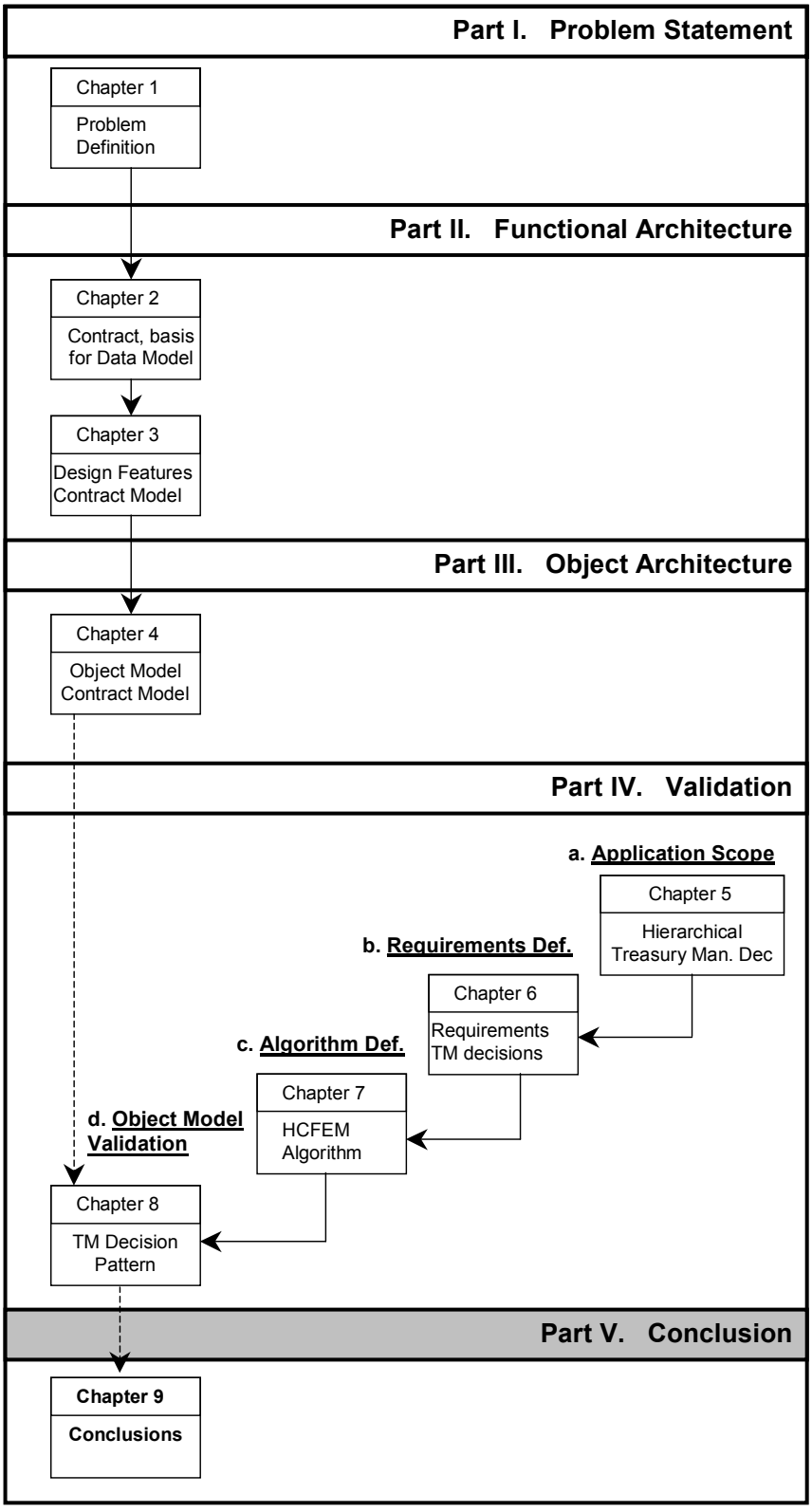
Part V: Conclusions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9. Conclusions

9.1 Introduction

In part five, the conclusions of the research presented in this dissertation will be drawn. First, Section 9.2 will briefly revisit the goals of this research. Next, Section 9.3 presents a reflection on the research method used. Afterwards, in Section 9.4, the research results are discussed and some recommendations for future research are made. The final conclusions are in Section 9.5.

9.2 Research Goals

The goal of this study was to define a better data model, allowing for its implementation in large ERP systems. This data model should be able to hold *ex ante* and *ex post* data to support existing, new and changing information needs for internal and external information users. Additional research into accounting data models was carried out because the research results of the most prominent research initiatives in this field (i.e. McCarthy's (1982) REA model and Riebel's data recording principles, based on 'Grundrechnung' (1984)) have not been adopted in practice. This problem was drawn from a literature analysis and was afterwards illustrated with a sample ERP system. The same literature base indicated that the problem of limited data availability to support existing and new information needs is still valid in today's information systems, thus justifying additional research in this area. There are two main approaches to supporting additional information needs. The solution either focuses on defining new algorithms and database modifications should insufficient data be available, or the solution is oriented towards defining a data model not designed for a particular application scope. This type of data model is defined around aspects of reality rather than specific application artefacts and therefore allows the support of a large range of existing and new applications within a broad scope. In this research, a new data model was proposed according to the latter approach to answer the question, '*Is there a better way to define and organize accounting data suitable for implementation and deployment in ERP systems which holds more complete* ex ante *and* ex post *data to support existing and new internal and external information needs?'*

9.3 Research method and design revisited

The overall research question was approached as follows. A design-oriented research methodology was applied to define a better accounting data model. This accounting data model should be capable of holding data on existing, new and changing information needs from internal and external information users. It should also be possible to use this data model as the data source of a large ERP system. McCarthy (1979) argues that accounting data models that need to hold reusable data have to be designed based upon aspects of reality. The important first step of this research therefore consisted of finding the aspect of reality relevant in business process instance data. Two aspects needed to be discerned here. On one hand, it was important to understand the recurring pattern in the scope of data to be recorded in the data model. On the other hand, the question of whether the aspect of reality found in the different types of business process instance data was useful as a foundation to design a data

model (following the recommendation of McCarthy) had to be answered. These two aspects are discussed next.

There are various possible ways to find the recurring pattern in business process instance data. As discussed in Section 2.4 of Chapter 2, the recurring pattern in the data of business process instances, currently serviced by double-entry bookkeeping data, was investigated here. According to the literature (McCarthy, 1979), double-entry bookkeeping is still the most frequently used data model to date, having survived for centuries. This approach therefore delivered a representative set of business process types, whose data is representative as required data for internal and external decision-making. The recurring pattern in business process instance data was found to be the recorded agreement on exchange of goods and services (in interactions between the organization and its environment) or value-adding activities (in interactions internally within the organization). A recorded agreement was described as a 'contract'. The activity of defining data as stored agreements was termed 'contract-based accounting'.

The other aspect is the question of the usefulness of the 'contract' as the aspect of reality used to design the accounting data model. This question was investigated in Sections 2.5 and 2.6 of Chapter 2. The answer to this question relates to the question of whether the 'contract' is sufficiently generic to build a data model that can hold reusable data. To answer this question, several aspects were explored. Only the most important are repeated here. The incidence, location and scope of the contracts relevant to the data model were determined. It was found that the data on business process instances to be recorded in the data model could be defined as all the data where the organization was one of the contracting parties. Another aspect investigated related to the question of whether the information on internal contracts could be recorded in the same way as information on external contracts. It was found that this was indeed the case. These findings lead to the assertion that the contract was a useful aspect of reality as the central design pattern for the new accounting data model.

Once the 'contract' was recognized as the recurring pattern in business process instance data also suitable for designing the contract data model, the next step was to investigate which relevant data components of this pattern needed to be stored in the data model. As a requirement for the completeness of the data stored, it was a prerequisite that data should be reusable to service multiple existing and new information needs. The relevant data components were found by investigating how contracts are described in two disciplines, law and accounting. The study of law was consulted as a representative source of information because aspects such as legal enforceability, contracting parties, etc. are well described in this science. The added value of accounting lay in the fact that contracts and fulfilments express what business transaction data is stored when a business process is started (the contract clause side) and how it gets executed (the fulfilment side). The way in which contracts are used internally within the organization can be illustrated using Agency Theory. The essential data components as a set of design features were described in Chapter 3, in order to have a finite set of requirements with which the accounting data model design would have to be compliant.

The fourth and last step concerned translating the design features for the new data model into an actual accounting data model design that could be the data model of an ERP system when developed further as a software project. To achieve this goal, it was important to express the accounting data model in a commonly used modelling language: UML ('Unified Modelling Language') was used here. The new contract data model was designed in Chapter 4.

Several aspects could have been subjects for the in-depth validation of the contract data model. These were explained in Section 5.2 of Chapter 5. Of the three aspects outlined in this section (i.e. the 'development aspect', the 'implementation and deployment aspect' and 'the data completeness aspect'), the data completeness aspect was chosen as validation for this research. The application used to validate the completeness of data provision by the contract

data model was outlined as 'hierarchical treasury management decision-making based on relevant cost information'.

First, the new application had to be defined. The domain of treasury management can be split into two types of questions. First, there is the set of questions on financial resource optimization (e.g. optimization of payments, collections, savings, investments, etc.). Second, there is the question of risk optimization (e.g. currency and interest rate hedging). In this dissertation, in order to validate the completeness of the data provided by the contract data model, only the first type of question was considered. The rationale behind this choice was the type of data stored in the data model as explained in Section 5.4 of Chapter 5. The aspect of 'hierarchical decision-making' is new to the treasury management domain but well known in business logistics. It was therefore a natural choice to define the hierarchical decision-making frameworks for treasury management on the basis of hierarchical decision-making concepts in business logistics. Three different decision-making frameworks were proposed in Chapter 5, one each for central, decentral and hybrid decision-making. The decision-making framework for hybrid decision-making was considered the most complete in covering all possible situations, and was therefore proposed as the scope for the validation of the contract data model. In this dissertation, the objective was to define a new application for validating the contract data model. The target audience for this part of the research are the system architects of ERP systems who can consider a treasury management application an extension of an ERP system. This dissertation does not primarily address the audience of professional treasurers who make these decisions as a daily activity.

In a second step in the validation process, the requirements for data availability had to be defined. It was decided to support the treasury management decisions on resource optimization with relevant cost information as part of the new element of the application. This was discussed in Chapter 6. The relevant cost approach is relatively new in the domain of treasury management. Treasury management decisions are currently predominantly supported by full cost information. In this dissertation, it was not a goal in itself to be fully complete on the question of which relevant costs play a role in each of the treasury management decisions. To answer this question, specific case studies would have to be conducted to understand the aspect in more detail. In this dissertation, the goal was to define the requirements for data availability for relevant costs in treasury management in general. The contribution on relevant costs per treasury management decision was therefore limited by outlining the scope of the decision and providing a series of plausible examples on relevant costs per decision. Requirements for data availability are defined on this basis.

In the third step in the validation process, the application logic was defined with a view to investigating whether additional data requirements apply that accompany the definition of the application logic. This was discussed in Chapter 6. The decision framework was based on business logistics concepts because hierarchical decision-making was already in use in this domain. In keeping with the choice previously made to define the decision framework, an algorithm from business logistics (i.e. MRP netting) was modified to render it useful in the domain of treasury management. The function of this algorithm is to calculate the relevant cost outcome of each treasury management decision alternative in a common and generic way. The objective of the algorithm in the context of the validation of the data model was to understand whether this algorithm prescribes new data requirements.

The fourth and final step in the validation consisted of evaluating whether the data requirements initiated by supporting treasury management decisions with relevant costs (Step 2) and the data requirements accompanying the definition of the algorithm for calculating the treasury management decisions outcome (Step 3) can be fulfilled using the data stored in the contract data model. This validation was described in Chapter 8. In order to gain this insight, two treasury management decisions were investigated in detail. The outcome was that the contract data model could support the new application on hierarchical treasury management decision-making with minor modifications.

9.4 Research results and recommendations for future research

9.4.1 Reflection on the newly proposed accounting data model

The main goal of this research was to propose a new accounting data model suitable as an ERP data model. This resulted in a data model expressed as a contract pattern designed in UML. It was the objective of this data model to hold data to support multiple applications (existing or new) and to be used by internal and external information users. The actual goal was not to create a completely purpose-neutral data model, but a data model purpose-neutral within a certain application scope. This application scope is determined by the type of data needed for the application scope and not by applications in one or more chosen functional domains, as discussed in Section 2.6 of Chapter 2. The following types of data were stored within the contract data model: data on contracts within the organization, data on contracts between a natural person and an organization and data on contracts between organizations. Data on events happening in the environment where the organization is not a contracting party are not stored in the data model. Without extensively validating the completeness of the data in the contract data model, the scope of applications that can be supported by data stored in the contract data model is determined as '*all applications that uniquely require data where the organization is one of the contracting parties*'. This can lead one application domain not being fully supported by data from the contract data model where, for example, environment data is also a required data source. The example provided in this dissertation was the treasury management domain. This resulted in the assertion that the contract data model does not necessarily have to be the sole data source of a business information system. This data model can be supported by one or more additional data sources that hold a different type of data (e.g. data on the environment). In comparison with today's ERP data models, the contract data model does bring together all the data where the organization is one of the contracting parties into a single source, already an important advantage.

The proposed contract data model is a significant contribution to the body of knowledge on accounting data models in several ways. First, this research concerns a problem that still exists in today's large ERP systems. Literature analysis has pointed out that today's ERP systems do not deploy accounting data models that are the outcomes of earlier prominent research initiatives in this area ('Grundrechnung' and 'REA') because these models are characterized by significant drawbacks in practice. However, the problems that inspired the original research in this area several decades ago still exist in the data models used today (e.g. limited reusability of data, complex extendibility, etc.). Second, existing accounting data models as described in scientific literature are not described at a level where they can readily be designed as ERP data models. Often the model is presented as a basic diagram, not offering the level of detail required to translate the research results into a model useful in practice. In this dissertation a new data model was proposed where essential data components are described as data model design features and where the actual model is expressed in a modelling language commonly used to design large business information systems (i.e. UML). Third, the validation of accounting data models in scientific literature has not been carried out at the level of evaluating completeness of available data components, but is more like an illustration. As a logical consequence, the question of the suitability of the proposed model to accommodate data for large ERP systems was never considered. In this dissertation, the question of data completeness for internal and external information needs has been made very explicit. The way in which this has been done is twofold. First, the essential data components were described in considerable detail, consulting knowledge developed in multiple functional domains to achieve the envisaged level of completeness (e.g. law and accounting as described in Chapter 2). The proposed data model was then validated against a deeply elaborated application whose breadth and level of complexity was representative of the applications occurring in an ERP system and for which a data model is expected to hold data in practice.

9.4.2 Recommendations for future research in the context of the contract data model

The reflection on the research methodology (see Section 9.3) has outlined how this research was conducted and which choices were made. At several points in the research process, some topics which could be the subject of future research were skipped. They are discussed below.

1. *Validation of the development aspect ('Can the contract data model be built')*. The goal of this research was to propose a data model that could be the data source for a large ERP system. This data model has been designed on the basis of recommendations in literature (e.g. design on the basis of aspects of reality) and the practice of designing large information systems (e.g. definition of design features, expression of the model in UML). This approach is crucial in the definition of a data model that can be built as part of larger information systems. Previous scientific research initiatives have not followed this approach. However, some questions remain unanswered because the data model has not been built in the context of a large ERP system owing to constraints of time and resources. They include whether the data model can be built in the context of the larger ERP system or are some modifications required? Does the system perform sufficiently when a representative number of users concurrently queries or updates the contract data model? To answer this type of question, building a prototype solution will not necessarily lead to the envisaged results since the question addressed here is whether the contract data model can actually be the data source for a large ERP system.
2. *Validation of the implementation aspect ('Can the contract data model be deployed')*. This topic concerns the question of whether the contract data model is a real, viable solution as a data source for a representative customer situation (i.e. a large variety of different types of information users, a large number of sites, a dynamic environment where information needs change, sites are added or removed, etc.). This question was not discussed during the research project since it assumes that the contract data model has already been developed as part of an ERP system on one hand, and the ERP system based on the contract data model being installed at multiple sites of a customer and deployed by all information system users on the other. An answer to this question would be to discover whether this approach to accounting data model deployment would really solve the problem of limited data availability and extendibility, which has existed in business information systems since their inception several decades ago. While of the utmost relevance, this question is difficult to answer and consequently, building a representative prototype that simulates the anticipated complexities is possibly the best approach to gain insight into this problem area.
3. *Design of a data model to concern external data*. In this research project the scope of data provided by the contract data model was defined as data where the organization is one of the contracting parties. This was a logical choice as the recurring pattern in the data (i.e. the contract) was found within this scope and the organization can easily identify and record this type of data. However, this type of data does not necessarily correspond with the full scope of data required to support internal and external business information needs. Should environment data be required to solve the information need (e.g. treasury management risk optimization), one or more additional data sources are required to provide the necessary data. Additional research is needed to handle external data adequately. Questions in these research projects could be, what type of external data should be recorded? Is there a recurring pattern recognisable in external data, and as a consequence, is it possible to design a data model to handle all required external data? A similar problem was mentioned in Section 2.5 of Chapter 2 on recording some general ledger account data; valuation aspects such as currency or fixed asset revaluation are not expressed in the format of exchange of goods or value-added activities and can therefore not be captured in the contract data model. It would be worthwhile investigating further how this type of valuation data can co-exist with data stored in the contract data model.

These three topics could be suggestions for additional research in the context of accounting data models and provide further insight into how the contract data model can be used in practice, or how the scope of information to be provided can be extended.

9.4.3 Reflections on the application of hierarchical treasury management decision-making

The aim of the application to hierarchical treasury management decision-making focusing on financial resource optimization in this research was to obtain an application sufficiently complex to be representative, and thus to validate the completeness of the data provided by the contract data model. The treasury management decision-making domain consists of financial resource optimization and financial risk optimization. A logical choice would have been to consider the full scope of treasury management decisions in the validation. However, as explained earlier, since the sub-domain of financial risk optimization requires data that is predominantly available in the organization environment (the organization is not a contracting party) and this type of data are not stored in the contract data model, only the scope of financial resource optimization was considered in the validation. This choice does not imply that the contract data model cannot hold data to support information needs on risk optimization. Questions like how much, where and when was the amount of each financial resource exposed to risk? etc., can be supported adequately by data provided from the contract data model. The area where no data can be provided concerns questions like, what different elements is the risk composed of? What is the importance of these elements and do they change over time, or under certain circumstances? What is the magnitude of the risk over time? To answer this kind of question, another type of data is required. Further investigation of information needs on risk optimization therefore fall beyond the scope of validating whether the contract data model can hold sufficient data.

The treasury management application was chosen to validate whether or not data can be provided by the contract data model to support representative and complex applications. The question that then arises is whether this application sufficiently demonstrated the claim that the contract data model is indeed a much better data model compared to today's data model in ERP systems and the research results from research initiatives working on improved accounting data models. This claim was broken down into a number of questions that will be elaborated below. First, is the hierarchical treasury management application a representative and complex application for this validation? Second, is the omission of risk optimization from the domain of treasury management to be considered as a serious limitation of the contract data model? Third, without performing a validation for the other applications at this point, for what other applications can the contract data model hold suitable data? Each of these questions will now be discussed in detail and conclusions drawn on completion.

First, is the hierarchical treasury management decision-making with relevant costs a representative application for this validation? The following considerations can be made. The contract data model is proposed as an improved data model for ERP systems that can hold data to support existing and new applications. New applications were judged to be the most complex situation relative to existing applications because data requirements are sufficiently well known for current information needs and most accounting data models can support them in one way or another. In other words, choosing a new application was the most complex option and provides a better answer to the validation questions on data completeness. The choice of treasury management as the application domain for this validation is also the most advanced since most of the current ERP systems still do not support this application area. From this perspective, the choice was for a non-trivial and less well-known application for validation. Finally, the choice to support treasury management decision-making with relevant costs is a new application currently not supported even by dedicated treasury management applications. Choosing this application puts high and representative demands on the completeness of the data model.

Second, is the fact that risk management was beyond the scope a serious limitation to the strengths of the data model? The scope in which the contract data model could hold data was outlined quite precisely, along with the finding that this scope did not coincide with functional application domains. This is not believed to be a serious limitation for the following reasons.

Again, the objective of the contract data model is to serve as the data model for an ERP system. Data entry and maintenance comes at a high cost to organizations. There are always data frequently in use and inherent to the activities of the organization and there are data that are very uncommon, only used in a limited number of information needs by a limited number of information users, thus soon outdated, where complete data provision comes at a high price. It is obvious that the contract data model should be able to hold data for current and future information requirements that are frequently on demand. There are alternative methods for handling information needs for infrequently used data. It should be reiterated in this context that treasury management is not commonly supported in ERP systems, and in this domain risk optimization is the most infrequent information need. A full single source data model is not a goal in itself. The objective of accounting data model research is to improve the reuse of data through its definition in a single data source. However, it is believed to be acceptable for infrequently used data to be stored in a second or a third data source. The most important reason for choosing this approach over a single source data model is that the optimization of the design of the data model can avoid having to adopt too many aspects of reality in its design.

Third, for what other types of application can the accounting data model accommodate data? As explained earlier in the first question, a high criterion of complexity has been applied already in defining an application for validating the data provision capability of the contract data model. In line with expectations, the contract data model can hold data for a wide range of applications where data are required on the exchange of goods or value-adding activities. When defining the application horizon of an ERP application like finance, sales, purchasing and manufacturing, it fits expectations that data can be provided for applications in these domains provided that the required data is based on goods or value-adding activities exchange. An example of an application where limitations could occur is a sales demand forecast based on macroeconomic and demographic data, etc.

The overall assessment of the choice of hierarchical treasury management decision-making as the validation approach for this contract data model is that it can be defended in terms of being a representative and complex application. From a data model design optimization perspective it is not a serious limitation to omit risk management; there are more optimal ways to provide data for this application than through a single source data model. Finally, it is felt that a large number of other applications could be supported by the data accommodated by the contract data model, its criterion being that the type of data required should be based on exchange of goods and value-adding activities.

As the focus of the validation was to understand whether the contract data model could hold the information required, the hierarchical treasury management decision-making using relevant costs application was defined with a significant amount of detail. Although no attention was paid to the question of how successfully Treasurers will be able to deploy this decision-making approach, the level of detail this application was worked out to has resulted in a significant contribution to the body of knowledge of treasury management in at least three different ways.

First, three different decision frameworks for treasury management decision-making focusing on financial resource optimization are provided in this dissertation. Current treasury management literature is strongly focused on the investigation of one decision in isolation, without attending to the relationships that can be found between treasury management decisions in practice. The definition of the treasury management decisions framework was based on business logistics concepts, where hierarchical decision-making has already been in use for a number of decades. Bringing this concept into the treasury management domain opens up a new perspective for treasury management decision-making. Treasury management decisions are now defined in the context of each other at multiple levels of decision-making, where the outcome of decisions made at a higher level outlines the optimization potential of decisions made at a lower level.

Second, how to support treasury management decisions with relevant cost information was demonstrated. Current systems for treasury management decision-making are predominantly based on full cost information. One of the reasons why relevant cost information is possibly not used in today's treasury practice is the fact that treasury management decisions are optimized independently of each other. Following this approach, the concept of 'opportunity costs', inherent to the approach of relevant costing, cannot be defined properly if the dependency of the outcome of one decision on other decisions is not taken into consideration. Having the treasury management decisions framework, as discussed in the previous paragraph, provides all the information required (a limited set of alternatives per decision are known) to define the concept of relevant costs. In this dissertation, the aim was to illustrate how the relevant cost approach could be used to support hierarchical treasury management decision-making with a view to defining the requirements for data availability. The objective was not to describe all possible relevant costs in the domain of treasury management exhaustively and completely.

The third contribution to the body of knowledge of treasury management can be found in the Hierarchical Cash Flow Equivalent Model research result (see Chapter 7). Using this model, an algorithm was provided to optimize each of the treasury management decisions generically, taking into account possible decision alternatives, evaluated on the basis of opportunity costs per alternative. Using this model, it became possible to optimize all treasury management decisions in mutual context (i.e. dependencies between decisions were taken into consideration). This model was based on algorithms known in the business logistics domain (i.e. 'MRP Netting') that were modified to be useful in a treasury management context. The way business logistics concepts were systematically reused in the treasury management domain has introduced a new dimension to the term 'financial logistics' in this dissertation.

9.4.4 Recommendations for future research in the context of the application of hierarchical treasury management decision-making

Owing to the fact that the hierarchical treasury management decision-making application was defined in the context of validating the contract data model, a number of research questions were left out of the scope on purpose. Future research could follow the following lines.
1. Does hierarchical treasury management decision-making based on relevant costs lead to better decision-making? In this research, describing the treasury management application only on the basis of literature and references to other functional domains (business logistics in this case) was attempted. Validation based on whether this approach is indeed useful in treasury practice was not conducted. Additional research could be conducted in this area by organizing a workshop with professional treasurers or by building the proposed software application and using it in practice.
2. What is the full set of relevant costs used in the domain of treasury management? This research demonstrated how the principle of relevant costs operates in the treasury management domain. The objective was to understand the data requirements related to the relevant costs. To this extent, relevant costs per decision were only provided by means of examples. However, a full overview of the relevant costs playing a role in the treasury management domain is an important and interesting contribution to the body of knowledge of treasury management. Additional research using case studies for each decision, with generalization afterwards, could provide a more complete answer to this question.

9.5 Final conclusion

This research provides a contribution to the body of knowledge of accounting data model research. The requirement was to define an accounting data model that could be implemented in ERP systems and serve as a data source in real-life customer implementations on one hand,

and that could hold data for existing, new and changing information needs for internal and external information users on the other hand. Crucial in the design of the data model was McCarthy's (1982) recommendation that accounting data models have to be defined according to aspects of reality. This research justified choosing contracts that record the exchange of goods and value-adding activities in and between organizations as the underlying architecture of the data model.

The scope of applications for which this data model can hold data is expected to be broad but not infinite. The type of data required by the application determines the boundaries of the scope of information needs for which the contract data model can adequately hold data. Should an application require a totally different type of data compared to contract-based data, it follows expectations that limitations will be encountered in holding all the required data. The validation of the data model through an application in the treasury management domain clearly illustrated that the scope of applications for which data can be provided does not coincide with a functional domain. It is perfectly possible for some applications within a given functional scope not to be supported if they require a totally different type of data. Does this finding suggest that the choice of 'contracts' as the relevant aspect of reality to design the data model was incorrect or incomplete? No black or white answer can be offered to this question. It is not felt that an ultimate data model able to respond to 'all' types of information needs exists or should exist. Both statements need explanation. First, true purpose-neutral data models do not exist. In accounting data model research, improved data models have already been proposed for a number of decades. As a result of improved technology or data modelling techniques, the scope of possible applications for which data could be provided has expanded. However, in following the recommendation to design data models according to aspects of reality, the aspects chosen to be adopted in the data model always determine the scope of the data that can be stored. There will always be aspects of reality that are omitted because they only become relevant for adoption when a new information need suddenly requires data of a type previously considered unimportant and therefore out of scope. Second, it is contended that purpose-neutral data models should not exist. There is a rule of efficiency related to the scope of required data to be maintained in a data model. In today's IT industry, the cost of data storage is no longer determined by the cost of hardware such as hard disk capacity. Cost is more closely related to data entry and data maintenance. It is therefore of the utmost importance to chose representative aspects of reality when designing the data model very carefully. The data model should accommodate data to solve the most important scope of existing, new and changing information needs from the perspective of the organization. Let us take the example of the treasury management application into consideration, where information from the environment was required but missing when trying to solve the scope of information needs on risk optimization. Even were it possible to define this type of data in the data model, it would be a significant cost to an organization to maintain a sufficiently large volume of external data to provide reliable information, for example to support risk optimization decisions. There are specialized companies whose business consists of providing this type of data to organizations. Therefore this research will close by stating that the goal of accounting data model research should consist of increasing the reusability of data in the area where the organization or one of its employees directly contribute to the definition of the data. For other required data, it is acceptable and sometimes preferable from a cost perspective for additional data sources to be used or for the data provision problem to be outsourced to specialized organizations.