle varying complexity in the various activities, with the described addition of time-equations. Secondly the adding the aspect of time, and making time the sole cost driver is an attempt to meet and solve the problems of ABC being overly resource demanding, both in the implementation phase and the following phases of maintenance. The main thought is that instead of

having to estimate the costs of many different actions to put together the costs of a complete activity, which will leave the system open to errors if some cost is lost, the method of dissolving all activity related actions in time will be a simpler and more precise way of correctly calculating the costs of an activity. It should however be noted that the extent of the task of measuring the time unit usage of every activity related action in a company or department, is quite formidable. Not only does these time measurements need to be updated from time to time as well, but the action of timing a task opens up for several errors as well, since the employee who is timed might attempt to influence the timing in some way. This will be explored more, later in the thesis.

Based on the improvements of the original ABC system, leading to the establishing of the TD-ABC model, companies have a model available to them, which offers a far more refined cost allocation than traditional system do. There is no doubt that the activity based approach will offer increased precision in tracing overhead costs to output for companies that fit the profile of a company with an overweight of overhead costs. This however is not enough to make the ABC system that is mandatory to adopt, since a company has to consider the price tag of the system. Companies who chose to implement either the ABC or TD-ABC system, must be aware that the activity based approach is more or less sure to be more expensive than a less refined cost system. Therefore it is important, as stated earlier, that a company make an in depth cost-benefit analysis, so that the total contribution of the system for the specific company becomes evident. It is very important that the company is aware of the fact that it is not possible or economically feasible to implement the ABC system that gives them the perfect cost allocation. Striving for the perfect system, will result in the company ending up with a very expensive system, which costs far more to implement and maintain, than it saves the company. The perfect system will create activities that keep track of even the smallest actions of employees, and gathering information to create realistic estimates for the cost or time use of all these actions will become a huge task.

It is therefore evident that companies need to make some deliberate simplifications and limitations when they implement an ABC system in the real world. This means that the company needs to limit the amount of activity pools to a realistic level, in terms of having to keep track of activity drivers for all of them, and gathering the needed information to create estimates of their costs. The logical consequence of companies having to give up on the perfect ABC system is that they have to accept an ABC system that is somehow flawed. Companies will have to come to term with this fact, and accept that they will only get a more accurate cost allocation, not a perfect allocation. It is however, not only the number of activities and activity drivers that can cause the system to contain errors, there is a number of other factors that a company has to keep in mind when implementing an ABC system. These errors will be cowered later in the thesis.

6. Strategic and operational uses of an ABC model

Before discussing the possible errors than can arise in an ABC system, it is relevant to determine the complete array of benefits from adopting an ABC system. The core benefit of utilizing an activity based approach is that the overhead costs are more accurately allocated to the company's output, which leads to a number of improvements in both the operational aspect and the strategic aspect of a company. Improving the operational aspect of company revolves around increasing the effectiveness and the efficiency, meaning decreasing the time it takes to transform input into output, and reducing the amount of input required to produce one unit of output. To be able to do this, ABC has to be able to discover where in the company there is room for this kind of improvement. When a company is implementing ABC, it has to go through its business processes in order to categorize them into actions and activities. This is an obvious opportunity for the company to discover and point out actions that are performed inefficiently. The actions that are part of an activity pool are often carried out across departments and functions of a company, where products are sent through the stream of production. The ABC system can highlight the areas of the company where an activity is

highly fragmented and carried out across too large of a span of the company's department (Robert S. Kaplan & Robin Cooper, (1998), p. 139).

The activities where it is possible to identify areas of improvements, can then go through various process improvements that in various ways can reduce the amount of resources required, or reduce the time needed. When a company in this way is able to reduce the amount of resources they need to perform activities, they can in turn either reduce the amount of capacity the company has or they can utilize the freed up capacity to produce more products. This way of optimizing the activities consumption of the company's resources and at the same time optimizing the use of the company's capacity, is some of the ways that ABC can optimize the operational aspects of a company. Optimizing these internal processes allows company to focus on long term strategic decisions, which is an areas where ABC also can help the company with a lot of information and insight.

The information that ABC can bring to a company is especially helpful to guide the strategic decisions that managers must make when it comes to how they want to run their company. At the core, the information consists of accurate allocation of the costs



overhead. This piece of information leads to the company becoming more aware of what the true costs are of producing their various outputs. This can lead to the company realizing that some products are more profitable than they realised, and others are profitable. Kaplan and Cooper's claim

is that of all the products that a company is producing, it is often the 20 % most selling products of a company that is responsible for 80 % of the company's sales. This can be seen on figure 1 above, which clearly indicates the high sale volumes of a company's most sold products, and how the remaining 80 % of products contribute fairly little in comparison. In some companies the 80 % of products that do not sell a lot, can be products that are necessary to sell in order to sell the last 20 % of high volume moving products (Robert S. Kaplan & Robin Cooper, (1998), p. 160-161).

As can be seen on the graph, the 40 % least selling products are only responsible for 1 % of total sales. Under a traditional cost allocation system, products with small volumes of production and sales, are often also allocated very little overhead costs, since these costs are allocated based on volume drivers such as direct labor hours or machine hours. Therefore products that are produced in small volumes, will often have costs that are not allocated to them, therefore disguising whether or

not they are profitable. On the other hand products that are produced in larger volumes will under а traditional cost system have more overhead costs allocated to them, due to the mechanism described above, thus making them appear less profitable than they really are.



The above statement is supported by the "whale graph" seen on figure 2. Data revealed by ABC systems often show that products that are sold, and produced, in small volumes are unprofitable due to the amount of support functions that they require, which adds overhead costs that the small

volumes can't support. Figure 2 shows how the 20 % most profitable products of a company generates 300 % of company's profit while the remaining products break even or generates a net loss for the company. It should be noted that this is not necessarily bad, since it often can't be avoided for a company to have certain products that operates at a loss. Often times these products are gateway products which lead consumers to purchase other more profitable products which the company is also offering. For example, take a company that sells printers, the company might sell printers at a price point where they lose money, but in turn they sell a lot of printer ink and printer paper at a high profit margin, making up the bulk of a company's sales and profits.

Companies utilizing an ABC system, whether TD or not, will allocate an amount of overhead costs to their products that are closer to the truth than under traditional cost system, which is the point of the system. This allocation will reveal the true cost of their products, and will make them aware of what products are actually profitable or unprofitable, and from this information they can also conclude which products that are justifiable as unprofitable, depending on whether or not the products is responsible for generating additional sales of other more profitable products. The information obtained from an ABC system, can used for a range of strategic decisions, which will be discussed below (Robert S. Kaplan & Robin Cooper, (1998), p. 162).

6.1 Strategic decisions: Product pricing

An example of a strategic decision that a company has to make is determining the price of their products. The price is based on several conditions, such as the price and availability of competitive products and naturally the price of producing the product. The dilemma for a company producing a product facing a normal level of competition, is that they want to choose a price that covers their costs, returns a satisfying margin of profit, and is still able to compete in the market. Under a traditional system, the distorted information that is delivered, can result in a company pricing a product either too high or too low, depending on the level of complexity in the product, and the volume in which it is produced. High volume products with a low complexity will often times be allocated too much costs, resulting in them being priced too high, in order to cover their costs. Companies utilizing ABC will be able to correctly pricing these products, those lowering the price, and thus perhaps sell more of the product by being more competitive compared to their rivals. The opposite stands for the low volume, high complexity products that will be allocated more costs under ABC, thus resulting in a higher price point. The company will have to decide if it is justifiable for the product to run at a lower price, or if the price should be raised. This will result in the consumers either accepting the new price or shifting to other product or competitors, but since the product was resulting in a loss for the company, this can be justifiable (Robert S. Kaplan & Robin Cooper, (1998), p. 166-168).

6.2 Strategic decisions: Determining the correct product mix

Changing the product mix of the company is a natural action based on information coming from an ABC system, and is also a natural reaction if the company starts to change the pricing of their products, since this will shift the supply and demand of the affected products. An ABC system gives a company an accurate picture of how individual products consumes its resources, which can be used to convince a customer as to why a it should shift to a cheaper product, or accept a higher price. When changing the product mix, companies should be aware that instead of simply eliminating products and their customers completely, it is better to shift the customers and the capacity used to produce the unwanted products on to producing other profitable products. If products are simply eliminated from the product mix, without efforts to reduce the capacity used to produce these products, or finding alternative uses for the capacity, the elimination will not result in a reduction of costs, but instead result in the company retaining unused capacity, which is very costly (Robert S. Kaplan & Robin Cooper, (1998), p. 170-171).

While the implications of the ABC system leads to the conclusion that low volume products that are high in complexity, should be left out of the product mix as they are very costly, they should not be avoided just because of this. As already stated, the products can be gateway products, in which case they are justifiable, and in other cases it will be possible to raise the prices to keep them profitable. Once the company has implemented an ABC system, and gained the insight that it offers, it will become aware of the costs of producing such products. The company can use this strategically to obtain a discipline in its development of new products, making sure that they are constantly aware of the costs that a product will carry, depending on the activities needed to produce it (Robert S. Kaplan & Robin Cooper, (1998), p. 171).

6.3 Strategic decisions: Customer profitability

Besides looking at the products and their price, the company can also choose to look at the customers that purchase the products, and whether or not they are profitable for the company. Since the ABC system will more accurately reflect what products are profitable or not, the company can also determine what customers are profitable depending on the range and volume of products that they are demanding. Because of the way the ABC system is constructed the product mix that a customer is demanding can be directly translated into its corresponding amount of activities, thus revealing an accurate estimate of the resources that are consumed in order to meet demand.

This type of analysis can be used to show if a customer is profitable for a company or not, which often times would be when the customer is buying a lot of high volume, low complexity products. It is of course not possible to only have customers that demand this type of products, but customers that are buying the less profitable products, should also be buying enough of the profitable products, to make it worth the company's use of resources. What should be avoided, are customers who only purchase the unprofitable products. These customers should only be held unto in the case that there exists unused capacity (Robert S. Kaplan & Robin Cooper, (1998), p. 198-199).

Thus far, the system itself has been covered, and now the benefits that a company can receive from it. However these benefits all rely on the fact that the allocation of the ABC system is more accurate than what the traditional cost system can offer. This accuracy is therefore threatened by the fact that the system might contain errors in its design, which leads to an accuracy that is less than what the company expects, thus casuing them make decisions on a false basis. In the following part of the thesis, the cause and nature of these errors will be cowered in detail.

7. Errors in ABC systems.

The reason for the improved accuracy in the ABC systems comes from a large amount of cost pools and drivers that operate on multiple levels of the cost hierarchy. These are better able to reflect the cause and effect relationship between products and their consumption of overhead costs. As earlier described such a system however, is not a guarantee of reflecting exact information, both because of practical limitations of the system relating to the cost of the system itself, but also because this limitation makes it is possible for errors to arise in ABC systems (Datar, S. & Gupta, M. (1994) p. 567). Errors can arise in any cost system, and in the ABC system errors arise in the following types:

- Specification errors
- Aggregation errors
- Measurement errors

(Datar, S. & Gupta, M. (1994) p. 568).

Specification errors arise when a company use a specific method to identify product costs, which does not correctly reflect the individual product's consumption of resources. In a traditional cost allocation system, this could be labor hours or machine hours, while in ABC a cost driver is selected for each activity, which should reflect the activity's usage of overheads. In the case that the production of product requires a significant amount of resources which does not correlate directly with the chosen cost driver, the system will allocate a false amount of overheads to the products that use the affected activity (Datar, S. & Gupta, M. (1994) side 568).

To thoroughly explain this and other types of errors, it is relevant to construct an example of a situation where an ABC model is used. AS an example we will use the hypothetical company called ServiceCorp that is utilizing an ABC model. ServiceCorp has, as a part of their business process, a support department in that carries out various actions that assists the company in carrying out its

various services for their customers. Therefore the costs that are incurred in this support department need to be allocated through various activities to the cost objects of the company. With ServiceCorp as the framework, it will in the following be used to explain the various errors that can arise in an ABC system.

The first error that will be shown in ServiceCorp is the specification error as described above. A part of the support department of ServiceCorp, is the activity that performs quality checks of the various services that the company performs. In the examples it is assumed that it is not possible to directly trace the costs of the actions that the support department performs, since their actions are performed without coherence between the services that they are supporting, and their usage of time spend on various services are not registered.

The designers of the system have to assign this activity the cost driver that has the highest correlation with the activity's usage of overheads. It is estimated that the number of serviced performed should be the best explaining factor for the activity's usage of overheads and therefore the measure that should be used as a cost driver. This is estimated based on the fact that the number of services performed often would be used as the basis for the extend and cost of the quality controls, since a lot of companies perform quality controls on a fixed percentage of the total amount of output, in this case services.

The above chosen driver is the correct one, but alternatively the company could have chosen then number of work hours as the cost driver for quality controls. This cost driver would have caused a specification error, since this cost driver poorly reflects the activity's usage of overhead cost. We assume that ServiceCorp performs services x and y in equal amounts, and the two services are very heterogenic since service x takes 3 hours to perform and service y takes 8 hours to perform. The quality control activity that is performed for both service x and y, independent of product type, has a duration of 10 minutes. This example clearly states that the use of work hours as a cost driver would lead to a faulty allocation of the overhead costs, since the usage of work hours have no correlation to the usage of quality control time. If the cost allocation is performed using work hours the allocation would end out as $3/11 \approx 27$ % of the costs allocated to service x and $8/11 \approx 73$ % of the costs allocated to service y. Based on the assumptions of the example, the correct cost allocation should be 50 % to both service x and y, since this would reflect the correct usage of overhead costs related to the quality control, since it is based on the service's usage of time per quality control which can be assumed to be the deciding factor for the generation of cost. Since the services use the same amount of time per quality check, and the services are performed in equal amounts, they should be allocated half of the costs each.

Aggregation errors occur when different sources and units of overhead costs are allocated to an activity containing heterogeneous actions forcing these actions to share a single cost allocation rate. Heterogeneity in this connection is said to be present when individual actions use different amounts of resources when correlated with a common driver. M. Gupta defines heterogeneity as the following: "Heterogeneity is defined in terms of diversity or dissimilarity of variable values or characteristics under consideration" (M. Gupta, (1993) p. 181).

From this it can be reasoned that an action can be defined as being heterogenic in its use of resource compared to other actions in the same activity if there is a difference in its proportional usage of resources across the activity.

Heterogeneity between the cost objects that serves as the target for the cost allocation can be defined as the degree of association between these outputs. The lower the association is between two outputs, the more heterogenic the outputs are compared to each other. A company's various outputs are defined as being heterogenic if they are significantly different from each other in the characteristics that drive their usage of activity resources, which could be production volume or number of components per unit.

These concepts of heterogeneity can be used by organizations in the process of identifying heterogeneity, where an increase in the number of cost pools, leading to less aggregation, is likely to lead to a significant change in the allocated costs to individual products (Gupta, M. (1993) side 181). To further explain the concept and problem of aggregation errors and heterogeneity it is feasible to again make use of the example regarding the quality control of service x and y in ServiceCorp. It is still presumed that the company performs service x and y, and that the time it takes to perform the two services is 3 and 8 machine hours respectively. The difference in duration of time it takes to perform them is assumed to be due to a difference in complexity relating to service y being involving significantly more complex procedures than service x which is relatively simple. The two services are therefore, according to the definitions made by Gupta, heterogenic in their usage of resources, which brings the possibility that aggregation errors can occur, since their consumption of company overhead will differ. To avoid aggregation errors in the support department of ServiceCorp, the quality control activity should be separated into two individual activities, one for each service. In the specification error example it was assumed that the quality control took 10 minutes for a control for either product, but this assumption no longer holds with the new information regarding the difference in complexity. When service y is significantly more complex than service x, it is logical to assume that the quality control of service y takes proportionally more time than the control of service x. It could therefore be assumed that the quality control of a unit of service y takes 14 minutes while it would take 8 minutes for a unit of service x. Based on these assumptions it becomes clear that there exists a heterogeneity issue between these two activities, and if the company decides to aggregate the two activities into a single activity, it would lead to an aggregation error due to the fact that their characteristics are significantly different. This is assuming that it is not possible to identify a different driver to use for the aggregated overall activity for both services.

The demand for a more refined cost allocation system such as an ABC system springs from company's desire to reduce the specification and aggregation errors which are a common occurrence in traditional costing systems. However, refining the cost system in order to avoid specification and aggregation errors can lead to an increase in the number of measurement errors, which is the last category of errors. Measurement errors typically arise as an effect of increased specification of the cause and effect relation in cost systems, and decreased aggregation since this increases the difficulty of identifying the correct amount of resources associated to a specific cost pool, and measuring the amount different activities that the individual products use. It is logical that it is far easier to identify the costs related to the various activities in an aggregated system with few cost pools, and similarly it becomes difficult for the company to come up with accurate information for every cost pool in a complex disaggregated cost allocation system. The measuring of the costs or units related to allocation rates become even more difficult to perform when the variables and factors that need to be measured are not measures that the company is used to measuring, and which they can find little guidance for measuring (Datar, S. & Gupta, M. (1994) side 568-569).

This risk of an increase in measurement errors is also relevant for ServiceCorp and their support department, since the company has adopted the ABC system in order to achieve an accurate allocation of their overhead costs and therefore seek to increase their level of detail and decrease their aggregation. ServiceCorp continues to perform service x and y, however it is now assumed that there exists three different variations of each service, which are x₁, x₂, x₃ and y₁, y₂ and y₃. The company now has to make a choice regarding the quality control activity carried out by the support department, deciding if they want to make the quality control activity more or less aggregated. The company could choose to keep the activity as an overall activity, for both service category x and y, as they have done thus far, thus keeping an aggregated system. Alternatively they could choose to split the overall activity into two activities and thus two different cost pools, one for the control of service

category x and one for the control of service category y. If the company seeks to create an even more precise cost allocation model, they could split those two activities up into three additional activities each, six in total, one for each of the variations of the services.

The initial wish of many companies would be to seek the least aggregated cost system since the reason that they are adapting a refined cost allocation system is to achieve a more accurate cost allocation. But by choosing the least aggregated option, the companies are opening themselves up to the risk of measurement errors. In the example of ServiceCorp, measurement errors are likely to arise in the case the company chooses to go from one quality control activity to six individual activities, they might even arise if they choose to go with the two different quality control activities. The reason that the errors might arise is that it will become very difficult, and costly, for the company to measure exactly which costs goes to the quality control of which individual service, especially since the quality controls are all carried out in the same department, and possibly by the same employees. The company is unlikely to create the same disaggregation on the operational level, since this would require an extensive restructuring of the department. This means that in order to correctly trace the individual costs for the new six activities, the company would have to put in a lot of controls and checks, both automatic and manual ones, in order to constantly be aware of which services are consuming what amount of overhead costs. If the company is not successful in this, the cost allocation between the six activities will be flawed, because of measurement errors. The consequence of such an error, can lead to companies making the wrong operational and strategic choices, as was discussed earlier.

As earlier mentioned, companies who adopt ABC systems will have to make a trade-off between how accurate a system they want and how expensive it is. It is now possible to see that this trade-off is also a matter of balancing the specification and aggregation errors versus the measurement errors, which is a balancing act of how specific cost drivers, cost pools and activities the company wants and the ease of getting correct and meaningful measurements to go with chosen level of aggregation and specification. Overall aggregation, specification and measurement errors are all direct threats to the ABC system and the expectation that it can deliver accurate cost allocation, which is why it is exceedingly important for the specific company to be aware of the areas where problems may arise, and that they try to overcome these by finding a fitting balance between the level of detail in the system and the difficulty of performing the required measurements.

7.1 Synergy between errors

As can be seen from the above discussion, the different kinds of errors in an ABC system have distinct features, and from a theoretically viewpoint, it is easy to separate them from each other. In a practical setting, this is however not a simple task. If for example a company uses the relative frequency (volume) as a cost driver associated with a cost object or process instead of the absolute frequency (time used), the specification error that happens as a result of this choice will be identical to the measurement error of the cost driver, resulting in an incorrect allocation of overhead costs to the activity (E. Labro & M. Vanhoucke, (2007) p. 942-943).

The above shows that it is important to be aware of the fact that the various errors can have a synergy effect on each other. Another case of this is the offsetting effect that can take place between aggregation and specification errors. If a company has decided upon a specific level of aggregation, and thereafter has a desire for an increased level of specification, in the form of more specific cost drivers, a situation can arise where the level of aggregation offsets the effects of the increased specification, thereby leading to decrease in the overall precision of the cost allocation system (E. Labro & M. Vanhoucke, (2007) p. 943).

If for example a company chooses to utilize a level of aggregation with 3 activities in a department, where they could alternately choose a less aggregated level of 6 activities, they also have a choice of how detailed they want their level of specification. If its assumed that they have the choice of two levels of specification, where level 1 is the least specific, the company will at the aggregation level of

3 activities be best suited with using the specification level 1, since the level of aggregation is relatively high, meaning that the company will not be able to fully utilize highly specific cost drivers, but instead need to use more general cost drivers. If the company wishes to utilize a higher level of specification, level 2, and thereby use more specific cost drivers, while still using a highly aggregated system in terms of cost pools, it runs the risk of getting offsetting effects. The company will in part of the ABC system design go towards better and more precise cost drivers for the various activities, while going towards fewer and less precise cost pools, which is an unwise choice, since the levels of precision should follow each other. It is important for the system that the cost driver of an activity is the explaining factor for the use of the resources for the entire activity, which is not likely to happen with specific drivers and general activity cost pools. The offsetting effect that takes place is the increased specification under a highly aggregated system, which leads to aggregation errors. The sought after effect from the increased level of specification, is therefore offset by the increased level of aggregation errors that happens as a result. The company needs to make a commitment to level of aggregation that is suitable for their level of specification and vice versa.

Another offsetting effect can arise between aggregation errors, and measurement errors. While a company normally wishes to pursue an overall low level of aggregation and measurement errors, it will often be difficult to achieve this goal, since a decrease in the aggregation of the system will likely lead to an increase in the amount of measurement errors. This is due to the fact that it becomes harder to measure correct information in a system with a higher numbers of cost pools (E. Labro & M. Vanhoucke, (2007) p. 943).

This leads to the offsetting effect between the desire to pursue a low level of aggregation errors and a low level of measurement errors. The deciding factor is the level of aggregation since this is the tool that the company can easily change, by adjusting the number of cost pools. The way to easily reduce the amount of measurement errors is to choose a high level of aggregation, since it will be easier to measure the data for fewer cost pools, but this will on the other hand lead to a higher level of aggregation errors. Specification errors therefore can either be true errors that are the result of careless designing, or they can be accepted errors that happen as a result of a chosen level of aggregation, in order to avoid measurement errors.

7.2 Errors at different stages

In the above chapter about errors in an ABC system, the various types of errors that can arise in a refined costing system such as ABC was identified and defined. However, the discussion focused on the errors pertaining to the activity cost pools, which is the point of the ABC system that defines stage 2. The defined errors can however also be discussed in connection with the allocation of costs from the resource cost pools to the activity cost pools, which is stage 1 of an ABC system. It is obvious that designers of an ABC system needs to be aware of the existence and relevance of errors in both of these stages, as the errors can lead to a reduction in accuracy of cost allocation no matter what stage they are present in. The stages are depicted in figure 3 below (E. Labro & M. Vanhoucke (2007) p. 939-941).

When designers realize that errors can occur in different stages of the cost system, it is acknowledged that the earlier defined types of errors can occur multiple times in different areas of the system. Aggregation errors can besides arising in the activity cost pools (AE-ACP), arise at the start of stage 1, in the resource cost pools, which is when the various resource costs are sorted into initial cost pools. Aggregation errors (AE-RCP) can arise here when heterogenic resource costs are aggregated into the



Source: (E. Labro & M. Vanhoucke (2007) p. 941).

same resource cost pools. This could for example happen if a company aggregates the costs of both building rent and production supervision in the same resource cost pool under the name of administration costs (E. Labro & M. Vanhoucke (2007) p. 942). In this example, it is very clear that the two cost types are heterogenic, since the rent of building should be allocated to activities based on for example the amount of space the activities take up, while the supervision could be the amount of people assigned to various activities, or a more precise measure of the supervisors' time. These issues of heterogeneity, will cause issues if the costs are concentrated in a single resource cost pool, since this will cause them to be allocated to activities using the same cost resource driver, and if the costs of the supervision and rent are aggregated it will be very hard to find a resource driver that can provide a fitting cause and relation with both of the resource costs. This makes it clear that companies adopting an ABC system should seek to aggregate the cost of resource that are best described through a common driver when these resources are to be allocated to the various activities. This means that instead of aggregating supervision and rent, companies would be better off aggregating the resource costs related to power, water and heat with rent since all of these are more likely to share a common cause and effect relationship with the cost of building rent. This also goes well with the earlier assumption of the amount of physical space used, as a driver for the building rent, and now utility, resources. It is fair to assume that the consumption of the general utilities also has a relationship with the amount of space taken up by the various activities.

As can be seen from the figure, measurement errors can also, like aggregation errors, arise in different stages of a company's ABC system. First of all, an over or under allocation in a resource cost pool can take place which will lead to a distorted amount of cost being allocated further down steam to activities and finally to cost objects (ME-RCP) (E. Labro. & M. Vanhoucke (2007) p. 942). This could for example happen if, by mistake, costs pertaining to a marketing campaign is registered under the resource cost pool for administrative costs, instead of the resource cost pool for marketing. This lead to too many costs being allocated to the marketing resource pool, and too little to the administrative cost pools to the activity cost pools. The fact that the costs will end up in the wrong activity cost pools, also means that the costs might end up allocated to the wrong cost objects, thus carrying the error all the way through the ABC system. This type of error is caused exclusively by a mislabeling of costs (E. Labro. & M. Vanhoucke (2007) p. 942).

Furthermore, measurement errors can arise in the resource driver in stage 1 (ME-RD), which happens when a wrong estimate of the frequency of the driver is used as a base for the allocation. Time is often used as a resource driver, which runs the risk of an error occurring, when an administrative employee for example estimates a faulty time usage relating to the handling of invoices, since this
time estimate is used to allocate the payroll of administrative employees amongst activities (E. Labro. & M. Vanhoucke (2007) p. 942). Alternately an issue could arise in a sales department who has to handle a number of incoming requests. In this department, measurement errors can arise if the estimate for handling a request is set to x minutes while it actually is y minutes, where y minutes is significantly different from x, so that the estimate will be inaccurate enough that it will lead to an under or over allocation of resources to various activities. Furthermore measurement errors can also arise at the stage 2, where the activity drivers are allocation costs from activity cost pools to cost objects (ME-AD). Measurement errors arise at this stage when a cost object is estimated to use x amount of activities per output, when in fact it uses y amount of activities per output, where again y must be significantly different from x so that the estimate results in a under or over allocation of costs to the cost object. This could be a cost object that is estimated to use 6 units of the quality control activity per output, but actually uses 4 units of the quality control activity, leading to an over allocation of costs to this cost object, and thus an under allocation of costs to all other cost objects that also uses this specific activity.

Finally specification errors can also arise multiple places in an ABC system, one place being in stage 1, in the resource driver (SE-RD) and the other being in stage 2, the activity driver (SE-AD). As earlier described in chapter 7 of this thesis, specification errors arise when the driver that is used to identify the relationship between the individual products and their usage of resources is unable to correctly explain it, resulting in costs being allocated based on a factor that does not correctly explain the cause and effect relationship between costs and cost generating objects. Specification errors in stage 1 is when an incorrect driver is used to explain various activities usage of resources, while the stage 2 error was explained earlier (E. Labro. & M. Vanhoucke (2007) p. 942).

7.3 Stage 1 errors versus stage 2 errors

When it comes to errors in ABC systems, emphasis has often been placed on the occurrence of errors in stage 2. But is it correct to mainly focus on these errors and not pay the same amount of attention towards the errors that can arise in stage 1. In order to answer this, it is important to focus on the overall effect that the errors from the two stages can have on the collected precision of the cost allocation system. According to E. Labro & M. Vanhoucke (2007), the errors that occur at stage 2 of the ABC system, always carry significance on the overall precision of the cost system, compared to errors at stage 1. An error at stage 1 has the possibility of being offset by an allocation at stage 2, which will reduce the effect of the error at stage 1. This leads to the conclusion that improved focus on errors at stage 2 can have a reducing effect on errors that arose at stage 1.

Because of the reducing effect that an effort to reduce errors at stage 2 can have on errors from stage 1, it its assessed that companies should have their main focus on reducing the errors at stage 2, and a secondary focus on the reduction of errors at stage 1. The assessment of the thesis is therefore that stage 2 errors has a far more essential influence on the overall precision of the ABC system. A company that operates with limited resources, which is the reality of most companies, should therefore first pay attention to errors at stage 2, since focusing mainly on errors at stage 1 might not provide an adequate effect, if this means that errors at stage 2 can arise to null out the effort made to reduce errors at stage 1 (E. Labro. & M. Vanhoucke (2007) p. 952-953).

7.4 Further errors in TD-ABC

Using a TD-ABC system, makes it possible for the company to attain a number of additional benefits and possibilities, described in chapter 5.1, compared to the original basic ABC model. It must however be made clear that the TD-ABC model also has a number of possibilities for errors to arise, that are important for designers of the system to place emphasis on, since they threaten the precision of the cost allocation. Just as the traditional ABC system, the TD-ABC system also has the possibility for specification, aggregation and measurement errors to arise. However, in the TD-ABC system it is assessed to be important to but an increased emphasis on the area of measurement errors and the various aspects that might generate the errors. An important area of focus in relation to measurement errors in TD-ABC is the concept of notification which holds significance for the precision of an employee's time estimate of his performed actions. Notification means the point in time where a company's employee is informed that his performed action or actions are to be time estimated. Two options exists when it comes to notification, one being where the employee is given the information before he performs the actions, meaning that the employee knows beforehand that his use of time on the actions is to be measured. Alternately, the information can be given after the employee has performed the actions, meaning that the employee is not told that he is to measure his usage of time till after the actions has been performed. This is a decision that the designers of a TD-ABC system must make when implementing the system in their respective company, since no matter if they choose to inform the employees before or after, it can have both benefits and drawbacks.

If the employee is informed that he is to measure the time used on a task before he performs it, an offsetting effect will happen, where on the positive side, the employee will be aware that he is to measure his time usage, and therefore allocate a portion of his mental resources towards keeping track of the timing task. This will lead to a more accurate and reliable time estimate which will in turn lead to fewer measuring errors, and thus to a more accurate allocation of costs. However on the negative side of the offsetting effect, is the fact that the employee might perform worse than usual since he has to allocate a part of his resources, concentration and focus, to keeping track of the time used. This will lead to a subpar performance, which will have an effect on the estimate that the employee delivers for the system, which will then lower the precision of the allocation.

Alternately, the system designers could tell the employee to estimate his usage of time after he performed the tasks, which will also lead to a scenario with an offsetting effect. The employee will have been focused only on the task while performing it, and must therefore afterwards estimate his usage of time based on his memory, his sense of time and any available signs or signals. Since the estimates the employee delivers is founded solely on a cognitive basis, the estimate will be less precise and could vary from employee to employee, but since they were focused only on performing the task, the actual performance of the task is closer to the true usage of time.

It is therefore clear that companies using TD-ABC is facing a trade-off when it comes to deciding whether to notify employees before or after the performance of their tasks, since they on the one side get a precise estimate at the cost of the quality of the actual performance, and on the other hand get less precise estimates coupled with a higher quality of the performance (E. Labro & E. Cardinals (2008) p. 740-741).

Another source of errors in a TD-ABC system is the coherence of tasks or actions, which can be seen in connection with the above discussion of time of notification. The tasks or actions that are included in an activity can be more or less coherent, which is to say that when an activity is coherent the tasks are performed sequentially and in a structured fashion. This could for example be a factory worker who works the same machine every day, where the activity he performs consists of performing the same tasks and pushing the same buttons in the same sequence. An employee with incoherent tasks could be a person working in a company's IT department, where he must in various ways help other people in the organization with their IT problems. This persons performs the tasks that is requested from him on an ad hoc schedule, and the nature of the tasks might vary widely day to day, which makes it incoherent (E. Labro & E. Cardinals (2008) p. 739-740).

As stated, it is important to view the coherence factor in connection with the notification factor. Designers of TD-ABC systems should be aware that the degree of coherence in an employee's tasks, should have influence on the choice of when the employee receives notification since it is research shows that the negative relation effect between the timing of the employee's notification and measurement errors in time estimates is stronger when task coherence decreases (E. Labro & E. Cardinals (2008) p. 741). If a company, department or unit primarily has incoherent tasks, they could benefit more from notification before the performance of the task, since choosing to notify after the fact would result in a negative effect. On the other hand, if tasks are coherent, companies are better able to choose to notify employees later without it resulting worse time estimates.

The level of aggregation also plays a role in the debate surrounding notification: "The negative relation between the timing of notification and measurement errors in time estimates is stronger when aggregation increases" (E. Labro & E. Cardinals (2008) p. 742). This means that organizational units who are operating with a high level of aggregation in their activities, should notify employees before they perform their tasks, since this will lead to a lower level of measurement errors. This makes sense since a higher level of aggregation means that more activities, and thus more tasks have been merged into the same activity, which means there is a higher chance of the tasks being incoherent, and also the fact that time estimates that run over a large amount of tasks are more difficult to keep track of. If on the other hand, the level of aggregation is low, and many separate and specific activities have been created for the actions that needs to be performed, it will not lead to any significant reduction in measurement errors, if the company chooses to notify its employees beforehand. This is because the employees have limited memory, which means that even though they are informed beforehand that they are to deliver time estimates of their activities, they will not be able to keep track of the large amounts of estimates, which results in little reduction of the measurement errors (E. Labro & E. Cardinals (2008) p. 750). The lack of reduction in measurement errors, is to be seen in connection with the previous mentioned offsetting effect that when employees are notified beforehand, they utilize a portion of their cognitive resources on the task of keeping track of the time estimates, instead of performing the actual task. In a setting with low aggregation, this offsetting effect will multiply due to the employee having to keep track of multiple estimates. The advantage of notifying employees in advance is supposed to be that time estimates are more accurate, but this effect is reduced due to the amount of estimates, which means that they

are not good enough to offset the lower quality of the performed task, which is also due to the early notification.

The above discussion concerning errors in TD-ABC, shows that there are additional aspects to take into consideration when choosing this type of ABC, since the time estimates opens op the system for a new type of human influence on the system. First and foremost, the timing of the notification of the employees will have an effect on the degree of measurement errors, and the choice of when to notify is further complicated by aspects such as coherence of tasks, and the level of aggregation in the individual TD-ABC systems. Depending on the profile on the company and the system, a range of correct decisions needs to be made in order to optimize the system in regards to time estimates, so that these lead to as little measurement errors as possible.

7.5 The consequences of errors in ABC

As described in chapter 6, the increased precision that ABC brings to the allocation of overhead costs, gives a company the tools to obtain certain strategic and operational benefits. The reasoning for this being that the more precise cost allocation a company can obtain, the better knowledge they have of how their various processes and outputs generate costs, and therefore they will be better able to make strategic and operational decisions that minimize their costs and thus optimize their profits. When making decisions on the managerial level of a company, the cost allocation system can be seen as a managerial information system, since the financial and operational data that is collected in it, is used as guidance to the decision makers of the company.

However, despite the focus on improving the precision of cost allocation in the ABC system, the previous chapters has shown that the system is far from perfect, and is in fact prone to several types of errors. The types of errors that have been mentioned could potentially have severe consequences for the precision of the data produces, and thus threaten the legitimacy and existence of the ABC system. Besides these pitfalls, it is also unlikely that it is possible for the ABC system to obtain every single piece of relevant information that might contribute to strategic decisions. Cost allocation

systems in general only include information that can be measured reliably, so important information that might fall outside of this scope are not included in them, and are therefore not accessible to the decision makers of companies. Based on these considerations and the points made in chapter 7, it is relevant to conduct an analysis of how the strategic decisions could be affected by the existence of errors in a company's ABC system.

As earlier mentioned the errors that arise in an ABC system is not only the product of human errors and oversights, but are also the result of trade-offs being made by the designers of the system, during implementation, since it is not feasible to create an ABC system that allocates costs perfectly accurate. Because companies operate with limited resources they have to make certain choices that reduces the level of detail, since the perfect level of detail would require an amount of resources that would make the systems net value negative. These choices first of all include the level of aggregation in the system and thus the amount of activities that the system will include. The perfect system that would perfectly allocate overhead costs, would be free from any aggregation, but any actual ABC system will include some form of aggregation, where a range of actions are bundled into activities. Because aggregation is needed, the threat of aggregation errors exists. When various actions are bundled into activities, the company needs to identify the drivers that most closely resemble a cause and effect relationship between the actions and the costs that they generate. Again because of limited resources, it might not be possible to identify or measure the correct driver, and therefore companies must settle for less than perfect drivers. Because companies have to settle for imperfect drivers it runs the risk choosing a wrong driver, thus creating specification errors. Finally, limited resources also means that the company will not always be able to measure information related to the drivers correctly or create perfect estimates, which creates measurement errors.

These errors will distort the information that the ABC system delivers to a company's decision makers, meaning that the information will not be completely correct, but instead be skewered by a certain variance, depending on much the company simplified the system, based on their available

resources. The decision makers need to be aware of this inaccuracy, so that they can compensate for it when they make decisions.

In the earlier chapter 6, certain types of strategic decisions were mentioned that companies might use the information gained from an ABC system to make. These were operational and process improvements, pricing of products, choosing a product mix and identifying good and bad customers for the company. There are other decision that these information could also be used for such as budgeting, transfer pricing, more precise assessment & reward of employees and general organizational decisions. Since ABM leads by taking advantage of the information given by the ABC system, the errors that have been mentioned can cause decision makers to make decisions based on false information.

This could for example be a decision regarding the pricing of a company's products, where it is important for a company to have exact information about the costs generated by the individual products, so that it is possible to discern how products are to be priced in order to be competitive while producing a net profit.

The company ServiceCorp, from an earlier chapter, is still using their ABC system and wants to use the system in order to correctly price their service x, y and new service z. However a measurement error arises at stage 2 in the system, which affects the ABC system so that service x is estimated to use 4 units on average of activity 1, when in fact the true average is 5 units. Such an error can lead to a significant distortion in the cost allocation since; it means that the service will be allocated 20 % less costs than it should have been allocated from activity 1. Depending on the amount of cost that is allocated from activity 1 and on the proportion of total costs of the company that is overhead costs, the error becomes more serious. If for example the company has 4 different activities, and they each allocate 25 % of the total overhead costs, the error will result in distortion of (20%x25%) = 5 % of the total indirect costs of the company, and if the company's mix of costs consists of 50 % indirect costs and 50 % direct costs, this will constitute (5%x50%) 2,5 % of the total costs of the company that are being under allocated to service x and instead allocated to service y or service z. If the decision makers of the company seek to price the services based on a markup of 15 %, they will fall of their target by the 2.5 % and instead only gain a profit of 12.5 %, thus making the service seem less profitable than it actually is, and the other services more profitable than they actually are. They would also risk overpricing the other services since they have to carry the weight of the cost that was under allocated to service x, which runs the risk of making service z and service y unable to compete in the market.

Much the same way, ServiceCorp might choose to use the information gained from the ABC system to make decision regarding their mix of services. This decision is rooted in the above example regarding measurement errors' influence on the pricing of services, since the profitability of their services will have a large influence on which services the company will choose to perform. If it is assumed that the company is also basing the pricing of their services on the prices that their competitors run, and must be able to set a competitive price, or else drop the services or perform less of it. ServiceCorp had three different services, x, y and z, and service x suffered from measurement errors regarding its activity usage. If the company had an accurate costing system, the services would be allocated their correct amount of cost, and thus the company would be able to price them correctly, but because of the measurement error, service x is allocated less cost than it should, and is thus priced lower than it should be. The other services, y and z, are now priced higher than they should be, and since all of the company's services operate in a market with fierce competition, the company soon realizes that services y and z are uncompetitive, since they according to the distorted information require a price that is above the price of their competitors. They therefore shift their attention to selling services x, which they find that they can perform cheaper than their competitors. If the company start performing more of service x, which is selling at a cheaper price, and performing less of y and z, the company will expect to get a large profit, but the actual result will be the opposite, since service x is more expensive than they realize, and they are selling it cheaper than it should be sold.

Lastly the information that an ABC system yields, can be used to examine the business processes of a company, to identify where it might be possible to improve these. If the company finds that their cost of producing a certain product is higher than the markets cost of producing, they can look into the cost of performing the activities that go into producing the output. Since ABC breaks down the inputs of the company into activities that can be measured, this type of analysis becomes easier. However, as with other decisions tied to the information gained by ABC, these types of decisions regarding process improvements can be compromised if errors arise in the cost allocation model. If for example, a company has a specification error at stage 1, which would mean that various activity cost pools are being assigned costs from the resource cost pools based on a wrong driver, which generates a distorted cost allocation. If for example ServiceCorp is still assumed to having three services, x, y and z, and these still use the same 4 activities as in the previous example, the specification error would mean that 4 activities are either being under or over allocated. In regards to process improvements, ServiceCorp might chose to look at the activity that seem to be the most expensive, in order to see if they can reduce the cost of performing it. However if the specification error leads to too much cost being allocated to for example activity 1, the company might wrongly choose to perform the process improvement on that activity, instead of other activities, which might actually be more deserving, if the specification error had been avoided. The specification error will result in the company using resources on improving the wrong activity, and it can be assumed that even though it might lead to some improvements, it leads to less overall improvement of profits, compared to focusing on the correct activity.

7.6 Utilizing ABC despite errors

The previous chapters clearly states the problems that ABC face when it comes to delivering accurate cost allocations in companies with limited resource available. Errors in the ABC system is at the same time seen as something that is unavoidable since it is unfeasible to create the perfect cost allocation system, but they are also seen as something that should be accounted for, and be taken into consideration when using the information the system delivers. The possibility, and reality that errors exists in ABC systems, and cause them to deliver less than perfect information, should however not be used as arguments for choosing a traditional costing system. A traditional costing system, might be cheaper to implement and operate, but it is also significantly less accurate, and can in no way compete with the information that an ABC system can deliver, if the company profile fits the specifications that an ABC system require to become profitable. As stated in chapter 5, companies with a significantly large portion of indirect cost compared to the total cost pool will generally be able to gain value from an ABC system, and especially companies with products that vary in complexity and size of volume production, as this can be indicators that a traditional cost system will lead to a significantly distorted cost allocation. A pitfall that decision makers can make is to envision that they will be getting perfect cost allocation trough ABC, when in fact they will get a more accurate cost allocation, not a perfect one, or one that can be interpreted as the "truth".

It is very important that companies are clear on what advantages they expect from the ABC system, and that they are clear on what characteristics their production and cost profile need to be. The discussion so far in this thesis, should therefore be seen as an argumentation for factors that companies need to be aware of, before adapting an ABC system, and not as arguments against adapting the ABC system at all. In the next chapters of the thesis, a lot of these arguments will be tested against an empirical case, which is the ABC system that employed by the Danish railroad company, De danske statsbaner, (DSB). Chapter 8 will start out with a short introduction to the company, its history and the political climate that surrounds it, as these are all important factors as to why DSB has chosen the cost allocation system that it has. In the following chapters the model will be described and analyzed, with special emphasis on certain factors within the system which are consequences of the decision that the designers of the system have made, thereby showing how several of the problems earlier stated in the thesis, can come to exist in practice.

8. An introduction of DSB

DSB is the main provider of railroad services in Denmark, regarding transportation of persons, both regionally and nationally. The earliest traces of DSB was established in 1847 with the first railroad between Copenhagen and Roskilde, and in 1885 DSB was formally established as a fusion between the regional rail road company on Sjælland and the one in Sjælland and Fyn. DSB was run as a nationally owned company from its foundation and until 1999, where its status was changed to a company structure called Independent Public Company. The new status carried with it new possibilities, since DSB was now able to operate more as a private company, being able to make investments without the approval of the Danish parliament, and being able to bid on jobs to operate train services in foreign countries as well. The change also meant that DSB now operated in Denmark as a hired company, instead of a national function, and the train service that it delivers in Denmark is therefore decided in a five year running contract called "Trafikkontrakten", negotiated between DSB and the department of transportation, where the some general terms of the service is decided, and also what compensation DSB receives for operating trains on some distances that might not be profitable. These distances are instead operated on as public service traffic.

DSB's business model is heavily based on the personnel traffic, both regionally, nationally and also as urban transportation in Copenhagen, the S-trains. When DSB changed its status to becoming an independent public company, certain services was granted to other companies, or some parts of the company was sold off. In 2001 DSB sold off its freight train company to the Dutch-German company Railion, now called DB Schenker Rail, and in 2003 certain parts of the regional personnel traffic in Jylland was awarded to the English based Arriva by the department of transportation. Since DSB gained status as an independent company, and started to operate under a contract, it has come under increasing pressure from its customers regarding the punctually of trains, from the shifting governments regarding its financials and from the Danish media regarding various incidents that has been heavily criticized, such as delayed IC4 trains, and the breakdown of DSB First in 2011. DSB is in its current climate increasingly dependent on producing a surplus and steady growth, while improving the efficiency of the company. After the breakdown of DSB First in 2011, DSB launched a project called "A Healthy DSB", aimed at improving their financial result with one billion dkk within 3 years, and reducing the amount of full time employees by one thousand. These measures were necessary as the current discourse in Danish politics revolves around the possibility of offering various train routes that DSB operates to other train companies, to increase the competition, and thereby seek to lower prices and improves the service. DSB is therefore operating in an environment where they constantly need to be capable of optimizing their business model, so that they can justify their existence to the department of transportation. In order to live up to this demand the company needs exact information in all areas, including how and where cost is generated in the company.

8.1 DSB's reasons for utilizing ABC

As stated in chapter 5, ABC is ideal to use for companies with large amounts of indirect costs to allocate. DSB is one of these companies, with a very large amount of resources spent on administrative and maintenance support functions, and since it is also hard to directly trace a large portion of the resources from the production staff, these costs are also generally regarded as indirect costs, in need of cost allocation. However, the need to allocate indirect costs is not the main cause for DSB to create an ABC system.

Because DSB has the status as an independent public company, and because they receive a compensation for delivering public service transportation under their contract, DSB has an contractual binding to document that the compensation that they receive from public funds, are not in any ways used to conduct business that competes with the general market. Therefore DSB makes a

distinction in their business where their various business functions are divided into categories, either A-functions which are business that is belongs to the services that DSB is contracted to perform under the contract with the state, or B-functions which are all of the other business areas where DSB operate, that are open to outside competition. This entails all of their subsidiaries, for example the 7/11 kiosks that DSB operate in many of their stations, whenever they perform maintenance on trains for other operators, or when they sell energy to conduct trains to Arriva.

Due to the complex nature of costs and costs objects in DSB, a refined cost system was needed in order to correctly show the flow of costs to the various cost objects, in order to be able to verify to the auditors of the state that public compensation had not been used on areas of business that are required to operate under fair competition.

It was this need that caused DSB to adopt the ABC model, which is untraditional since it the theory advocates adopting ABC in order to allocate costs in order to manage the company through strategic decisions based on these choices. DSB however initially sought to utilize the ABC model's ability to allocate cost with greater accuracy to be able to live up to the task of documentation, and therefore DSB also chose to create their ABC model as a full cost model. This means that DSB runs all their costs through their ABC model, both direct and indirect, with the directs costs being assigned directly, and DSB lastly also run their revenues through the model in order to correctly assign the income to the various cost objects, and also between the A and B types of functions. This means that the model is also able to calculate the profitability of cost objects.

DSB started out by creating an ABC model in 2001 that was heavily based on the task of documentation, and used this model until 2013, where they created a new model that while still fulfilling the role of delivering the documentation needed to validate the usage of government compensation, was also equally meant to be used as a strategic tool, and as a tool to analyze the way the various activities of DSB use the organizations resources and thereby generate costs.

The first model could therefore be said to be less of a true cost and strategic control model since its primary focus was documentation, while the new model has moved further towards becoming a model that can be used for activity based management. It is this model that will be the topic in this thesis going forward, and the focus will be on how this model treats the various costs going into the model until they are allocated to a cost object. The interesting case will be to see how the designers treat the risks of errors in a system built to be accurate in its allocation of cost and how they prioritize the cost and the size of the model versus its accuracy. Furthermore the analysis of this model will provide an opportunity to examine the ways that the information the system provides can be used.

8.2 DSB's cost profile

As mentioned above DSB created a new ABC model in 2013 aimed at being able to provide the company with exact information about how the organization generates cost on top of the existing task of documenting the correct usage of public compensation. As was also mentioned above, the costs that need to be allocated by this model are highly different in their nature, as DSB's business is diversified in many things related to their operation of railroads. The core business functions are of course the operation of the trains and the related customer minded services, such as selling tickets and so forth. On top of this DSB has a subsidiary company dedicated to maintaining their various trains, and DSB also own and manage many of the train stations along their routes, and also own several franchises of 7-11 kiosks located in these stations.

These businesses along with the central administration of the company as a whole, make for a company with a cost profile that consists of many indirect costs, which theoretically makes ABC a sensible choice as a cost allocation system, since a traditional system would be likely to provide DSB with a faulty cost allocation. Since the core business of DSB is delivering public transportation, DSB is in a unique position when it comes to capacity costs. DSB is unable to stockpile their products, as it is a service product in nature, but they are also, at least in the short term, unable to prevent unused

capacity, since their contract specifies how many trains they are to drive on specific routes. The amount of passenger seats, and the time of departure for the trains cannot be changed at a moment's notice due to passengers planning accordingly to the announced timetable. This creates a situation where DSB could be driving trains that are very close to being empty, but have to drive them anyway due to their contractual and public commitments, and this creates a need for a cost system that can discover what the costs for unused capacity is, so that this cost is not put directly upon the cost objects, but can be treated as such. If DSB knows what their costs to unused capacity is, they can take steps to either reduce this cost, if possible per their contract, or they can take steps to try and utilize the capacity. With these points made regarding DSB's cost profile it is time to analyze the ABC model of DSB.

9. DSB's ABC model

Like the ABC models described in the theory, DSB's ABC model is built of various familiar objects, such as resource pools, activity pools and cost objects. The cost flow into the resource pools and are then allocated by resource drivers to the activity pools and then allocated to the cost objects using activity drivers. Below, figure 4 shows a visual overlook of the model created by the department in charge of designing the cost allocation model. As can be seen in figure 4, the DSB model is constructed of these familiar objects, but within the various object categories several levels exist. This is done in order to capture the complexity of the costs that DSB incur, since this model is created not only to give information about the final cost object, but also about the various capacity units and functions that owns the cost that is finally put upon the cost object. As can been seen this means that the stage with resource pool contains two different levels and the activity level contains anywhere between 1-4 levels depending on the degree complexity of the particular cost. As mentioned earlier the model is a so called full cost model, and also a profitability model, which is why direct posts mentioned on the left hand side under resource pools. With figure 4 beneath on page 48 as a point

Figure 4:



Source: Internal power-point presentation from DSB's cost model design department.

of reference, we will next give a detailed explanation of each stage in the ABC model, in order to completely understand how it allocates DSB's costs.

9.1 The resource pool stage:

The resource pool stage is the first stage of the model, and it is therefore here at the R₁ objects, the resource elements, that the model takes in all the cost information from the various source systems and starts to filter it. DSB's model receives its cost data primarily from their Enterprise Resource Planning (ERP) system, SAP, which contains all logs of raw cost data. Each piece of cost data coming from the SAP system contains a series of information that the ABC model can use in order to decide where to initially send the information. This is information such as cost type, and then information regarding the object in SAP that the cost was put on. The cost will always be related to a profit center, which handles where in the organization in the cost originates.

Cost type	Profit center	Cost Center	Litra type	RP ₁
23709	4012	5012	IC3	4

The example above depicts the allocation rule for a cost of the type 23709, which has been accounted on the cost center 5012. The fact that it is accounted on a cost center tells the system, and its designers, that it is a cost associated with compensation. This cost center is associated with the profit center 4012 which tells the designers where in the organization the cost comes from. Finally the cost data also tells the system which type of train that the given cost is related to. This unique combination of information warrants this specific cost to be allocated to resource pool RP₁. Based on this combination of the above information, the designers of the system can also reason what kind of variability and reversibility, the cost has. Specifically the reversibility of the cost is deducted based on whether it is a material or it is a personnel cost, and in the case of the personnel cost, it is decided based on the type of employment contract, the specific group of employees have.

Since indirect costs often contain costs that relate to the capacity of a company, it is very relevant for DSB to have a grasp of how reversible capacity costs are, and especially how these capacity costs, with varying reversibility, relate to their cost objects. This will always be relevant when it comes to the discussion of how DSB can use the information in the model for strategic decisions.

Figure 4 further shows that the initial R_1 resource pools are divided into a number of categories based on the above combination of costs. The categories consists of indirect production costs, overhead costs coming from decentralized support functions or so called local overhead (On the figure depicted as Område-OH) and overhead costs stemming from the central administration or so called corporate overhead (On the figure depicted as Koncern-OH). The two final categories are special categories, in the way that there is one for direct costs (Direkte Poster), which are transferred directly to the groups of functions in the A_1 level where they are allocated to the activities along with the indirect costs. The last category is for special cases (Enkeltposter) of cost which might for some reason not fit into the other categories, and are therefore treated with special rules. This could be costs such as tax or the compensation that DSB receives from the traffic contract. These costs are allocated directly from the R_1 pool to the various activity pools in A_4 . Again it should be remembered that DSB is using the ABC model as a full cost model, which is why these kinds of costs and income are also run through the model. It is however only the first three categories that flow on throughout the entire allocation mechanism from the R_1 stage.

The first step of the model is the allocation of overhead from the R₁ resource pools to the R₂ resource pools. What happens in this step is that the resource pools containing the indirect production costs are mirrored from the R₁ pools to the R₂ pools, thereby being evenly assigned, but the R₂ pools are then allocated their share of costs from both the local resource costs and the corporate overhead costs. These costs are allocated based the approximation of how many average full time employees that are employed at the various production units that are responsible for the indirect production costs. This means that at this very early point in the model, a very general and possibly inaccurate driver is being used to allocate a portion of the costs to the final resource pools. The driver used, number of average full time employees employed, could be an accurate driver for an overhead department like human resources, but it might not be for a corporate department that deals with procurement. This is the first sign of an error in the model, specially a specification error, and this will be discussed later on in the thesis.

The model separates overhead costs coming from the local supports functions and overhead costs coming the centralized corporate support functions, as shown, where the corporate support function would entail functions such as the corporate procurement function, the corporate economy function, the HR function or the IT function. The decentralized support functions on the other hand are the local economy functions for the various organizational units or specialized support units that differ depending on where in DSB the production unit is located.

Once the costs have been allocated to the R₂ pools, they have been assigned to their final resource pool which are the units that generate the capacity that is then used by the various functions and activities further downstream in the system. This could for example be a resource pool that contains all the costs relating to train operators, maintenance personnel or sales personnel. This means that the total amount of indirect production costs for, for example, train personnel is collected in a cost pool together with the allocated amount of decentralized overhead costs and centralized overhead costs. From these R₂ pools the costs are then allocated onto the first stage of the activity cost pools.

9.2 The activity cost pool stage:

The next step in the allocation of the cost model is the allocation from the resource cost pools R₂ to the initial pools in the activity cost pool stage. Like the resource pool stage, the designers of DSB's model have chosen to create several layers of activity cost pools, in order to improve the precision of the final activity pools. The first group of activity cost pools, A₁, are constructed based on the 3not the target of actual allocations, since the capacity pools in R₂ are mirrored into this stage, evenly

allocating the costs into new pools. This is done in order to create groupings of various types of activities, signaling their overall function, which can then later be analyzed for strategic purposes.

For example train and maintenance personnel costs are mirrored to functions such as operational planning, maintenance, preparation and train operation, which are functions, which these groups of personnel carry out. Other capacity unit pools are mirrored to function cost pools such as strategic development, train scheduling and material scheduling and personnel scheduling, with these costs obviously mainly coming from strategic and managing operational personnel. Finally DSB also has a number of service personnel such as sales personnel, personnel attached in order to keep their stations and the associated buildings and general customer support personnel, whose costs are mirrored to function cost pools regarding information & sales, traffic information, station maintenance and travels & customer handling.

The initial R₂ cost pools mostly holds costs related to indirect personnel cost, since costs related to production materials, machines and fuel mostly are treated as direct in DSB's model. This would also include the various types of fuel and energy that is used in both the operation of the trains, maintenance and so forth. In their ERP system, DSB has a tradition of registering their various cost entries with a lot of additional attributes, such as what train car the cost is related to, and which type of train it is. It is clear that the more information that is attributed to an entry of cost, the easier it becomes to somehow trace that cost directly, instead of having to allocate it. The direct costs are however only traced directly to the A₁ level, and then allocated to the activities along with the rest cost less direct and more indirect. The various extra information that the cost data is born with from the ERP system are therefore the deciding factor for which A₁ functions pools they end up in.

The above gives a description of the various types of activity cost pools in the A_1 category, how they are constructed and which cost pools in the resource cost pool stage, R_2 , they receives costs from. As

shown it is the choice of the designers of the DSB model to perform very little allocation in this step, which means that most of the cost pools in the R_2 stage are evenly assigned to the pools in the A_1 stage.

Having described how costs flow into the first level of the activity cost pools, it is time to look at the next levels in the activity stage. DSB has created the possibility for costs to be allocated through a maximum of 4 stages depending on the precision needed for the given type of cost. However it is very few costs that are directed through the all four levels, and therefore the levels A₂ and A₃ will not be further discussed. The indirect costs in the system, along with the direct, are primarily assigned to the A₁ stage pools, the functions, before being further assigned to the A₄ stage pools which contains activity cost pool for costs relating to the function train operation. This function can be said to contain various such as delivery of train, operation of the train and service tasks related to the train. The final assignment of costs from the A₁, A₂ or A₃ cost pools to the A₄ cost pools are in most cases assigned based on measurements or how the various functions divide their time between the various activities that the individual activities perform, and in very few cases the personnel in the functions are asked about how they divide their time between various activities. The designers of the model are however very keen on primarily using objective and systematically measured driver, instead of drivers that are based on subjective observations.

The final grouping of activity cost pools, A₄, consists of a large amount of cost pools, where all the various types of costs from the first stage, R₁, is ready to be allocated to the cost objects. Activities such as energy, contain direct costs in the form of the actual costs of energy, but also contain indirect costs in the form of costs from the personnel from DSB's energy office who are in charge of managing the energy that DSB purchases, consumes and sells on to other train operators in Denmark.

The activity pools however, are more complex that this, since there does not only exist, for example, one activity pool for energy for trains or one pool for the activity preparation or material for material production. Instead there exists multiple cost pools related to these activities, but separately for each type of litra, which is the term used to differ between the various types of trains that DSB use, such as IC3, IC4, IC2 or IR4. Due to the choice that DSB has made for their cost objects, it is necessary for the costs to be separated into these separate activity cost pools, that are identical expect for their associated litra type. On top of this, the various activity pools also exist identically for the various organizational units so that costs relating to national train routes, regional train routes, international train routs and the S-trains are not mixed together.

This describes the model as far as to the point where the costs are ready to be allocated DSB's cost objects. At this stage the cost data have been refined from raw bookkeeping data entries in the SAP system, into costs related to specific activities performed by certain types of personnel or materials in certain functions on certain types of trains. This is a tremendous increase in the precision of the information regarding how cost is generated in DSB, compared to what DSB would have under a traditional system. The precision that is achieved thus far is achieved partly because of the depth of the system that DSB utilizes with two levels of resource pools and up to four levels of activity cost pools. The way that the system is constructed causes the system to become less aggregated, which can be the cause of several errors as mentioned earlier. This will be discussed later in the thesis. The next step in the description of DSB's ABC model will be the description of the ABC models cost objects, how they have been chosen, and how cost is allocated from the numerous activities to their final destination.

9.3 The cost object stage:

The final stage that needs to be analyzed is the cost object stage, which is a very defining stage for the DSB model, since the choice of cost objects has a large impact upon how the rest of the model has been structured, and is very significant for how for example DSB's direct costs are treated by this model.

DSB is a company where their actual product can be hard to specify, since what is the end product that they sell to their customers. They sell transportation to their users, but the due to the special type of product that DSB delivers, their users are not necessarily their customers, since the real customer that DSB has is the department of transportation. Therefore DSB have to select a tangible objects that tells them something about the product that they deliver to the department of transportation and for this purpose, the designers of the system decision was to allocate the costs on the various routes that DSB operate such as Copenhagen – Roskilde, Odense – Aarhus or Frederica – Esbjerg. This choice was necessary because of DSB's obligation to show how their compensation from the traffic contract with the state is used only on the various routes that DSB is obligated under the traffic contract, and not on any of the other various ventures that DSB also engages in as an independent company, which has to be free of any public subsidies in order to comply with a free market model.

As was also discussed earlier in the theory chapters of this thesis, it is important that the company selects the correct objects as cost object, and that these cost objects represent the core value proposition that a company presents to their customers, and that the cost objects are signified by the fact that it is the one thing that the company is funneling all its resources into. In this aspect it can be said that the choice of train routes as the main cost object for DSB is the correct choice, since it is the intangible product of transportation that DSB sells, and the train routes are the closest approximation that DSB can get.

Earlier the thesis touched upon the fact that DSB in their initial registration of cost data, are very detailed, so that these cost data are assigned a lot of information about their origin. These cost data allow DSB to assign their costs to specific trains, but there does not exist any information regarding

these costs relation to the various routes, which is why the direct costs also needs to be allocated in some ways to the cost objects.

So fundamentally DSB's ABC model exists because of the fact that costs cannot be directly registered on the cost objects that DSB need information about. The model is also so far relying heavily upon using a large amount of cost pools that costs are assigned to, based on the information that is tied to it from the ERP system, and based on assumptions and statements from the employees on how they spend their time on various activities. The majority of the allocation of the system through various drivers does not happen until the last step between the A₄ activity pools and the CO₁ cost objects. As can be seen from the figure, the cost objects are grouped into two overall categories based on whether or not they are cost objects that belong under the traffic contract, and therefore whether or not they are allowed to receive funds that relate to the compensation from the traffic contract. Within the grouping of cost objects that are related to the traffic contract, the largest grouping is the cost objects that relate to passenger traffic, which is where the various routes are placed. The routes are grouped based on what kind of route it is, since the type of route has a significance on what type of trains that are used and what kind of driver it is therefore possible to use.

Since the majority of the allocation takes place in this stage, it is very interesting to look at the drivers that DSB has decided to use to allocate various kinds of costs. For example the cost that relate to the activity "train delivering", which is the primary activity for the locomotors conductors, driving the train from station to station. The specific activity from each of the organizational units is allocated to the various routes based what routes the organizational unit operates, and based on a time based driver. DSB has a time measurement system in place called LTD (Locomotive driver Time Dispositioning), that their various personnel who operate the trains enter the time into, and which measures what amount of time they have used on delivering a train from a specific station to another specific station, thereby allowing DSB to utilize the time as a driver for allocating costs to the cost object. This is done as the theory suggests, by dividing the total amount of costs with the total

amount of time spent, thereby finding the cost for a single unit of time, and then allocating each route its amount of the allocated cost based on its use of time. While the activity "train delivering" covers more costs than just the wages to the locomotive personnel, such as various indirect costs, this choice of driver can be said to be quite precise, as it can be assumed that the amount of time spent on a given route is proportional with the amount of costs generated by the activity, since resources needed to provide the activity is more or less generating cost at a constant pace while it is being operated on a route. The chosen driver therefore correctly describes the cause and effect relationship between the use of the activity and how this generates costs.

The driver is made even more precise due to the fact that it is actual time measured and not based on some form of assumption or guess on the part of the employee, but in fact an automated system that keeps track of the time that the locomotive operators spend on the various routes.

Another driver to examine is the driver that is used to allocate the activity "station services", which covers tasks related to the stations along the routes. In the case of the costs related to the activity "train delivery", it could be said that the main cost to be accounted for was the wage of the locomotive operators and therefore it was relatively easy to conclude that the driver chosen was a good match. For the "station services" activity, it is hard to choose a driver that in the same can be deemed correct, since a lot of different personnel cost and other various indirect costs go towards supplying the resources needed to perform this activity. The designers of DSB's ABC models has to decide upon the driver that in their eyes makes for the best explanation of how the various train routes generate costs from the "station services" activity, and here they decided that the number of partial travels would be the most significant driver. This means that the activity uses the measure of how passengers on a specific route use the various station along the route in order to board the train, shift trains or end their travel. DSB is then able to divide the total amount of expenses generated by the activity at a specific station and allocate it to the various routes that interact with

this station based on the amount of passengers and the ratio of how many passengers that utilize the various routes.

As the last example, the driver for the activity "energy" will be examined, since it is interesting to look at an activity cost pool that does not only allocate indirect cost, but in fact also allocates the direct cost in the form of the actual energy consumption of the trains. As earlier mentioned, the "energy" activity consists of both costs relating to the actual energy consumption which is allocated to the activity from the function pool A₁ to where it was directly traced as direct cost from the R₁ cost pool. Indirect costs such as the costs related to the personnel that work in DSB's energy office, where they manage the purchase, strategic use and sale of various forms of energy is also allocated to this activity along with the cost for actual energy. The costs are allocated from the activity to the various cost objects based on litra kilometers driven, which is a measure of distance that DSB uses to signify the distance driven by a specific set of trains.

It should be explained that DSB operates with two forms of measures for distance driven, train kilometers and litra kilometers. Where train kilometers specify the distance an entire train drives (including all the sets of train cars included in the train), litra kilometers specify the distance that each individual set of train car drives. This would mean that if a train consisting of 2 IC3 train sets drives 10 km, the train has driven 10 train km and 20 litra km.

This means that DSB has chosen the driver litra km to allocate the costs of the "energy" activity, because they deem that it is the measures that best depicts the cause and effect relationship, which makes sense due to the fact that if they used train km the train could consist of an for example 3 train sets and the route that the train operate would be allocated the same amount of costs as if it was operated by a train consisting of only 1 train set. The litra km measure takes into consideration how many train sets is driven on the specific route which has a direct effect on the amount of costs that the cost object generates from the activity. This makes it evident that the measure is well chosen to allocate the costs of the cost relating to the consumption of the energy, but the activity

pool for energy also contains costs relating to the energy office. In this case the designers have decided that since the personnel at the office spend their time managing the energy, it is reasonable to tie their costs to the costs related to the energy consumption as well.

This is a fair assumption since a second best option to allocate the energy office would be as an overhead costs that is allocated based on full time employees in the production units. Since the energy that is supplied to the cost objects can be seen as a product of the work effort of the energy office, it is fair to tie the cost of the office to the cost of the energy itself, since the assumption can be made that as a train route increase its usage of energy, it thereby also increases its usage of the resources used by the energy office.

The three above examples show very well how DSB's ABC model make use of detailed drivers that are carefully selected in this last stage in order to get a refined allocation of their costs related to their chosen cost objects, the train routes. The choice of routes as cost objects is however only limited to the business activities that take place in the passenger traffic under the traffic contract, or the A category as DSB has labeled it. Other cost objects within the A category fall under the clearing grouping and under a grouping labeled as miscellaneous commitments, where the cost objects are not train routes. These groupings will not be discussed in this thesis. The cost objects that are placed in the group of offerings that are operating with competition from the free market, or category B as they are called, consists mainly of DSB's subsidiaries such as their DSB Maintenance who sell their services to other train companies or DSB Kort & Godt who maintain a number of 7/11 kiosks. Cost objects in these companies are naturally not train routes, but cost objects that are of a more fitting nature. This thesis will not go further into detail concerning these cost objects.

With the three examples regarding various activities and how their drivers allocate costs onto the final cost objects, the ABC model of DSB has been fully explained. It has been shown to be a highly detailed model that in its first stages are focused upon creating cost pools based on the initial information that the cost data comes with from the ERP system. This leads to the initial resource cost

pools in the R₁ pools that leads the cost data onto the R₂ stage where various overhead costs are allocated to the indirect production costs. From here on the cost are funneled through a strategic grouping of functions to their activity cost pools in the A₄ stage, where direct cost data are directly traced to the various activity cost pools. Finally from these activity cost pools, the various type of costs related to each activity is allocated through a specific individual driver to the various cost objects. In order to specifically show this flow of costs, the next chapter will take two of the examples of activity pools and their respective drivers and map specifically how the cost flows through the various stages into the cost objects.

9.4 The full flow of the ABC model

To fully show how DSB's ABC model allocates various types of cost, we will first examine the example of how the activity train delivery receives its costs and allocates it to the cost objects, building on the explanation in the last chapter.



Figure 4:

Source: Figure created by the author of the thesis.

As can be seen from figure 4 the cost flow starts with the various resource pools in the R₁ category receiving cost data from the SAP ERP system. The cost data related to the train delivery activity are sorted into three different resource pools, the cost related to the locomotive drivers are funneled into a separate cost pool that is specific for their production unit and meanwhile a number of cost

data regarding decentralized support functions and corporate support functions is also funneled into various cost pools that will ultimately end up in the activity for train delivery. As mentioned earlier the costs that end up in the local overhead cost pools are signified by the fact that they are only allocated to limited portion of the company, so in the case of locomotive drivers, it would be costs that originate from local administration in for example the S-train organizational unit or the Far &Regional organizational unit. The corporate overhead cost pool on the other hand contain costs that are common for all the organizational units in DSB, such as HR. The costs from these different cost pools are now assigned to a single cost pool in the R_2 stage as seen in figure 5 which is a cost pool that is a mirrored copy of the specific production unit from stage R₁. All the costs related to the locomotive drivers are therefore evenly assigned from R₁ to R₂, and the costs from the local and the corporate overhead cost pools are allocated based on the amount of full time employees in the locomotive driver capacity unit compared to the total amount of full time employees in respectively the pools that receive costs from the local overhead pool and the pools that receive costs from the corporate overhead pool. With the locomotive drivers having their share of overhead costs allocated, the cost pool in R_2 is now evenly assigned to an activity cost pool in the A_1 stage where it is grouped according to what kind of function it is, for strategic purposes. From these function cost pools the cost is now allocate further on to the specific activity cost pools in A₄.

In the case that a certain function would perform more than one activity, the cost would is allocated based preferably on a systematically measured driver. In the case of the locomotive drivers and the train delivery activity, the assigned based on the LTD system as well since this system both measures the amount of time that the spend on their routes, but also how they divide their time between the various activities. Once the cost has arrived at the activity cost pool for the train delivery activity, the cost contained in it is allocated as described in the last chapter based on a time based driver that finds its data in the LTD system that DSB utilizes, and with this DSB is able to allocate the cost with satisfying accuracy on to the various routes. As can be seen from figure 5, it is important to remember the flow of costs related to the activity train delivery is not a single flow, but a simultaneous identical flow for each of the different organizational units in DSB that utilize the train delivery activity such as S-trains or Far & Regional trains.



Figure 5:

Source: Figure created by the author of the thesis.

Another example that can be explained further is the example with the energy activity. This activity is different from the train delivery activity since it contains what the DSB model labels as direct costs, in the form of the actual costs for purchasing the various forms of energy that DSB uses, such as electricity, diesel or coal for their veteran trains. As can be seen from figure 6, the cost again start out in the R1 stage but this time there is four different pools. In the production unit pool, cost is placed that is related to the energy costs, and the personnel that works here generate various overhead costs that are placed in the local and corporate overhead cost pools. Finally the costs related to the actual energy is placed in the direct cost pools. In the R2 stage, costs are allocated identically to how it was allocated for the train delivery activity, with the production unit being mirrored and allocated its share of the overhead costs from both overhead pools and as can be seen from the figure, the costs from the direct cost pool in R1 skips this stage. Instead the costs in the R2 pool is evenly

assigned into the A1 activity cost pool, and the direct cost pool in R1 is evenly assigned into this cost pool.

Finally the costs in the A₁ pool is evenly assigned to the activity cost pool in A₄ for the activity energy, but it is important to keep in mind that there is several different energy activity cost pools, one for each litra type. The various energy activity pools are allocated their share of the costs from the energy office based on an assumption of how the employees spend their time on the various types of energy for the various litra types, and from these activity cost pools, the cost is allocated on to the various cost objects. As can be seen from the figure below the energy activity is not only allocated to train routes but also allocated to cost objects such as the train museum, for the energy for the various of the cost objects in the category B since DSB sells some of their electricity used to drive trains on to other train operators such as ARRIVA. This final allocation from the activity cost pools to the cost object is done based on the driver litra km as explained in the last chapter.

The below equation from DSB shows mathematically how the entirety of the cost data included in the ABC model is treated throughout the model, with all costs being a part of the allocation in the R₁ phase, and direct costs and special costs being left out of the R₂ phase. Direct costs are then allocated into the activities in the A₁ stage and special costs are allocated into the activities in the A₄ stage.

Figure 6:

$$\sum_{\substack{P_1 = P_2 = P_1 \\ P_1 = P_2 \\ Enkeltposter}} \sum_{\substack{P_1 = P_2 \\ P_2 = P_2 \\ P_2 = P_1 \\ P_2 = P_2 \\ P_1 = P_2 \\ P_2 = P_2 \\ P_1 = P_2 \\ P_2 = P_1 \\ P_2 = P_2 \\ P_1 = P_2 \\ P_2 = P_2 \\ P_1 = P_2 \\ P_2 = P_2$$

Source: Internal power-point presentation from DSB's cost model design department.

9.5 DSB and Time-Driven ABC

As can be seen from the explanation of the model, DSB utilizes the original form of the ABC model, which means that they have not chosen to use the time-driven model of the cost allocation system. When asked about this Michael Oxager comments that "it would require too much effort to obtain and update the various time measures for a company of this size, it does simply not fit our model". While time-driven ABC according to the theory might be more accurate than the original model, it is always a trade-off between the accuracy of the model and the amount of resources that the company wishes to spend on the it, and in this case DSB has chosen to go with the original model, since their existing systems were able to support it, and adopting the time-driven model would require radical new systems.

With the entirety of the model having been explained now, it is time to look at some of the problems which the model is facing. From the above discussions of the model it is clear that parallels can be drawn between the various types of errors discussed earlier in chapter 7 and the issues and tradeoffs that the designers of DSB's ABC model have had to make. In the following chapter the different types of problems that are present in the model will be analyzed as well as a couple of other issues that the designers of the model have commented on.

10. Errors and trade-offs in the DSB ABC model

As earlier discussed the theory states three different forms of errors than can arise in an ABC system: Specification errors, aggregation errors and measurement errors (Datar, S. & Gupta, M. (1994) page 568), and these errors can arise in different stages of the ABC model. In the ABC model designed by DSB, all of these three types of errors can be found, or said in a different way, several scenarios can be identified where it is evident that the designers of the model have been forced to make trade-offs that allow for these errors to exist.

10.1 Specification errors in the model

The most evident case of this, as was also briefly mentioned when the model was being analyzed, is the case of how the local decentralized support function and the centralized corporate support functions costs are being allocated to the different production units in the stage between the R₁ and the R₂ cost pools. The choice of the designers of the model here has been to allocate the overhead costs generated by these support functions to the production units based on the number of full time employees employed at the individual productions units. In the earlier theory chapters it was discussed how allocation drivers need to change from the volume based drivers that was often used by the traditional cost systems, to more refined drivers, if the ABC model was to bring about a better cost allocation. To exemplify how the full time employee driver is a less precise driver, it is necessary to look at the various types of costs that put into these categories. The corporate overhead cost pool contains cost from for example the HR department, the corporate procurement department, the corporate economy department or the accounting department. The degree of how correct it is to use a full time employee driver for the various departments varies with how significant the amount of people employed at a unit is for the service that the departments deliver to the unit.

The HR department for example could is an example of how the full time employee driver could be said to be a good fit, since the services that the department has to deliver to the production units is highly correlated with the amount of people employed at a unit. Actions such as recruiting, processing payroll, registering vacation time and sickness & absences are all services that are performed for each individual employee, which allows the costs that these actions generates to be allocated relatively precisely based on the full time employee driver. However, on the other hand the driver might not be the perfect driver, since some production units have groups of employees that use HR resource more than other personnel groups, which can be due to the their frequency of retention, or if processing their pay is more labor intense due to the need to register over time and so on manually.

If we on the other hand look at a the economy department, using employees as a driver quickly becomes more dubious, since the tasks that this department performs are far less dependent on the number of employees that work in the production units. The corporate economy department performs actions such as corporate controlling, assisting decentralized units with the periodical and annual budgeting processes, creating quarterly and annual reports and consolidation of the corporations economy. The services that this department actually delivers to specific production unit is most likely impossible to identify since the product it delivers is so intangible that it would be hard to find an accurate driver. But it can be assumed that the time and resource consumed to assist a unit where 50 employees work and a unit where 100 employees work, are not significantly different since the budgeting process or the controlling process remains the same. But since it is hard to find other drivers that could more accurately allocate these costs, the full time employee driver could be said to be the best alternative.

Finally we look at how the full time employee driver is also being used to allocate costs generate by the central procurement department. Again it can be conclude to an inaccurate driver to use for this kind of department, since it is not necessarily certain that the procurement department would be using more of their resource on a production unit simply because that production unit has more a higher number of employees. If we assume that the procurement departments cost rise with factors such as the number of purchases and specifically the number of unique or first time purchases, since these purchases would require additional research into getting the correct supplier, it becomes less likely that full time employees is the correct driver to use. DSB might have maintenance units with relatively few employees that conduct a higher number of purchases and unique purchases, compared to production units such as the locomotive conductors whose unit would rarely make purchases except perhaps for uniforms which is not exactly a unique or first time purchase. What can be concluded from this is that a department such as central procurement might be better suited with another driver than the full time employee driver that the model is using at the moment, and it might be possible to allocate the costs better with a driver that measures the amount of purchases performed by the individual production units. As we can see from the above analysis the driver that DSB use to initially allocate their overhead costs in stage between the two resource cost pools, can be said to be inaccurate for some of the costs that it has to allocate and more accurate for other types of costs. The chief of the department in charge of creating the ABC model, Mikael Oxager has also said that this driver is used "in lack of a better driver" (Quote from an interview), since it is not cost effective to specify individual drivers for these types of overhead costs.

Generally the DSB model is less precise with their cost drivers in the first stage of their model, since the model besides this allocation based on full time employees, mostly evenly allocates its costs onwards through the model till they reach the activity cost pool stage A₁. From here on they allocate to the final cost activity cost pools based on systematic measures, such as the LTD system, or in very few cases statements from the employees who work at the various functions on how they spend their time on various activities. In the allocation from the activity cost pools in stage A₄ to the cost objects that DSB also utilize are much more refined and highly specified for the individual activity pools such as the case of the LTD system for locomotive drivers or the Litra km for the energy activity.

But as stated in chapter 7.3, E. Labro & M. Vanhoucke (2007) concluded that it is far more important to focus on utilizing correct drivers in the second stage of the ABC system, meaning between the activity cost pools and the cost objects. This means that the fact that DSB utilize cost drivers with higher precision in their allocation of costs from activities to cost objects can have a reducing effects on the errors that arise from the fact that they use less precise drivers earlier in the model. It is therefore a correct decision by DSB to spend less resources on having accurate drivers in the first stage and instead focus the efforts on the second stage.
10.2 Aggregation errors in the model

The level of aggregation in DSB's model is overall low, with especially the stage between the A₄ activity pools and the cost objects being very detailed. The detail in this levels shows itself through the multiple different pools for the same activities across different litra types and organizational units. Besides the level of detail in this part of the model, the overall model is also highly detailed in its depth, since it has several stages of cost pools within the traditional resource and activity stages.

If there is one place in the model where the issue of aggregation errors can be discussed, it would be the same case as was just discussed in chapter 10.1 regarding specification errors, the corporate and local overhead cost pools in the $R_1 \rightarrow R_2$ stage.

As stated earlier in chapter 7 aggregation errors stem from the fact that a model aggregates actions into a single activity causing them to share a driver, when the actions in fact cannot be explained by a common driver. In these pools, different actions were collected, and as was discussed, these actions were a poor match for sharing the same driver. While the specification error is no doubt the result, the cause of this specification error is the aggregation of the actions, therefore an aggregation error as well.

As can be seen from this, the lines between these two kinds of errors, quickly become blurry, which will always be the case in an ABC model due to their natural connection. As was also discussed regarding specification errors, the choice of having an aggregated pool for local and corporate overhead costs, is an accepted trade off made by the designers, since they deem it difficult to choose correct drivers for many of the actions aggregated in the overhead cost pools. As was discussed in chapter 7.1 regarding synergy effects, a company should be aware to adapt a level of aggregation that matches the level of specification that they chose for their drivers, and since the designers of DSB deemed it difficult to come up with specific drivers, it is also the correct choice to further aggregate the cost pools into a more general pool that can then be assigned a general driver. But the

fact that this choice is "correct" under the given circumstances, does not hide the fact that it will still result in a less precise cost allocation.

If we return the focus to the A₄ stage, it is interesting to note that prior to the current ABC model, DSB used a different ABC model that was far greater in its scope, with the lead designer Mikael Oxager stating that the current model is only "1/10th of the size that the old model was". However what is interesting to note is that he also states that "taking the statistical uncertainty into consideration, the new models allocation of costs is as accurate as the old less aggregated model". The question therefore is if DSB earlier increased the aggregation of their system, without this resulting in any notable effects on their cost allocation, could DSB further aggregate their ABC model and thus reduce its complexity and its cost. This is a question that is hard to give any definite answers to, but should be considered since they have done so in the past, and the fact that their activity cost pools are as detailed as they are could mean that too many resources are being used to support a too large model with too specific drivers, compared to what is necessary, resulting in an overly expensive model.

10.3 Measurement errors in the model

The above discussion regarding the depth of detail in the activity cost pools in the ABC model gives for another discussion regarding the possibility of existing measurement errors in the model. Given the fact that it is not possible to use actual numbers from the model, this is a hypothetical discussion, but as was discussed in chapter 7.1, aggregation errors and measurement errors can often share an offsetting effect, where a highly detailed system with many different cost pools, and therefore many different drivers, can result in the system not being able to collect sufficiently precise data, needed to utilize the pools and drivers correctly. This is an issue that the designers of DSB's ABC model need to be very aware about.

Besides this possible cause of measurement errors in the activity drivers concerning stage A₄, Mikael Oxager points out another actual cause of measurement errors, which is the inaccuracy of

production data entering the system from the SAP system, which is responsible for measurement errors in the activity drivers seen on figure 3 earlier in the thesis, since these production data are used as the basis for many of the drivers that are used to allocate the costs to the final cost objects. The issue regarding these production data, stems from the fact that most cost data are registered centrally in the accounting department, and treated with a strong bookkeeping culture and discipline, meaning that the model can trust that when an accounting period is over, these data are closed for further changes, and the model can then utilize them. When it comes to production data such as stocks in various stores or other items that are registered and kept track of closer to the actual production, it is no longer done with the same tradition and training in bookkeeping and the personnel do not have the same form of discipline. The issue at hand is the fact that these production data were not originally meant to be used by a refined cost allocation system such as ABC, and therefore the personnel that manages this data do not have the mindset that is necessary to collect the data. Concrete examples of this lacking discipline is the fact that not a 100 % of the production data is being registered since the culture surrounding this is more relaxed and if the data is found to be incorrect, the data is corrected in retrospect, meaning that they change the historic data which can suddenly change the base for the model going several month back. This is of course a huge area of contention, since a model is no more precise than the data it relies upon.

As was noted earlier in the description of DSB's ABC model, DSB generally has a very detailed ERP system that feed data to the model. However, due to the fact that these data are put in manually this also becomes an area where measurement errors can arise, specifically mentioned by Mikael Oxager. If the data coming into the system is categorized incorrectly for example a wrong cost type or the controllers forget to register a certain value that might change the resource pool that the cost type is put into. The discipline in this registration varies greatly across the organization, and therefore allows for the occurrence of measurement errors.

Following this same train of thought, DSB's ABC model face a similar threat regarding its data foundation, since the model is tasked with reflecting the use of cost in an organization that is ever changing. Mikael Oxager states how when the subdivision train readying shifts from the organization division Operations to the subsidiary DSB maintenance, it can take up to six months before all relevant data has been changed in order for the cost data to be allocated to the correct resource pools. This means has the same effect as the production data issue above, since it means that the ABC model could potential be based on inaccurate data, due to organizational changes. This also means that in the case that DSB would like to use the data for strategic purposes for specific organizational units, the model might be weaker during periods of changes in the organization, and ultimately not fully trust worthy.

The three above cases of measurement errors in the resource cost pool stage and the activity drivers are examples of errors that arise due to the fact that the organization that the model is trying to depict, has in some ways not adapted their procedures to support the model itself. This is a fundamental issue that can only be fixed by stressing the importance of this model, which is a stance that needs to be taken by central decision makers in the organization.

The previous discussions regarding the errors in DSB's model has demonstrated how the errors that are stated as a pitfall for the ABC model in the theory, actually occur when an ABC model is utilized in a practical setting. What has also been evident is that some errors solely occur because of design decisions, and how these errors can more be seen as design trade-offs than actual errors, since the choice between errors and accuracy of the model, and thereby the choice of cost of the model, will always exist. These types of errors should therefore not always be seen as a flaws of the model but as necessary evils, and the company should, as earlier stated in chapter 7.6, seek to be aware of these errors, so that the choice between errors and the cost of the model can be made continently. These trade-offs will always exist in a cost allocation model, and if companies are not aware of this, they might think that their cost model is flawless, which is the real danger. In the previous discussion it is shown how DSB is actually aware that these tradeoffs need to be made, and that no cost allocation model can be perfect. Mikael Oxager has stated that the model "does not give DSB the truth, truth is not the goal when it comes cost allocation, the model however gives a more accurate picture than DSB could achieve otherwise".

Having discussed the model and the errors that errors that threaten the accuracy of the model, this thesis will now shift its focus to look at the various ways that DSB is utilizing the information that the model is delivering and what goals they have for the use of the model in the future.

11. DSB's utilization of the model's information

As was mentioned at the beginning of the chapter discussing DSB, the company's original motivation for adapting the model was to be able to document the use of public compensation for operating train routes under their traffic contract with the department of transportation. However, since then the model has been redesigned into a new model that also has a focus on providing the company with information that can improve the control that DSB has over their costs, and thereby improve their business model. This is especially needed due to the increased pressure that DSB is under to perform well as an independent company, and faced with the threat of having its routes offered to other train operators, it is more necessary than ever for DSB to improve their competitiveness.

Currently one of the ways that DSB is utilizing the strategic benefits of the ABC model is how the model can be used to look at the use that the various cost objects have of cost of varying variability and reversibility. As was mentioned in the chapter 9 regarding the data that enters the model, each piece of cost is attached information that can be used to deduce its variability and especially regarding how long it would take to become reversible. This is important information since as was stated in chapter 6, the theory states that it is highly important for a company to be aware of how it can reduce its costs over time, which depends highly on the way that the costs vary over time. As was stated in chapter 8.2 regarding DSB's cost profile, the company has a high amount of capacity costs due to the nature of their business, and it is therefore important to have a grasp of how they can

change their costs over time, if they either see an increase or a decrease in the demand for their product.

In, for example, the case that DSB would need to stop operating on a route due to various factors, the ABC model can deliver information regarding which costs that should stop occurring when the route has been shut down, and which costs will keep coming unless action is taken. Furthermore the model is able to identify how large a portion of the capacity costs can be cut such as personnel and train units, and the model can identify how long time it will take for the company to be able to cut these cuts. For a company such as DSB this is incredibly valuable information.

Besides this use, the model is also the only way that DSB can get actual key performance indicators regarding the routes which they have deemed as their actual products. The information that is gained both regarding the cost objects, but also regarding the cost of various activities can provide crucial information as was discussed earlier in chapter 6 regarding strategic decisions such as pricing, customer profitability and product mix. Furthermore the information is also able to be used to internally benchmark various activities across organizational units since the activities have been divided into separate activities for the individual organizational units. An example of how DSB can use the information for such decisions, is how they use the model's information to calculate bids that they have to make regarding new routes that might be open to other train operators competition. Using the information that the ABC model delivers, DSB is able to calculate a competitive offer with greater accuracy, than they would otherwise be able to.

Furthermore DSB has used the information that they gained from the model for external benchmarking as well, by using benchmarking agencies who take the information that they obtain from the model and compare it to other train operators around the world. This way DSB can obtain crucial information regarding how well they are performing their processes and their competitiveness. The various ways of using the information obtained from the ABC model that DSB is currently utilizing can be seen from the figure below, with the upper left quadrant containing the internal current uses, and the upper right quadrant containing the external uses.

	Interne styringsbehov	Eksterne styringsbehov
Adresserede	 f Nøgletal på aktiviteter f Nøgletal på strækninger f Kapacitetspriser f Falde bort analyser (variabilitet og reversibilitet) f Benchmarking f Input til tilbudsgivning 	 f Hovedregnskab (Statsstøtte) f Strækningsregnskab (Forvaltning)
Mulige	 f Simuleringer (what if analyse) f Prognosticering f Marginalregnskaber f Kapacitetsudnyttelse 	

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Source: Internal power-point presentation from DSB's cost model design department.

As can be seen from the lower left quadrant, DSB are hopeing to be able to utilize the model in future ways for strategically purposes. Mikael Oxager would emphasis the wish to be able to move the model towards ABP or Activity Based Planning. This would entail using the model to produce prognoses for the immediate future of the company, and be able to run simulations that would provide the company with insights into what would happen if the company took specific courses, such as closed a route or if they wanted to change the amount of train cars used on a specific route. Furthermore the designers of the model would like to be able to strengthen the company's grasp of their capacity even further, so that they would at all times be aware of how much spare capacity there is available. This could be important in order to separate the cost of the spare capacity from the current use of the capacity, so the current cost objects are not wrongfully assigned the cost for spare capacity, making them more expensive than they actually are.

The above discussion gives a good picture of how DSB utilize the information that the ABC system delivers, both for internal strategic purposes very much like the theory suggest, but also to fulfill external demands, which is an untraditional way to utilize the ABC model. Furthermore it is evident that the designers of the model have several further uses for the model envisioned for the future. Regarding this Mikael Oxager states that "the output of an ABC model should be used to find focus points that you can wonder about", which captures the fact that an ABC model often times can make the company realize information regarding their business that they would have noticed if they were utilizing a traditional cost allocation model.

As shown in this chapter, the strategic uses that is advocated by the theory is very much able to be used in a practical setting, and the information is even able to be used for uses that was not originally envisioned by Kaplan and Cooper, such as the way DSB use it to document the allocation of their compensation. Early on in chapter 8.2 it was pointed out that DSB was a company that fit the profile well for adapting an ABC model due to their large portion of indirect costs. As this has turned out to be correct, it is shows especially when it comes to these strategic uses, since DSB would be unlikely to be able to obtain this kind of information if they merely used a traditional allocation system.

A point to note regarding the strategic use of information, is that the larger and more complex the system becomes the harder it becomes to correctly explain to the people who are supposed to use the information. As Mikael Oxager remarks, if people do not understand the system, they are much less likely to accept the information and use it, since people will dismiss it as theoretical allocations. This "selling" of the system to the internal users pose a great problem for an ABC system, since designers generally would seek to great a precise system, which leads to it becoming more complex. But as this same complexity dismisses the company from using it, it becomes obvious that designers

of a system must be careful to great the optimal system that is balanced between complexity and errors.

12. Source criticism

Having conducted the various analysis' and discussions that were planned, the thesis will now seek to look at its sources and its method through a critic lens before moving on to the conclusion.

The early model describing theory discussed in this paper is built on articles written by Robert S. Kaplan, Robin Cooper and S. R. Anderson, and therefore one should be careful to note that these are the inventors of the ABC and the TD-ABC model, which means that they are bound to have a positive outlook on the model.

To counter this issue the thesis sought to incorporate a discussion of the errors of the model, based on other authors, and the approach of the thesis has through the paper been to have a critical approach towards the scope of the benefits that ABC contributes to a company compared to the resources that it consumes and the system requirements that it demands.

The analysis of the ABC model employed by DSB is written based on interviews with Mikael Oxager, who himself is chief of the department in charge of creating the model. While this does ensure a good source of information regarding the model, it is also a weakness since it is reasonable to believe that he would have a positive outlook on the model that he has himself created. The thesis has sought to get statements from the auditors that utilize the model for the external uses, such as the use of public compensation, but it has not been possible to obtain this. Recently however, the information that this model delivers has been used for management reports to the board of directors of DSB, so this does in some way validate the model, and proves that it is not only the creators of the model that believes it to be accurate.

Based on this, I find that the sources used for the analysis of the DSB model is sufficient, as long as it is kept in mind that the main source might be biased towards supporting the model.

13. Conclusion

This thesis has focused on the ABC model as the answer to the problems that companies experience with their cost allocation of indirect costs, and especially on the trade-off that exists between the precision of the model and the amount of resources that the model consumes. As it is clear that any company operates with a limited amount of resources it is clear that a company must design a model that presents a compromise between these two factors.

The initial analysis of the model shows just how the ABC model works through its use of activities and a two-step allocation process by collecting the indirect costs of a company in resource cost pools and allocating the costs from these to the activity cost pools based on the activities use of the various resources. From here on the activities are allocated to the cost objects based on how the various objects use these activities.

As is evident from the analysis of the DSB model, its design is based on the theoretical framework, however the company has made several adjustments to the model in order to design a model that is better equipped to deal with the unique situation their company is in.

The model is built from the idea that it needs to show the full allocation of not only indirect costs but also direct costs and the revenue of DSB, due to the models dual nature, of both being used for external reporting and internal analysis. This full cost model approach leads an untraditional design, which shows in the way that the model is structured with several layers within both the resource and the activity cost pool stage. While the theory suggests a dual allocation model, the DSB model allocates its various costs over up to as many as six times, which however is used rarely. This thesis has shown examples of cost objects receiving costs that have been through a triple allocation model, with various indirect production costs first being allocated their share of overhead costs, then allocating these combined indirect costs to the various activities that they support and finally allocating the activity costs to the various cost objects. As was discussed in chapter 7 regarding errors in an ABC model, a system becomes vulnerable to various errors, both if it is overly simplified, and if it is overly complex. The size of the ABC model employed by DSB, opens up for a scenario where both of these cases might be present.

On the one hand, the allocations that takes place between the local and corporate overhead pools to the indirect production costs are simplified to a point where it is the case of an aggregation error from a theoretical point of view. This is however a deliberate choice, since it is not possible to measure the precise use that the various production units have of different overhead costs. This is therefore a classic tradeoff where a company is choosing an aggregation error, instead of creating a system with a higher level of detail that results in overly specific drivers, that they have no way of measuring.

On the other hand, the allocation of costs that takes place in the later stage of the model, between the final activity cost pools and the cost objects are very precise and constitutes of a large group of highly specific activities each created separately for various types of trains and various organizational units, in order to achieve a high degree of accuracy. This design creates a highly complex model in order to avoid aggregation and specification errors, in order to achieve the goal of highly detailed knowledge concerning DSB's cost objects, the various train routes that DSB operates on. While it has not been observed in this thesis, the theory states that models with the level of detail found in the later stages of the DSB model, are prone to suffer from measurement errors dues to the extremely specific nature of the activity cost pools and their drivers. This is therefore an issue that the designers of the model should be most aware of.

The thesis also found that the model might suffer from measurement errors in the very early stages of the model, since the data that is loaded into the model might be burdened by the fact that it is reflecting an organization that is changing too fast for it to keep up with. Furthermore some of the production data that is loaded into the model also suffers from the fact that the production personnel are changing the data as they see fit from a practical point of view, which however conflicts the data's function as a source for the ABC model.

While these measurement errors do exist, the overall quality of the data in the source ERP system, is of such a level of detail that it allows DSB to create its later stages with detailed activities individually for separate types of trains and organization units. The fact that most of the errors takes place in the early stages of the model, is redeeming for the system, since the theoretical analysis found that errors early in such ABC systems can be corrected, and their effects dampened, by more complex and precise allocations later on, as is the case in DSB's model. The overall assessment of the model is therefore that the designers are very well aware of the choices that they have to make in order to balance the size and complexity of the system against the errors that can arise.

As stated earlier, DSB's original reason for adapting the ABC model was to be able to document how the public compensation they receive from the Danish state was allocated, since it cannot be used to support business that is not awarded to DSB under the traffic contract with the department of transportation. However, the model has evolved from dealing with this purely external demand for control, into a device also used for internal reporting and strategic decision making.

The model offers a unique perspective for DSB, since the model focuses on the train routes as the main cost objects, making it possible for DSB to receive key performance indicators concerning the costs and revenues of the various routes. Besides this, the various activities established by the model are also able to be analyzed, giving DSB an insight into how their organizational resource create capacity for their core business. Without the ABC model DSB would not be able to obtain measures regarding cost of operating various types of train on various train routes, especially not information that is as detailed as what the ABC model offers.

The information that DSB receives is currently used in a number of ways to guide internal strategic decision making, for example to provide DSB with insight into their capacity costs, and using this they are able to perform various forms of analysis regarding what consequences it would have to add or

remove certain train routes from their business. Furthermore the information obtained is ideal for benchmarking against similar companies in order to continuously improve their business and live up to their goal of becoming one of the leading train operators in Europe.

In the near future, the designers of the model have an ambition for the internal use of the model, to be able to utilize it for Activity Based Planning, which includes running simulations based on its data, using it for prognostication and better control with the degree of utilization of capacity in DSB.

14. Suggestions for further research

The results of the thesis open up for a couple of interesting questions that has not be answered in this thesis. As stated, DSB faced a problem with errors in the data used for the model, both from production personnel who lacked the discipline and mindset to properly supply data to the model, and the speed with which DSB organizational structure changes, also poses a problem for the model. These issues are unique from what this thesis has otherwise focused on, since they pose human issues that a model cannot simply solve through its design. The issue of conforming personnel and organizational structural changes to work in accordance with a cost model is therefore interesting since it poses a different challenge to the designers of a model.

In line with the idea of investigating human problems regarding such a model, it could be interesting to see how DSB would guard its model against manipulation in the future, if the ambition of the model is fulfilled, and is used more extensively for internal control purposes. Control systems and measures are always prone to employees attempting to game the systems, and an ABC system is different. An even more interesting notion is the possibility that the designers themselves might manipulate the system, in order to achieve an agenda. This brings up the classic question "Who watches the watchmen?" or "Who will guard the guards themselves?". Scenarios might arise where the designers could be pressured to skewer the system in order to make it reflect a specific result, for example to the board of directors or to the external auditors in the case of the public compensation that DSB receives. In these cases, how can one be sure of the results produced by the model, since it is designed and maintained by DSB itself?

As a last point of interest, it would be interesting to see if DSB could draw benefit from switching from the classic ABC model to the newer TD-ABC model. As stated in the theoretical chapters of the thesis, the TD-ABC model is supposed to be better in a number of ways, however DSB has chosen not to adapt it due to limitations of the current systems and processes that support their ABC model. Could these limitations be overcome, or could it be worth the investment to implement new systems that could support a TD-ABC model at DSB.

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Mikael Oxager - Head of the Office of Financial Control Modulation at DSB