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The MetaMIS approach for the specification of management views on business processes

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**The MetaMIS Approach for
the Specification of Management Views on
Business Processes**

Roland Holten

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Summary

The specification of management views on business processes is a main development task in the requirements specification of reporting systems for the management. Today the information warehouse is the accepted IT architecture for this purpose. The paper summarises the state of the research on the so called MetaMIS Approach. The methodological background is discussed and the modelling language comprising the conceptual and the representational language aspects is specified. Guidance rules complete the MetaMIS Modelling Technique. Examples show how the modelling technique works in enterprise environments. Some remarks on problem solving techniques as part of the MetaMIS Modelling Method are given. The appendix gives a detailed overview over the required linguistic operations for the construction of the modelling language.

1 Introduction

Following the ARIS (Architecture of Integrated Information Systems)¹ approach for the development of information systems the development process is structured by three phases, which are called *requirements definition*, *design* (or programming in the large) and *implementation*. These phases are characterized by their proximity to information technology. Every phase is defined by means of a specific class of development decisions characterizing the system under consideration. The phases depend logically upon each other. The development process has to start with the *requirements definition* specifying “what” the system under consideration should do within its domain.² This phase has to define the domain specific requirements in a language providing domain specific concepts. The *design* or programming in the large phase is the second development phase.³ It has to specify the system’s components and the resulting system’s architecture. Typically decisions concerning the logical database model⁴ and the user interface⁵ are made in this phase. The architecture of the system describes every component, the functions it provides and its relationships to other components. The definition of component interfaces and the separation of a component’s definition and its realization are core principles of this phase. The *implementation* phase is next. It deals with the realization of the previously defined components. Tasks in the implementation phase comprise coding, development of algorithms and data structures as well as documentation.

Of course the three phases are integrated in an evolutionary development process with jumps back to (logically) previous phases if necessary.⁶ Additionally, there could be a phase like maintenance. But since the phases are structured logically here and following NAGL⁷ maintenance can be seen as another loop of the development process itself, and thus, another instantiation of the phases mentioned so far.

This paper deals with the conceptual specification of management views relevant e.g. for the development of information warehouse systems or other information systems providing information for the management. The term *information warehouse* is used here to describe a layer oriented architecture storing materialized views on business processes in support of management’s information requirements⁸. A data warehouse is located on a central layer of an idealized layer oriented architecture connecting online

¹ cf. Scheer (1999); Scheer (2000); Scheer (1998).

² cf. e.g. Pohl (1996); McMenamin, Palmer (1984); Davis (1990); IEEE (1984).

³ cf. e.g. Boehm (1981); Davis et al. (1988); Weske et al. (1999).

⁴ cf. Codd (1990); Date (1990); Embley (1998); Gupta, Horowitz (1991).

⁵ cf. Balzert (1996).

⁶ cf. Boehm (1981).

⁷ cf. Nagl (1990).

⁸ cf. Inmon (1996); Inmon, Hackathorn (1994); Inmon et al. (1997).

transaction processing (OLTP) systems to components enabling online analytical processing (OLAP)⁹. The latter components are intended to support navigations adequate for management users through so called multi dimensional information spaces. OLTP systems directly support the business processes and are the sources of data used by OLAP systems. Typically they are connected to the data warehouse by means of tools performing so called extraction, transformation and loading tasks (ETL)¹⁰.

The approach presented in this paper is the result of a research work discussed in a set of papers.¹¹ This paper is intended to document the state of the *MetaMIS Approach* reached so far in an integrated and consolidated manner with focus on the *MetaMIS Modelling Technique* for the specification of management views on business processes. Additionally the *MetaMIS Method* with its sub phases for the specification of management views on business processes is discussed.¹² Section 2 summarises the methodological background of the paper. Section 3 presents the consolidated state of the MetaMIS Modelling Technique with focus on the representation formalism. Section 4 embeds the modelling technique into the methodical steps of the MetaMIS Method, gives some concluding remarks and an outlook.

⁹ cf. Becker, Holten (1998); Chaudhuri, Dayal (1997).

¹⁰ cf. Inmon (1996); Widom (1995).

¹¹ cf. Holten (1999 a-c); Holten, Knackstedt (1999 a-b); Holten (2000 a-b); Holten (2001 a-b).

¹² cf. Knackstedt et al. (2001) ; Böhnlein et al. (2001).

2 Methodological Background of the MetaMIS Approach

This section summarises the methodological understanding the MetaMIS Approach is based on. Especially the understanding of the terms language, conceptual language aspect, representational language aspect, guidance, (modelling) technique and method are presented in short.¹³

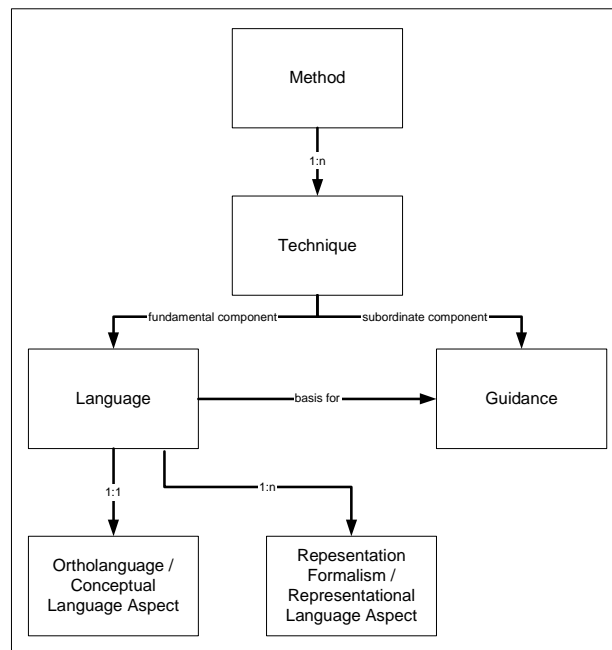
A (modelling) *technique* is an operational approach of constructing models. It comprises a *language* and *guidance* concerning the use of the language.¹⁴ The language provides terms and concepts to formulate the model and representation formalisms to present the model. The concepts as a whole define the *conceptual language aspect*, the representation formalisms define the *representational language aspect* (Figure 1). The conceptual language aspect defines the meaning of the terms and their relationships in the sense of an ortho language. The representational aspect assigns representation formalisms to the terms of the ortho language. There are many representational aspects possible for one technique but only one conceptual language aspect. The *guidance* defines *rules* for usage of the conceptual and representational language constructs while modelling. The guidance comprises four classes of rules:

1. *Syntax rules* define how elements of the representation formalism can be combined to models. These rules are defined within the representational language aspect.
2. *Semantic rules* define how identifiers (so called *predicators*) can be assigned to representational elements and the meaning of this assignment. These rules are defined by the relation of representation formalisms and terms of the conceptual language aspect.
3. *Rules of pragmatics* define what the sense of assigning identifiers to representational elements and of combining representational elements is for the person constructing or using the model. These rules are defined within the conceptual language aspect.
4. *Rules of reasonable model construction* define sequences of model construction tasks. Existence dependencies of ortho language terms and the assignment of representation formalisms to these terms limit the set of reasonable orders of as-

¹³ cf. Holten (2000b); Holten (2001 a – b); Knackstedt et al. (2001); Böhnlein et al. (2001) for deeper discussions.

¹⁴ cf. Holten (2000b), pp. 4.

signing identifiers to representation formalisms and combining elements of the representation formalism.



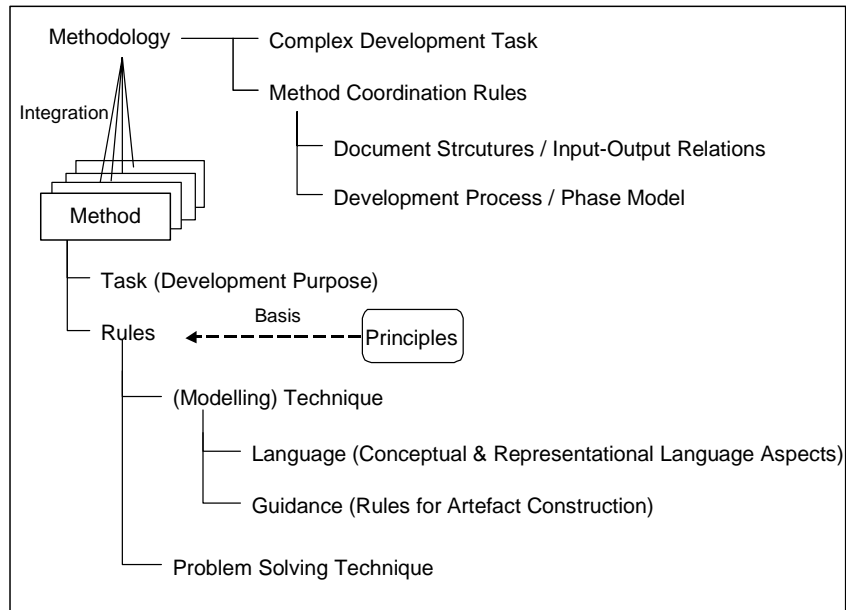
cf. Holten (2000b), p. 5

Figure 1: Modelling Technique and Components

Techniques are related to one or more *Method(s)* (Figure 1). A method contains additional rules concerning the analysis of real world situations and input artefacts used in the modelling process. The creative transformation of input artefacts into output artefacts is supported by means of heuristics. The set of rules characterising a method is called *problem solving techniques*. Problem solving and modelling techniques have to match with respect to the purpose of the model construction process.

Methods are integrated into *methodologies* to solve complex development problems.¹⁵ Output artefacts of preceding methods are used as input artefacts in succeeding methods. Methodologies thus comprise *rules* for the *coordination* of the integrated methods which are typically documented in so called *phase* or *development process models*.

¹⁵ cf. Knackstedt et al. (2001), pp. 10.



cf. Knackstedt et al. (2001), p. 43

Figure 2: Methods and Methodologies

3 MetaMIS Modelling Technique

3.1 MetaMIS Modelling Technique - Language

This section gives a survey of the conceptual language aspects of the MetaMIS Modelling Language and introduces the current development state of the MetaMIS Representation Formalism.¹⁶ The first concept of the language is *Dimension*. It is used to create and organize the space the management's view is composed of. There are compulsory dimensions (like e.g. time) because any management view must have a relation to time and to (optimistic or pessimistic) planning scenarios of the business. All other dimensions are non compulsory.

Concerning the combination of dimensions while defining views for the management it is required that dimensions are explicitly compatible from the managements point of view. E.g. there could be two dimensions characterising the set of clients with respect to the branch they are working in (dimension "client branch") and a second dimension classifying clients with respect to the gender (dimension "client gender"). The first dimension defines e.g. the sub class "private clients" consisting of all end consumers without a meaningful branch classification. On the other hand the second dimension has a sub class "business clients" which comprises all clients without a meaningful gender classification. From the management's point of view both classification are useful but can not be combined in a meaningful way. Other incompatibilities exist concerning the classification of date of time with respect to weeks versus months. Since weeks do not correctly overlap with months or even years these dimensions are incompatible from the management's point of view. Finally it does not make sense to combine dimensions concerning the kind of business (e.g. warehouse business, seasonal business and promotion business in retailing companies) with the same classification of articles (standard articles for the warehouse business, seasonal articles, promotion articles) since there is no meaningful analysis of promotion articles for the standard warehouse business.

Dimensions are represented by means of (red) *rectangles* and there is no distinction between compulsory and non compulsory dimension. This distinction is part of the guidance rules. The association of identifiers and dimensions (predication) is represented as shown in Figure 3. The compatibility of dimensions is not represented here.

¹⁶ cf. Holten (1999a); Holten (2001 a-b) for deeper discussions of the conceptual language aspects. The roots of the representation formalism are discussed in Holten, Knackstedt (1999).

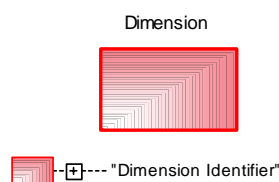


Figure 3: Representational element for concept *Dimension*

Dimensions are defined by means of dimension objects. Based on the enterprise theory of RIEBEL dimension objects can be understood as entities which are objects to arrangements or examinations of the management.¹⁷ The enterprise theory provided by RIEBEL is centred around the decision as the fundamental element.¹⁸ Any activity in an enterprise is produced and maintained by certain decisions which therefore are the real sources of costs, outcome and liquidity. Based on RIEBELS findings the language concept *Dimension Object* is introduced. Dimension objects are organized in hierarchies (concept *DO-Hierarchy*) and are part of a dimensions' definition. The concept of *DO-Hierarchy* allows the construction of e.g. product hierarchies or hierarchies of regions. Every dimension object is associated to exactly one hierarchical level (concept *Hierarchy Level*). The hierarchies defining dimensions are always balanced. That is, the number of hierarchy levels in every branch of the hierarchy is the same within one dimension. Dimension objects on the lowest hierarchical level are called *Leaves*, all other dimension objects are called *Non Leaves*. The concepts *Dimension* and *DO-Hierarchy* are intended to hierarchically organise certain attributes of objects which are matter of decisions from the management's point of view. Additionally these attributes are orthogonal from the management's point of view since they can be combined with each other to demarcate the objects management decisions are dealing with.

Dimension objects and the respective hierarchies are represented by means of hierarchical structures (Figure 4). Squares represent hierarchical levels of non leaves. Dimension objects on the lowest level have no square as prefix. Every dimension object is associated with an identifier (predication). Hierarchy levels identifiers are associated to the respective levels which are visualised by means of the indentation. Lower level objects are placed rightwards of higher level objects. Every hierarchy level is associated to an identifier (predication). The squares with the "+" sign indicate that there are more sub-ordinate dimension objects which are not shown to enhance clearness. For squares with the "-" sign all dimension objects of the succeeding hierarchy level are visible.

¹⁷ cf. Riebel (1979).

¹⁸ cf. Riebel (1992); Holten (1999).

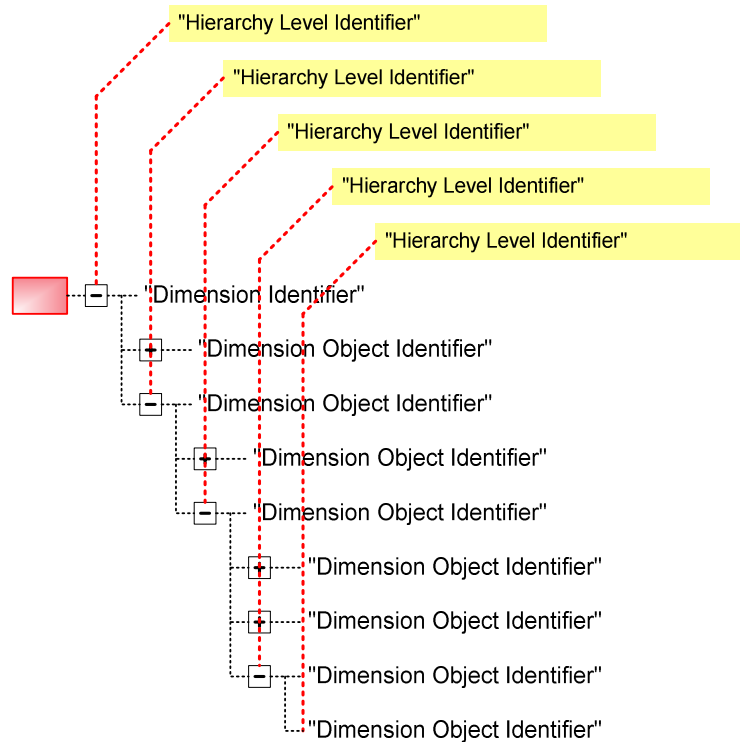


Figure 4: Representational elements for concepts *Dimension Object*, *DO-Hierarchy*, *Hierarchy Level*, *Leave*, *Non Leave*

The leaves of the DO-Hierarchies introduced above are in fact the objects management decisions are dealing with. This implies two important things:

1. Leave elements can appear in many dimensions. These appearances are based on the existence of different views on identical objects. Since every dimension organizes certain attributes of these objects in a hierarchical manner the objects on the bottom level of the respective hierarchies are identical. This is expressed by means of the concept *Leave*.
2. To consistently integrate all the hierarchical views on identical objects another concept is required. For this purpose the concept *Dimension Grouping* is introduced.

Dimensions which define views on identical objects are subsumed in one dimension grouping. All dimensions belonging to one dimension grouping have the *same set of leaves* in their hierarchies. E.g. in retailing companies it is necessary to look at different aspects of stores as fundamental objects. It is e.g. of interest which competitors have stores in the same area in order to classify the own stores according to this situation.

Other important aspects are concerned with the sites of the stores (e.g. down town, outskirts or village) or the age and degree of modernization. All these attributes of the stores are relevant for the management and all relate to the same identical set of stores as objects. Additionally it makes sense to combine any of these aspects or classifications with another to create complex management views. It follows that these aspects are orthogonal from the management’s point of view and thus lead to different dimensions in the sense defined above. Nevertheless a grouping of all these dimensions makes sense since they all relate to one unequivocal set of objects, e.g. the set of stores belonging to the retailing company under consideration.

Dimension Groupings are represented by means of (red) *rectangles containing a set of smaller rectangles*. Dimensions belonging to a dimension grouping are hierarchically subordinated to this dimension grouping (Figure 5). The association of identifiers and dimension groupings (predication) corresponds to the one of dimensions.

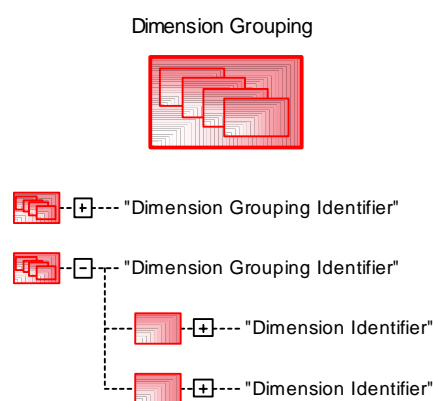


Figure 5: Representational elements for concept *Dimension Grouping* and its association to dimensions

To prevent information overflow individual excerpts out of dimension hierarchies are required and are combined to task specific views. For this purpose the concepts *Dimension Scope* and *Dimension Scope Combination* are introduced. Dimension scopes are sub trees of dimensions. Their combination defines a space of objects relevant for a management user. The type of vectors within this space is termed by means of the concept *Reference Object* with respect to RIEBEL’S enterprise theory. Reference objects are defined as all “measures, processes and states of affairs which can be object to arrangements or examinations on their own”¹⁹. The set of hierarchical levels of a dimension scope is a subsequence of the dimension’s hierarchy levels the dimension scope belongs to.

¹⁹ cf. Riebel (1979), p. 869.

Dimension scopes are represented by means of (white) rectangles with (red) triangles inside (Figure 6). The respective sub trees are directly related to this symbol. The association of identifiers and dimension scopes (predication) corresponds to the formalisms introduced above. Their relation to the basic dimension is not represented explicitly. The representation of the respective dimension objects corresponds to the representation of DO-Hierarchies introduced above.

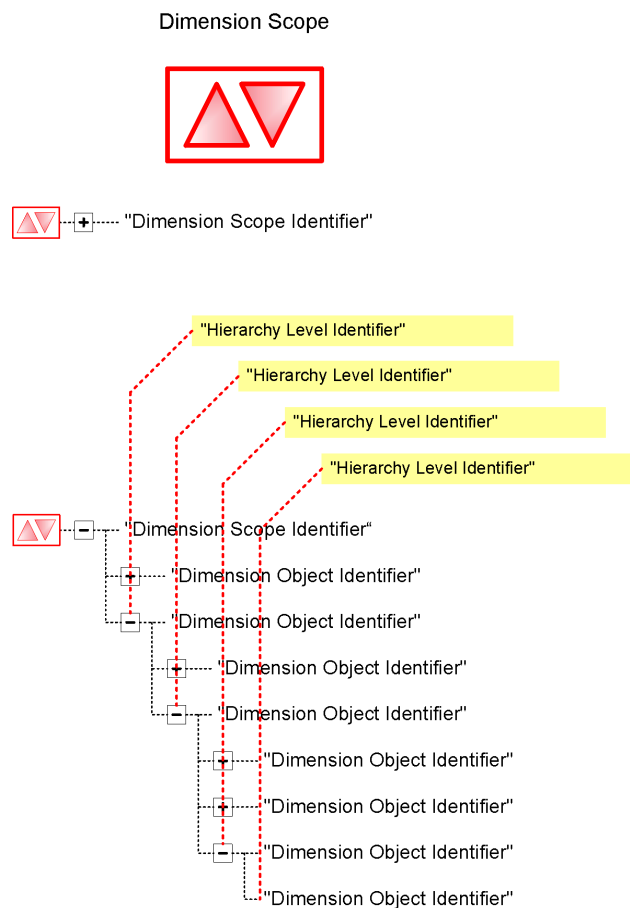


Figure 6: Representation elements for concept *Dimension Scope* and the respective sub trees

Dimension scope combinations are represented by means of (red) rectangles with small dimension scope symbols inside. The associated dimension scopes are related to dimension scopes by means of the hierarchical constructs introduced for dimension groupings. The association of identifiers and dimension scope combinations (predication) corresponds to the formalisms introduced above.

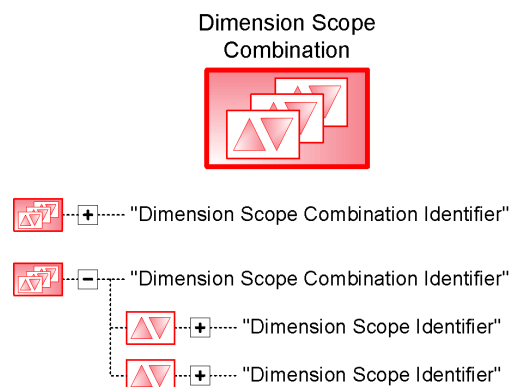


Figure 7: Representation elements for concept *Dimension Scope Combination*

The next concept required is *Ratio* which is of fundamental importance for specifying information in management processes. Ratios are core instruments to measure the value of companies²⁰, the performance of the business²¹ and to analyse the financial situation of an enterprise²². Synonyms found in the management accounting literature are operating ratio, operating figure or measure of performance. Ratios like e.g. “gross margin” define important aspects of reference objects. Their economic meaning is clearly specified and their calculation is defined by means of algebraic expressions (e.g. “profit = contribution margin – fixed costs”). The entire DuPont-Pyramid with its main ratio “return on investment” can be expressed based on algebraic expressions. Another form of organizing ratio sets is used by so called ratio systems (concept *Ratio System*). Ratio systems are organized hierarchically and enable the top down analysis of one unequivocal reference object according to different economical aspects relevant to the management. E.g. the balanced scorecard presented by KAPLAN and NORTON²³ is a set of ratio systems supporting this top down analysis of reference objects in the strategic performance measurement process. Since the balanced scorecard organizes ratio systems hierarchically further concepts are required to be able to express this situation. Hierarchies of ratio systems can be unbalanced.

Ratios are represented by means of rows in tables. Every ratio has an unequivocal identifier. The association of identifiers and ratios (predication) leads to a respective table entry (Figure 8, Figure 9). Basis ratios are defined from the management’s point of view by means of statements (linguistic actions) (Figure 8). Additionally there are synonyms listed.

²⁰ cf. Copeland et al. (1990).

²¹ cf. Johnson, Kaplan (1987); Eccles (1991); Lapsley, Mitchel (1996); Kaplan, Norton (1997); Kaplan, Norton (1996); Kaplan, Norton (1992).

²² cf. Brealey, Myers (1996).

²³ cf. Kaplan, Norton (1997); Kaplan, Norton (1996); Kaplan, Norton (1992).

Calculated ratios require in addition calculation expressions for their definition (Figure 9). Every definition of a calculated ratio requires that ratios used in the calculation expression are defined beforehand.

Ratio	Description / Unit	Synonym
"Ratio Identifier"	Ratio description and definition including unit	"Ratio Identifier Synonyms"
...

Figure 8: Table for the definition of basis ratios

Ratio	Calculation Expression	Description / Unit	Synonym
"Ratio Identifier"	= "algebraic expression"	Ratio description and definition including unit	"Ratio Identifier Synonyms"
...

Figure 9: Table for the definition of calculated ratios

Ratio systems are represented by means of (yellow) boxes with numbers inside. The hierarchies of ratio systems is represented by the constructs introduced for hierarchical orders above. The association of identifiers and ratio systems (predication) corresponds to the formalisms introduced above.

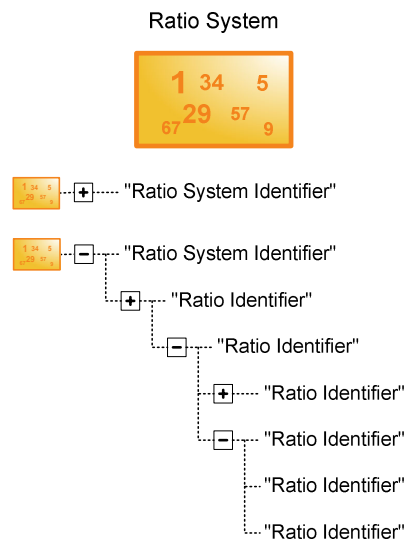


Figure 10: Representational elements for the concept *Ratio System*

To define information spaces relevant for a management user the set of reference objects specified by means of a dimension scope combination and the set of ratios specified by means of a ratio system must be integrated. For this purpose the concept *Information Object* is introduced. An information object is a relation between a set of reference objects (defined by means of a dimension scope combination) and a set of ratios

(defined by means of a ratio system). The type of elements of this relation is termed *Fact*. A fact is a relation of one reference object and one ratio.

Information objects are represented by means of (blue) rectangles with a (blue) rhomb inside (Figure 11). The association of identifiers and information objects (predication) corresponds to the formalisms introduced above. The association of dimension scope combinations and ratio systems to information objects is represented by means of the hierarchy constructs used above.

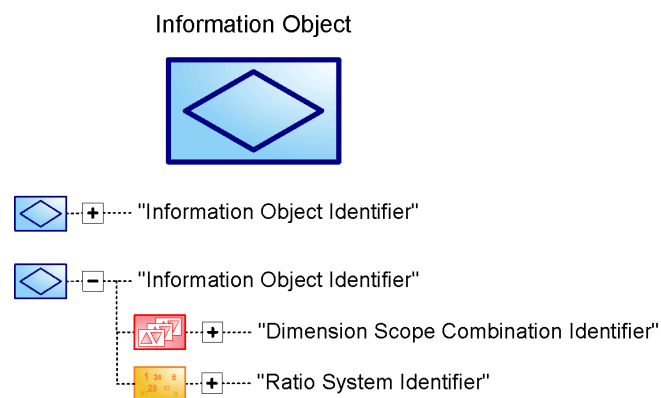


Figure 11: Representational elements for concept *Information Object*

The conceptual aspect of the language constructed so far is shown as integrated meta model in Figure 12. A detailed overview of the construction process of the conceptual language aspect is given in Table 1 in the Appendix.

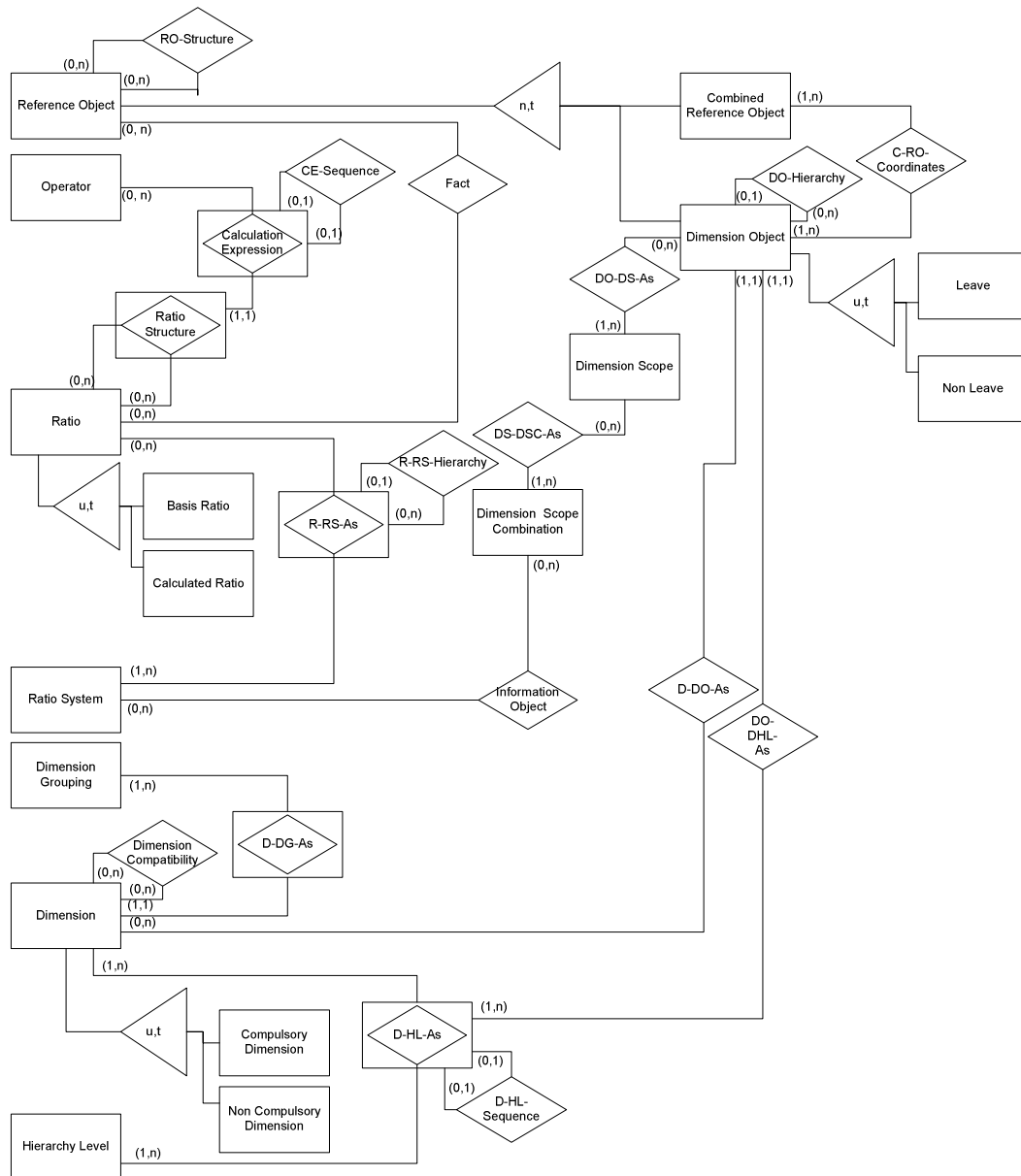


Figure 12: Meta model of the conceptual language aspect of the MetaMIS Modelling Technique²⁴

3.2 MetaMIS Modelling Technique - Guidance in Examples

Concerning the four classes of guidance rules for modelling techniques defined in section 2 the previous section explicitly defined syntax and semantic rules and rules of pragmatics. The fourth class of rules, rules of reasonable model construction, is implicit.

²⁴ cf. Holten (1999a) for detailed discussions. Previous versions of the meta model can be found in Becker, Holten (1998); Holten (1999 a-c); Holten, Kanckstedt (1999 a-b); Holten (2000 a-b); Holten (2001 a-b).

itly defined by means of the meta model of the conceptual language aspect (Figure 12). Using the following example these rules are explicitly demonstrated.

First of all dimension groupings must be modelled. They are the basis for the consistent specification of dimension scopes and dimension scope combinations.

The CEO of the retailing company EXCOM requires a report for short term management tasks. Aspects of relevance are the time structured in month, the articles and the stores of the company. Additionally there exist a lot of ratios used in EXCOM's management so far. But the CEO is interested in a sub set only.

The models from Figure 13 to Figure 16 show (excerpts of) the four dimensions relevant for the management of articles. For every dimension the hierarchy levels are shown. The leaves of the hierarchies are identical for all four dimensions. The first dimension "Store Assortment CCG" (Figure 13) is relevant for benchmarks since the CCG structure is an accepted standard in the retailing branch. E.g. the article "36904711 Powder Power -S11- R" is member of the 4-digit merchandise category "3690 Mens Ski Boots Alpine". The second dimension "Quality / Price Level" (Figure 14) is relevant for the segmentation of the assortment according to quality levels. The same article "36904711 Powder Power -S11- R" is associated to the quality level "high". The third dimension "Category Management" (Figure 15) is relevant to manage categories according to customer needs. E.g. the article "36904711 Powder Power -S11- R" belong to category department "Seasonal Sports". Categories are required to structure layouts. Finally there is a dimension relevant for fashion managers called "Colour". The article "36904711 Powder Power -S11- R" belongs to colour group "Red". There also exist the blue version "36904711 Powder Power -S11- B".

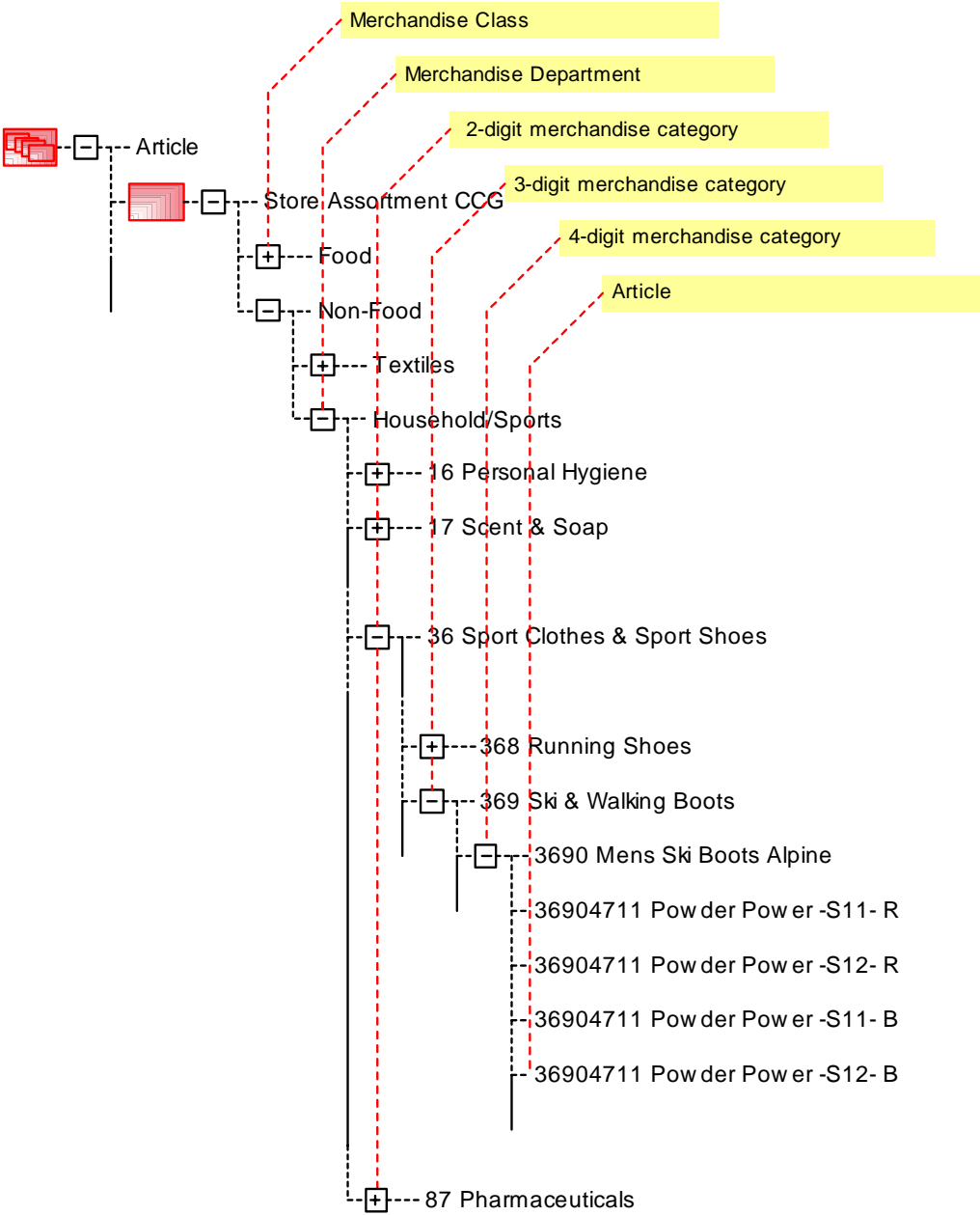


Figure 13: Dimension Grouping Article-Part 1

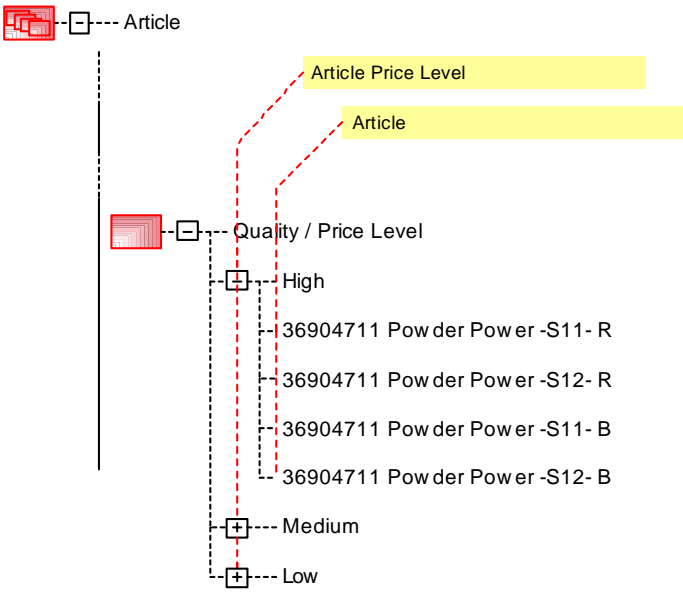


Figure 14: Dimension Grouping Article-Part 2

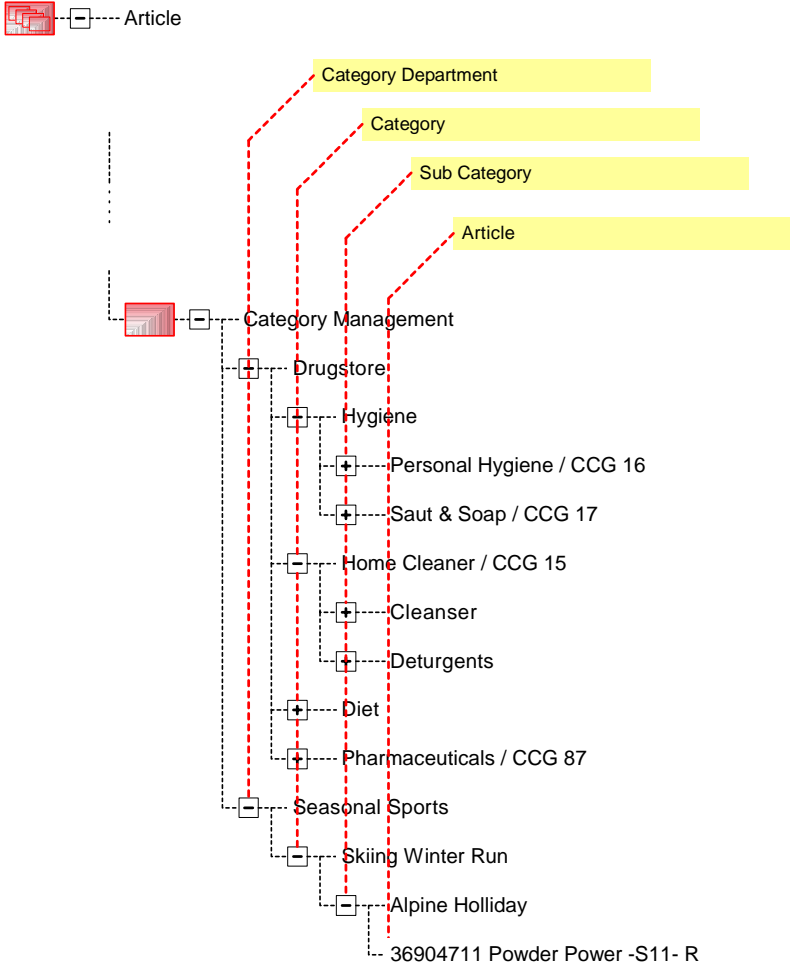


Figure 15: Dimension Grouping Article-Part 3

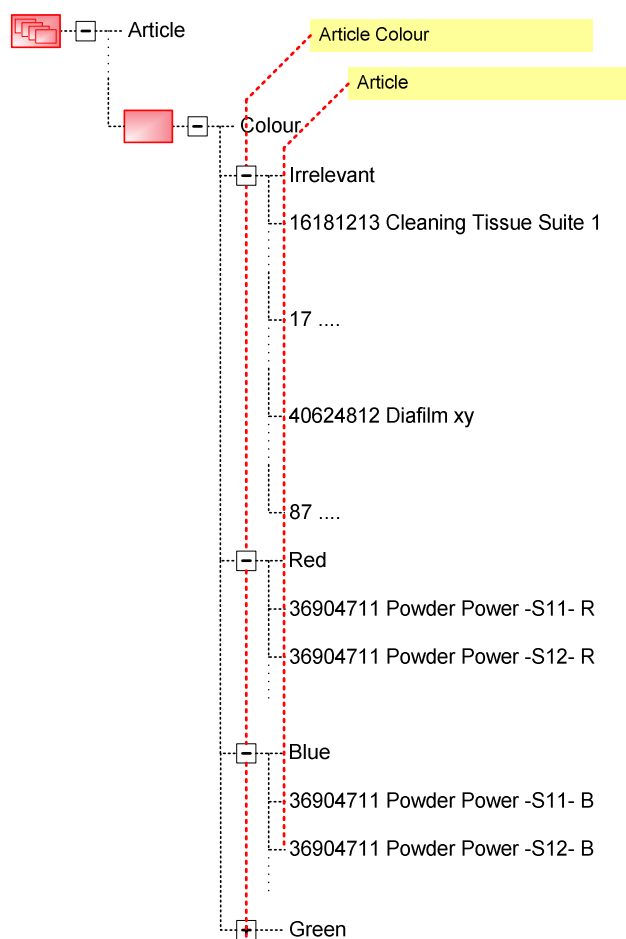


Figure 16: Dimension Grouping *Article-Part 4*

Concerning the dimension grouping Time-Calendar there exist two dimensions. One structures the time according to months, quarters and years. The other structures the time according to weekdays. Every date is associated to every dimension. The first dimension is the compulsory time dimension required for the specification of management views. In the example there is no scenario (e.g. as is values versus plan values) for simplicity reasons. Scenarios are typically also compulsory dimensions in real enterprise projects.

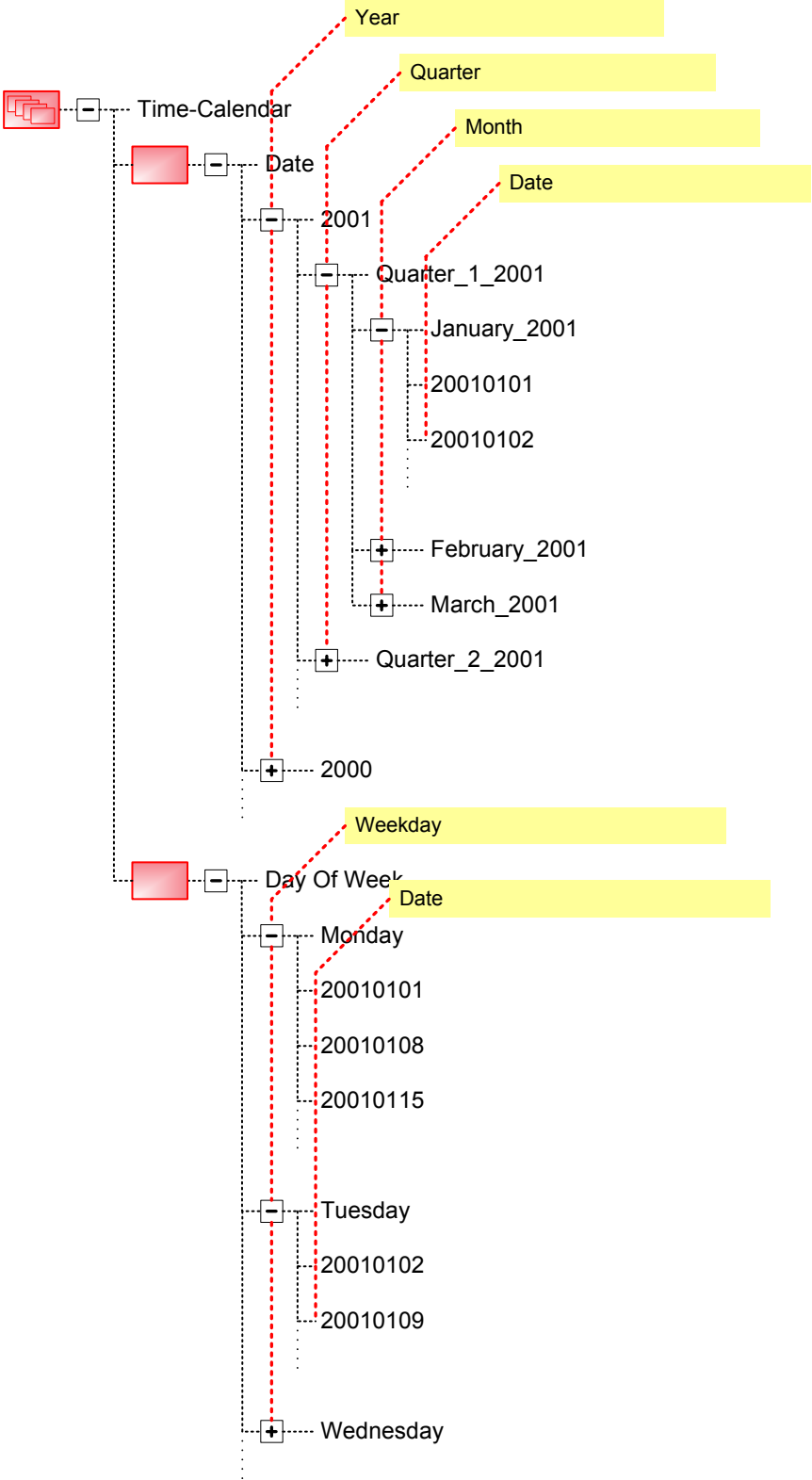


Figure 17: Dimension Grouping *Time-Calendar*

The dimension grouping “Store” comprises four dimensions (Figure 18 and Figure 19). The dimension “Region” shows the regional structure of EXCOM’s business. The dimension ”Competition” classifies the stores according to the degree of competition the

management senses suitable. “Area / Location” classifies the stores according to the spending power of the respective areas. Finally “Modernization” is a classification with respect to the appearance of a store.

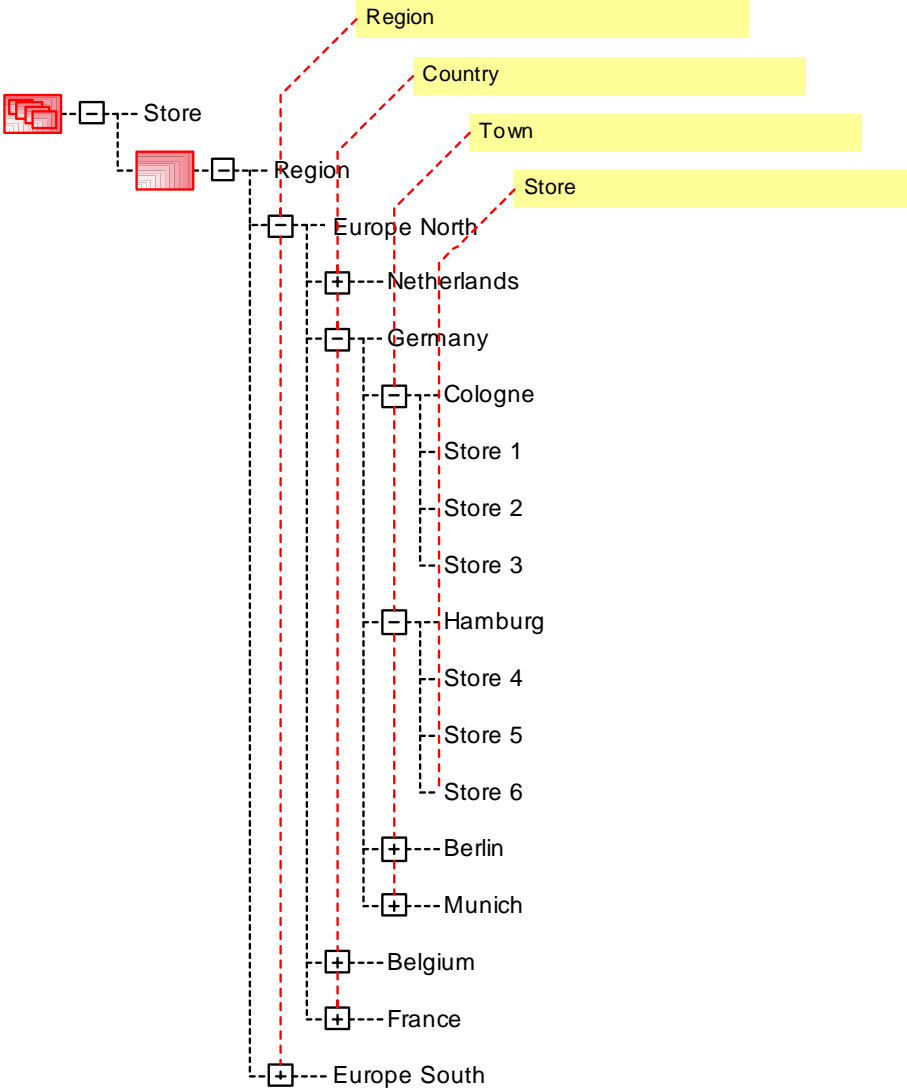


Figure 18: Dimension Grouping *Store Part 1*

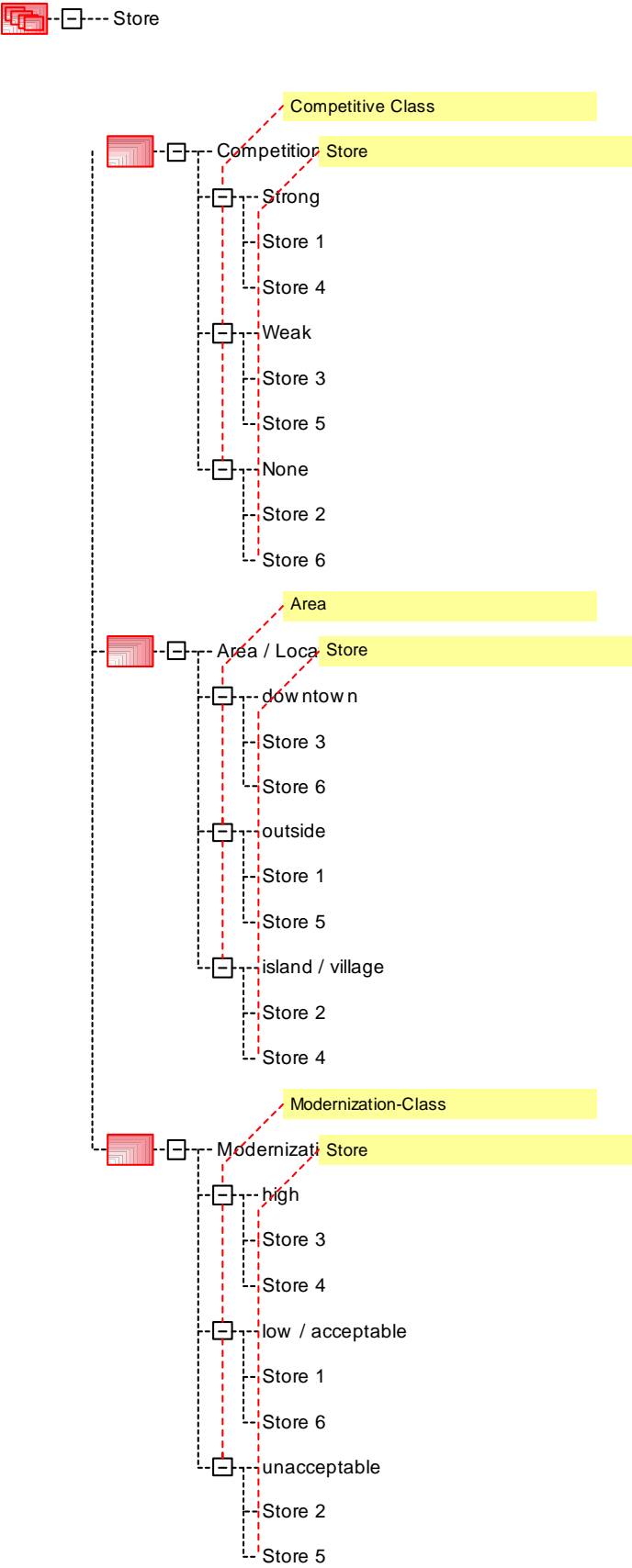


Figure 19: Dimension Grouping Store Part 2

Having modelled the dimension groupings the required basis information for the development of dimension scopes and dimension scope combinations is available. Modelling dimension scopes and dimension scope combination define the second development step.

The first dimension scope defined is “Month -> current Month” which is in the example case shown for January 2001 (Figure 20). It is shown that this dimension scope is defined based on the dimension “Date” and comprises the hierarchical levels “Month” and “Date” of the sub tree “January 2001”. Based on this definition the second dimension scope “Month -> pervious Month” is defined in relation to “January 2001” (Figure 21). The relevance of hierarchical levels for the definition of dimension scopes is shown for the definition of dimension scope “Town” which is an excerpt of dimension “Region” of the dimension grouping “Store” (Figure 22). The hierarchy levels “Region”, “Country” and “Town” are relevant. The Hierarchy level “Store” is ignored. The squares with the “-“ sign indicate that “Town” is the lowest hierarchy level of this dimension scope.

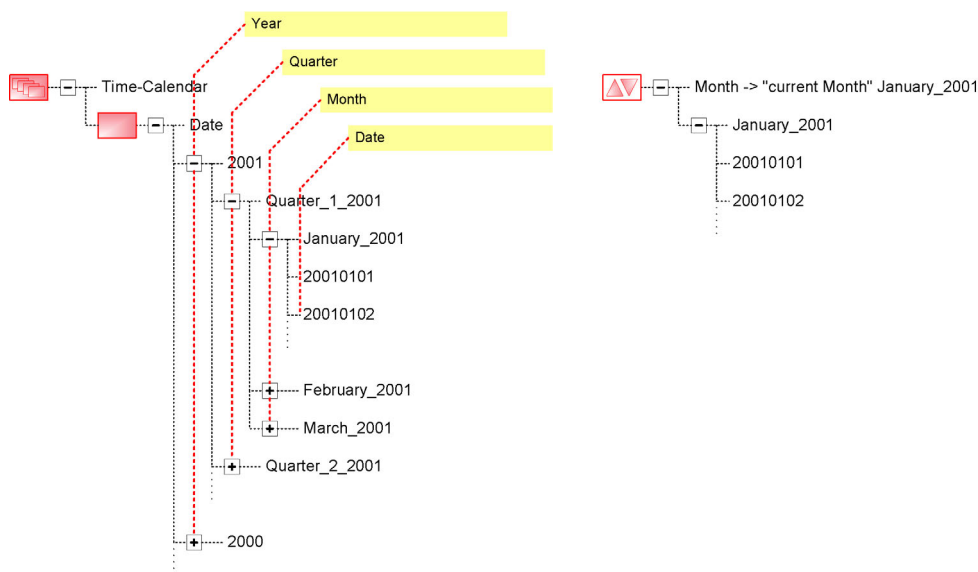


Figure 20: Dimension Scope *Month (January 2001)*

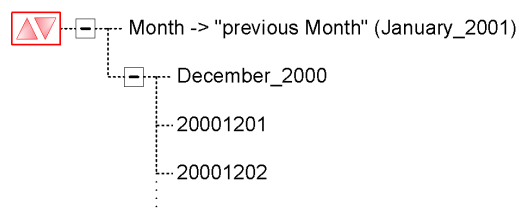


Figure 21: Dimension Scope *Month (previous Month in relation to January 2001)*

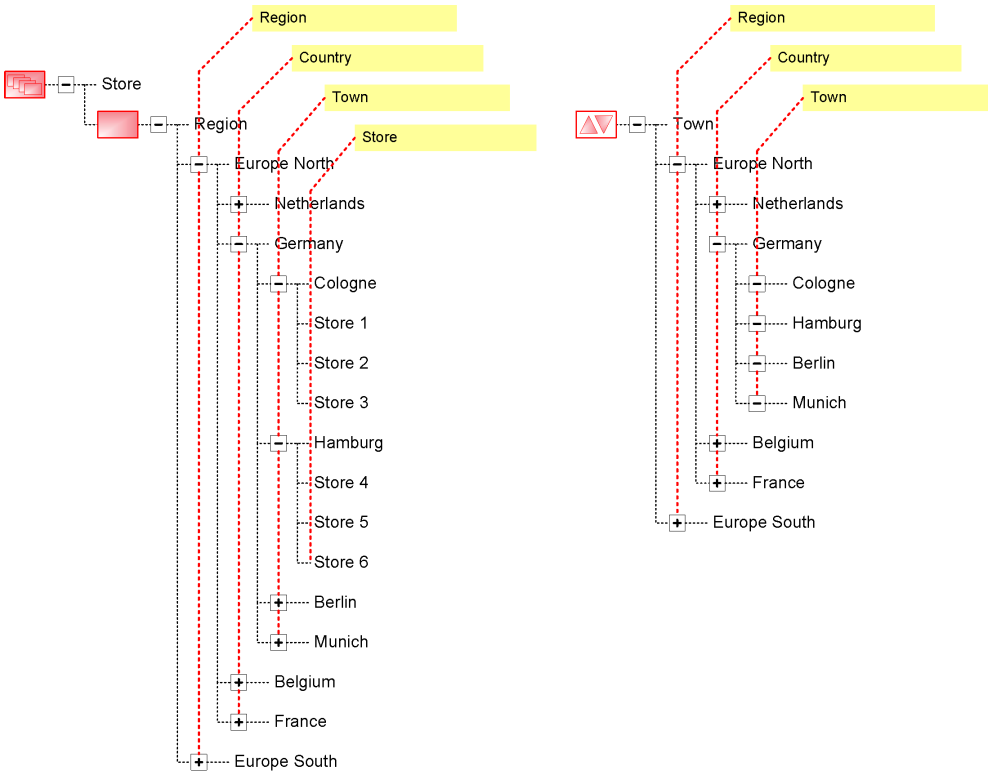


Figure 22: Dimension Scope *Town*

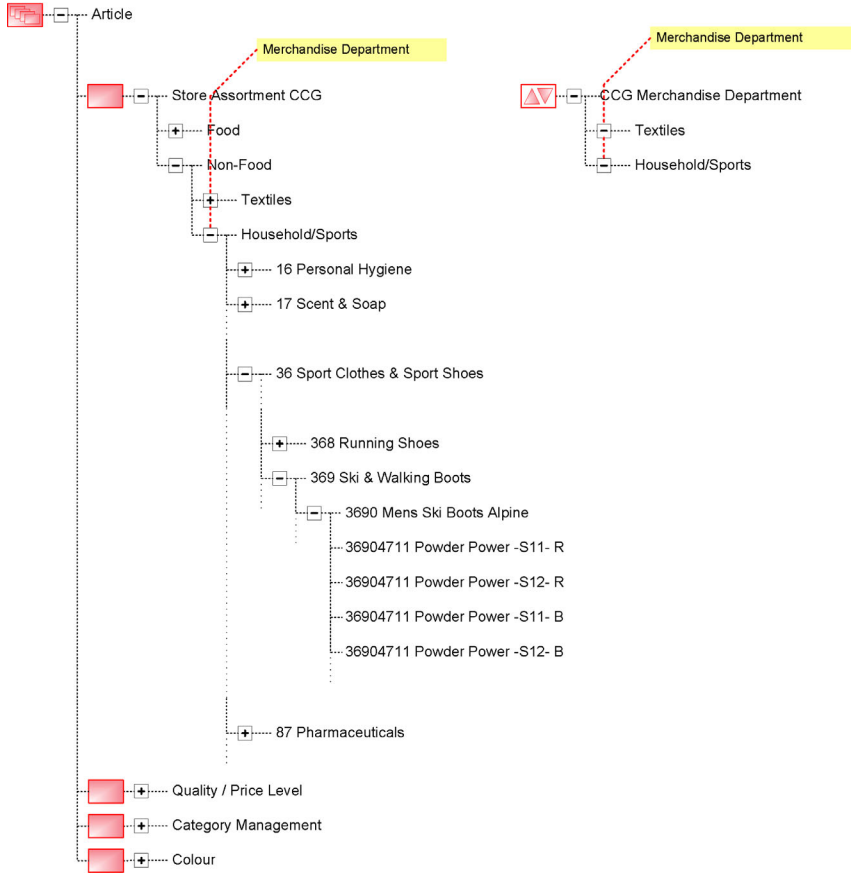


Figure 23: Dimension Scope *CCG Merchandise Department*

Finally dimension scope „CCG Merchandise Department“ is defined based on dimension “Store Assortment CCG” (Figure 23). It is shown that many details of the dimension are ignored in the dimension scope.

Having defined the dimension scopes the dimension scope combination can be modelled (Figure 24).

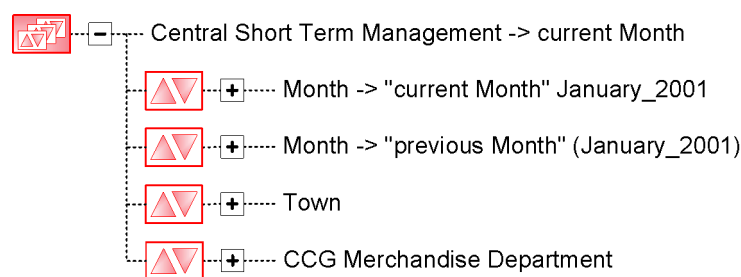


Figure 24: Dimension Scope Combination *Central Short Term Management -> current Month*

Ratios and ratio systems are the next model components required. Basis ratios and calculated ratios must be listed in tables (Figure 25 and Figure 26).

Ratio	Description / Unit	Synonym
<i>average annual sales</i>	average sales per year in the local currency valued in planned sales standard prices	<i>annual sales</i>
<i>average daily sales</i>	average sales per day in the local currency valued in planned sales standard prices	
<i>average annual inventory</i>	average value of goods in stock per year in average purchase standard price	<i>average annual inventory level</i>
<i>average inventory</i>	average value of goods in stock in average purchase standard price	<i>average inventory level</i>
<i>contact distance</i>	in m ² of shelf space	
<i>current inventory</i>	value of goods in stock in average purchase standard price	<i>stock</i>
<i>inventory adjustment</i>	adjustment of current inventory to physical inventory valued in average purchase standard prices	<i>(physical) inventory difference</i>
<i>net purchase price</i>	purchase price after discount, rebate or other reductions	<i>net purchasing price</i>
<i>net sales price</i>	planned sales standard price after discount, rebate or other reductions and without sales tax	
<i>net sales value</i>	value of sales in planned net sales prices	<i>net sales</i>
<i>number of employees</i>	number of employees	
<i>order volume</i>	value of orders in the local currency valued in purchase standard prices	<i>order value</i>
<i>presentation area</i>	in m ² of floor space	
<i>promotion sales price</i>	sales price referring to a promotion	<i>promotion price</i>
<i>promotion purchase price</i>	purchase price referring to a promotion	
<i>promotion purchase value</i>	value in the local currency valued in purchase prices referring to a promotion	<i>promotion purchase</i>
<i>promotion sales value</i>	sales value in the local currency valued in planned promotion sales prices	<i>promotion sales</i>

Ratio	Description / Unit	Synonym
<i>purchase price</i>	purchase standard price	
<i>purchase value</i>	purchase value in the local currency valued in standard purchase prices	<i>purchase, goods usage</i>
<i>returns</i>	returned goods valued in planned sales prices	
<i>sales price</i>	sales standard price	
<i>sales quantity</i>	sales quantity in quantity units	<i>asset sale</i>
<i>sales value</i>	sales value in the local currency valued in planned sales standard prices	<i>sales, turnover</i>
...

Figure 25: Table of Basis Ratios

Ratio	Calculation Expression	Description / Unit	Synonym
<i>area intensity</i>	= average inventory level / presentation area	measure for usage of presentation area as stock in stock value / m ²	
<i>area productivity</i>	= sales value / presentation area	productivity of floor space in use measured in sales value / m ²	
<i>employee productivity</i>	= sales value / number of employees	productivity of staff measured in sales value / person	
<i>gross yield</i>	= net sales – goods usage	margin of goods sold in absolute value based on planned sales prices	<i>profit margin I</i>
<i>discount gross margin</i>	= gross yield * 100 / sales	margin in percent based on sales values (in %)	<i>sales margin</i>
<i>markup gross margin</i>	= gross yield * 100 / purchase	margin in percent based on net purchase prices (in %)	<i>goods receipt margin</i>
<i>inventory turnover</i>	= sales value / average inventory level	productivity measure for the goods usage and level of inventory	
<i>annual inventory turnover</i>	= annual sales / average annual inventory	productivity measure for the goods usage and level of inventory annual periods	
<i>order gross yield</i>	= net sales – order volume	margin of goods sold in absolute value based on planned sales prices	
<i>markup order margin</i>	= order gross yield * 100 / order volume	markup gross margin of orders based on purchase prices in percent (in %)	<i>order margin</i>
<i>promotion gross yield</i>	= promotion sales – promotion purchase	margin of goods sold in absolute value based on promotion sales prices	
<i>discount promotion gross margin</i>	= promotion gross yield * 100 / promotion sales	margin in percent based on sales values referring to a promotion (in %)	<i>promotion sales margin</i>
<i>range of coverage</i>	= current inventory / average daily sales	time period daily sales are covered by current inventory (in days)	
<i>shelf productivity</i>	= sales value / contact distance	productivity of shelf space in use measured in sales value / m ²	
<i>stock gross yield</i>	= net sales – stock	margin of stock in absolute value based on planned sales prices	
<i>stock gross margin</i>	= stock gross yield * 100 / stock	markup gross margin of stock (in %)	<i>stock margin</i>
<i>inventory shrinkage rate</i>	= inventory difference * 100/ sales	rate of inventory difference in relation to sales (in %)	
...

Figure 26: Table of Calculated Ratios

Based on this set of ratios the required ratio system can be developed (Figure 27). The meaning and calculation of every ratio is defined in the tables. The ratio system “Profitability and Store Management” shows the hierarchic structure of its ratios according to their importance for the management user. This means that e.g. the ratio “sales” is on a higher level than the ratio “returns”. “Sales margin” respectively is of the same importance as sales but is more important than “asset sales”, “promotion sales” etc. This structure implies a certain drill down logic for ratios without any algebraic meaning.

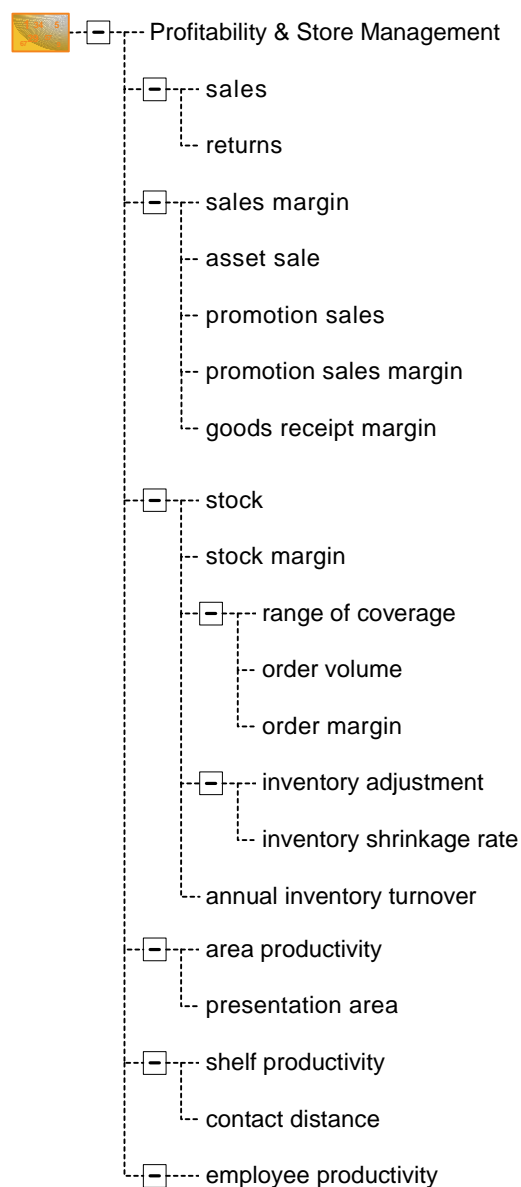


Figure 27: Ratio System *Profitability and Store Management*

Having provided dimension scope combinations and ratio systems information objects for the management users can be modelled. This is shown for the information object “CEO Retailing Company -> current Month” (Figure 28).

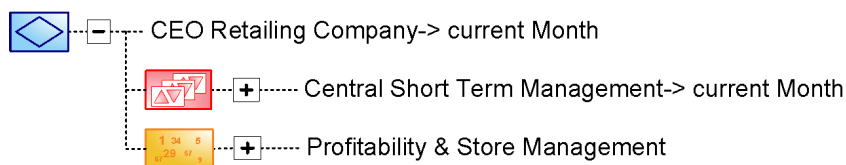


Figure 28: Information Object *CEO Retailing Company -> current Month*

Recapitulating the guidance rules of reasonable modelling call for the following sequences of model construction subject to the MetaMIS Modelling Technique:

1. Dimensions and dimension groupings must be constructed based on dimension objects. The hierarchy levels for every dimension must be defined. The set of leaves is the same for all dimensions of one dimension grouping.
2. Based on the models of dimension groupings dimension scopes can be defined.
3. Dimension scope combination can be modelled having provided the set of dimension scopes.
4. The set of basis ratios must be listed.
5. Calculated ratios can be defined based on basis ratios and other calculated ratios as well.
6. Ratio systems can be constructed according to their hierarchies based on the lists of basis and calculated ratios.
7. Information objects can be modelled based on dimension scope combinations and ratio systems.

4 MetaMIS Method and Conclusion

The MetaMIS Modelling Technique has to be methodically integrated with problem solving techniques (see section 2). Main tasks and problems to be solved comprise:

1. The identification of basic objects relevant for the management. These objects lead to the leaves of all dimensions belonging to the respective dimension grouping. Basic objects must be identified based on analyses of the core business and the main business processes of the enterprise.
2. Identification of all aspects relevant concerning the basic objects. These aspects lead to the set of dimensions within the respective dimension grouping and the balanced dimension hierarchies. Defining the dimension and the respective hierarchies is an iterative task. Especially the identification of hierarchy levels and balanced hierarchies are complex modelling tasks.
3. Identification of required management views. These views lead to the sets of dimension scopes and dimension scope combinations according to management tasks. Dimension scope combinations must be defined based on the analyses of management tasks. These tasks must be associated to steering and control functions related to the main business processes.
4. Identification of basis and calculated ratios relevant for the management. The definition of a consistent ratio base requires an analysis of the whole set of ratios used in the enterprise. Main problems will occur in solving synonyms and homonyms. Additionally the exact meaning of every ratio must be defined from the management's point of view.
5. Specification of task specific ratio systems. Ratio systems must be defined based on the analysis of management tasks.
6. Definition of information objects suitable for addressees. Based on analyses of management tasks information objects can be designed. It is important to solve the problem of consistent information objects for hierarchically structured management teams. This requires the usage of identical ratio systems and of dimension scopes with intersections referring to hierarchical levels. These information objects are the basis for management teams realising management by objectives principles.

The required tasks of the MetaMIS Method are shown as function decomposition diagram in Figure 29. As basis for the process model of the MetaMIS Method Figure 30

shows the required technical term models. These models are directly related to the document types defined in the meta model (Figure 12) of the conceptual language aspect of the MetaMIS Modelling Technique (see section 3.1). Technical term models are more suitable for the modelling of processes than data models.²⁵ An abstract process model of the MetaMIS Method is shown in Figure 31.

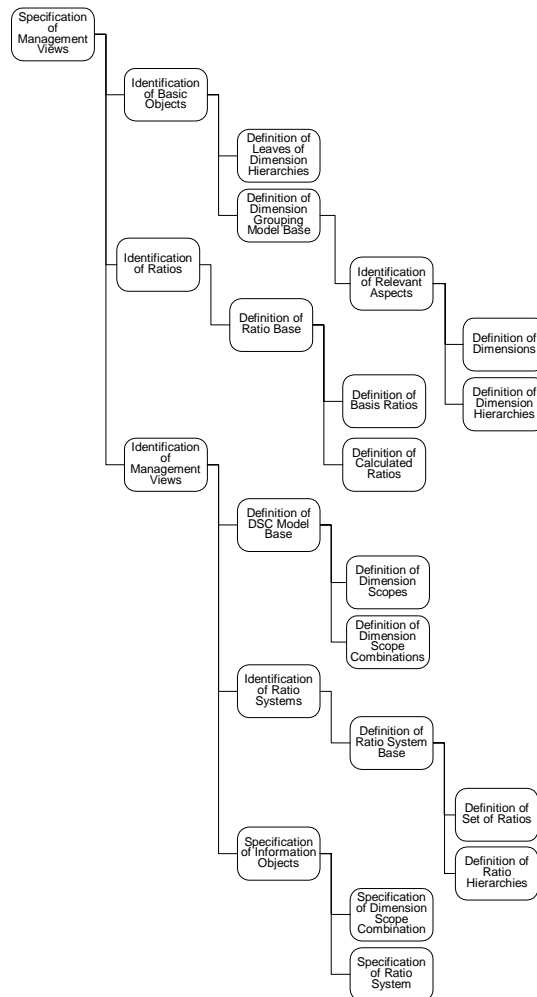


Figure 29: Function Decomposition Diagram of the MetaMIS Modelling Method

²⁵ cf. Kugeler (2000), pp.131. The notation of technical term relation types is based on the propositions of Kugeler (2000), pp.156 and Speck (2001), pp. 145.

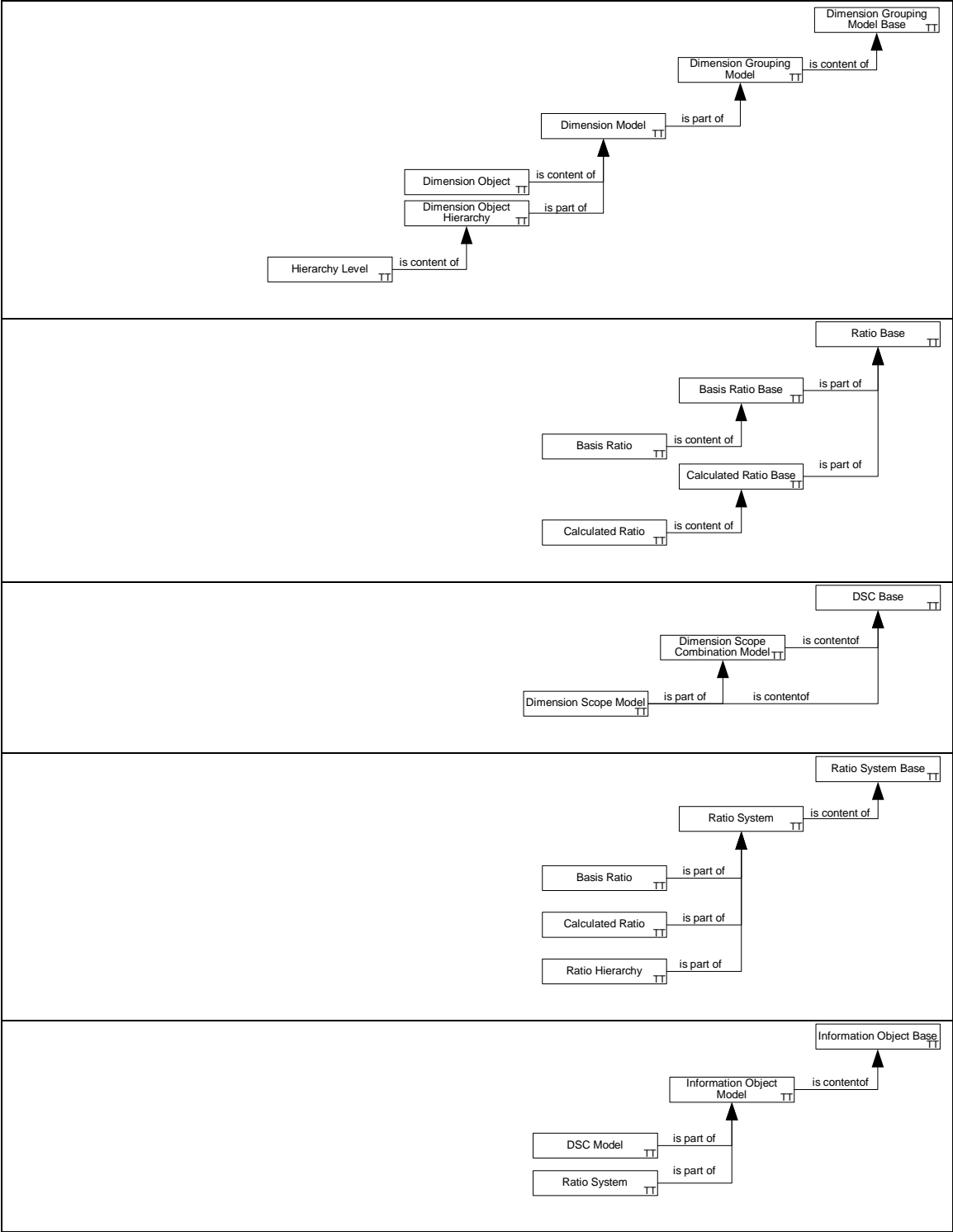


Figure 30: Technical Term Models of Process Model Documents

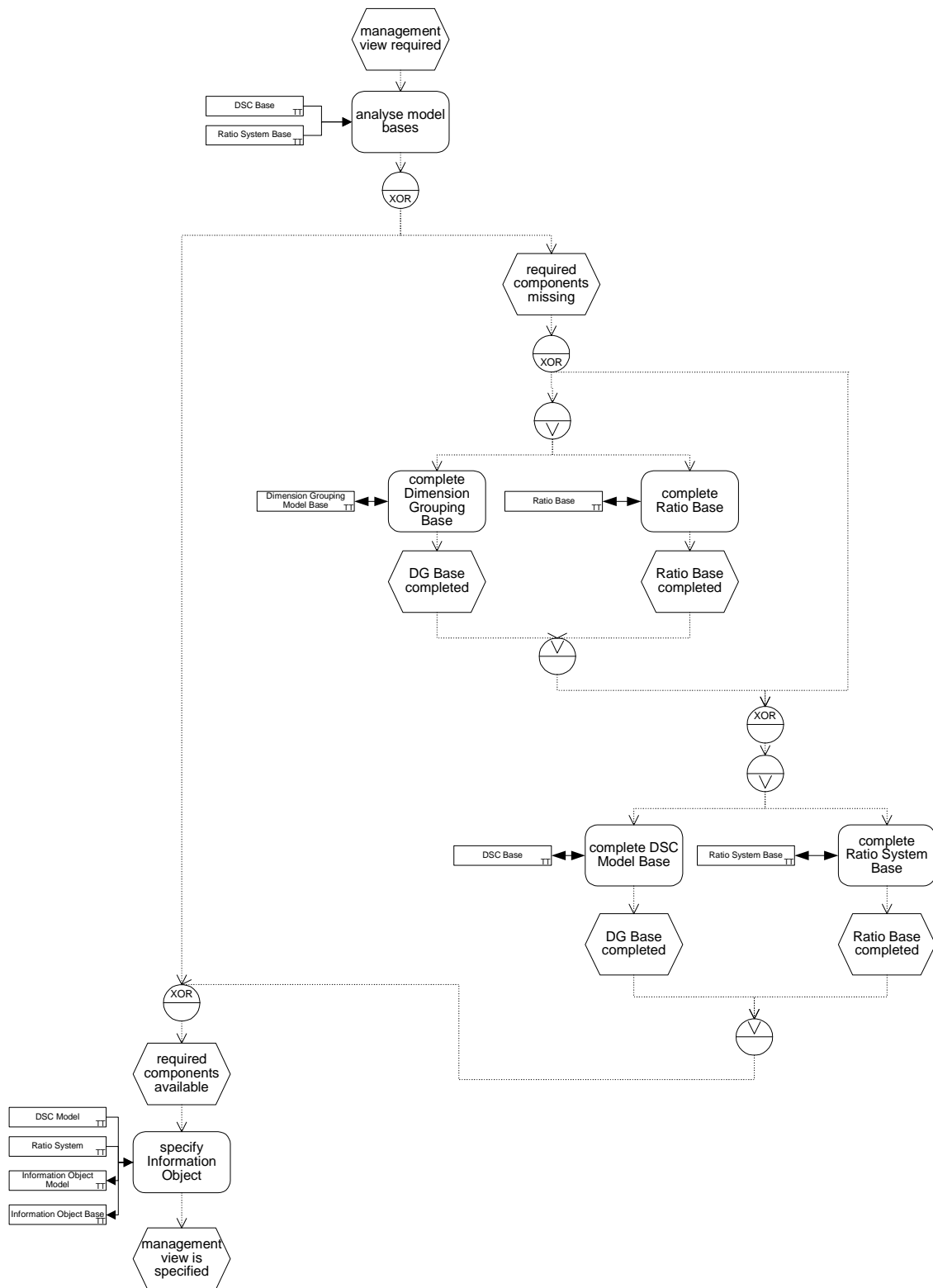


Figure 31: Event Driven Process Chain Model of the MetaMIS Modelling Method

Every function of the process model and the function decomposition diagram as well requires a detailed description of problem solving techniques. Additionally more detailed process models are required to define the respective methodical tasks exactly. To

provide these models will be part of future work on the MetaMIS Approach. Another goal is the development of modelling tools supporting this approach and enabling the integrated development of information warehouse systems.²⁶

²⁶ cf. Holten (2000a); (Holten (2001b)).

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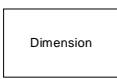
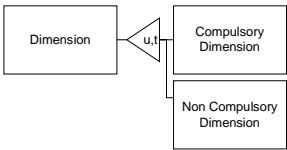
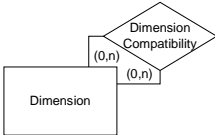

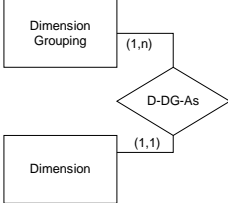

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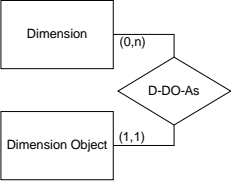
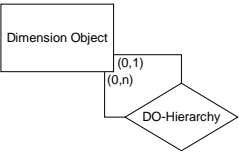
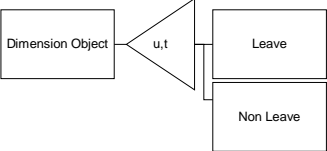
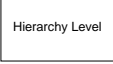
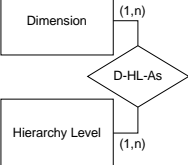
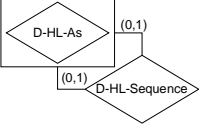
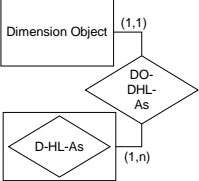
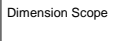
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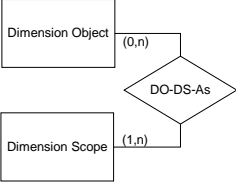
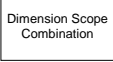
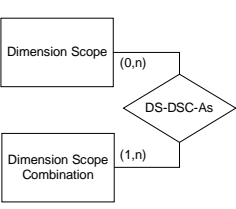
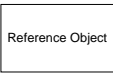
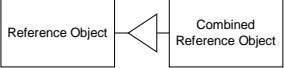
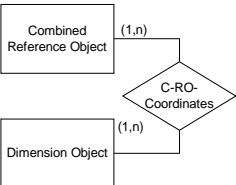
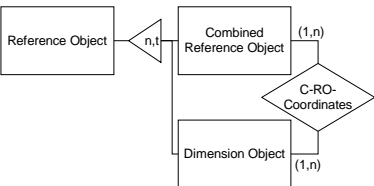
The conceptual language aspect of the MetaMIS Modelling Technique is constructed based on the *Language Critique Approach* developed by KAMLAH and LORENZEN.²⁷ A detailed discussion of the methodological background in the context of the development of modelling techniques can be found in other papers.²⁸

Conceptual Language Aspect	Linguistic action and statement	Meta Model Component (cf. Figure 12)
Dimension	Subsumption: Used to create and organize the space the management's view is composed of.	
Compulsory Dimension, Non Compulsory Dimension	Subsumption and Subordination: Some dimensions like time and scenario are compulsory for any conceptual description of management views. Any other dimension is non compulsory. The specialization is unequivocal (symbol u) and total (symbol t).	
Dimension Compatibility	Composition: Recursive relationship of concept Dimension to itself. From the managements' point of view it may make sense to combine a dimension with none or many dimensions while defining management views on the business. The concept Dimension is used twice in this relationship (cardinalities (0,n) (0,n)).	
Dimension Grouping	Subsumption: A specific object type for which different dimensions can be used to characterize its aspects relevant for the management.	
D-DG-As (Dimension Dimension Grouping Association)	Composition: Relationship between concepts Dimension and Dimension-Grouping. A certain dimension belongs to one unequivocal dimension grouping (cardinalities (1,1)). A certain dimension grouping comprises at least one dimension but may comprise many dimensions (cardinalities (1,n)).	
Dimension Object	Subsumption: Entities relevant for management's arrangements and examinations and part of the definition of dimensions in the sense that they have strong relationships to each other from the management's point of view.	

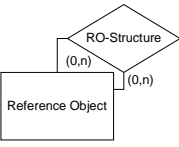
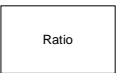
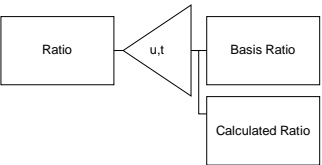
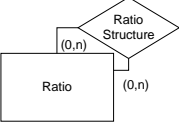
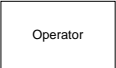
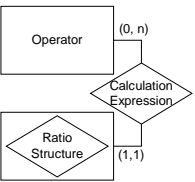
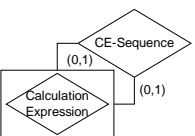
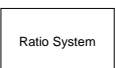
²⁷ cf. Kamlah, Lorenzen (1984); Kamlah, Lorenzen (1992); Lorenzen (1987); Lorenzen (2000).

²⁸ cf. Holten (1999 a), pp. 18; Holten (2000 b), pp 9; Holten (2001 a), pp. 6; Holten (2001 b), pp. 11.

Conceptual Language Aspect	Linguistic action and statement	Meta Model Component (cf. Figure 12)
D-DO-As (Dimension Dimension Object Association)	Composition: Relationship between concepts Dimension and Dimension-Object. A dimension requires a (possible empty) set of dimension objects for its definition (cardinalities (0,n)) and any dimension object requires a unequivocal relationship to one unequivocal dimension (cardinalities (1,1)).	
DO-Hierarchy (Dimension Object Hierarchy)	Composition: Recursive relationship from concept Dimension Object to itself. For dimension objects a hierarchical order is required. Any dimension object may have zero or one higher dimension object (cardinalities (0,1)) and zero or many subordinated ones (cardinalities (0,n)).	
Leave, Non Leave	Subsumption and Subordination: The concept Dimension Object is unequivocally and totally (symbols u, t) specialised in the concepts Leave and Non Leave. Leaves are on the lowest level of the dimension hierarchies. Non Leaves are on all other levels. The set of leaves is the same for all dimensions belonging to the same dimension grouping.	
Hierarchy Level	Subsumption: Levels of hierarchy dimensions consist of and dimension objects are assigned to.	
D-HL-As (Dimension Hierarchy Level Association)	Composition: Relation between concepts Dimension and Hierarchy-Level. Any Dimension comprises one or many hierarchical levels (cardinalities (1,n)) and a hierarchical level as abstract object can be related to one or many dimensions (cardinalities (1,n)).	
D-HL-Sequence (Dimension Hierarchy Level Association Sequence)	Composition: There is a unequivocal order of the hierarchy levels associated to a dimension. Every hierarchical level of a dimension has zero or one predecessor and zero or one successor. (cardinalities (1,0) on either side).	
DO-DHL-As (Dimension Object Dimension Hierarchy Level Association Association)	Composition: Relationship between concepts Dimension-Object and D-HL-As. Every dimension object must unequivocally be associated to one hierarchical level of the dimension it belongs to (cardinalities (1,1)) and every hierarchical level of a dimension must contain at least one or many dimension objects (cardinalities (1,n)).	
Dimension Scope	Subsumption: Used to define scopes out of dimensions relevant for a management view.	

Conceptual Language Aspect	Linguistic action and statement	Meta Model Component (cf. Figure 12)
DO-DS-As (Dimension Object Dimension Scope Association)	Composition: Relationship between concepts Dimension-Object and Dimension-Scope. Any dimension object may or may not be member of a dimension scope (cardinalities (0,n)). Any dimension scope comprises one or more dimension objects (cardinalities (1,n)).	
Dimension-Scope-Combination	Subsumption: Used to identify combinations of dimension scopes while defining management views.	
DS-DSC-As (Dimension Scope Dimension Scope-Combination Association)	Composition: Relationship between concepts Dimension-Scope and Dimension-Scope-Combination. Any dimension scope combination may contain one or many dimension scopes (cardinalities (1,n)) whereas any dimension scope can be a member of zero or many dimension scope combinations (cardinalities (0,n)).	
Reference Object	Subsumption: Reference objects are defined by RIEBEL as all “measures, processes and states of affairs which can be object to arrangements or examinations on their own” ²⁹ .	
Combined Reference Object	Subsumption and Subordination: A combined reference object is a reference object interpreted as a vector.	
C-RO-Coordinates (Combined Reference Object Coordinates)	Composition: Relationship between concepts Combined-Reference-Object and Dimension-Object. Dimension objects are used as coordinates to specify combined reference objects. Any dimension object can be used as a coordinate for one or many combined reference objects (cardinalities (1,n)) and any combined reference object has one or many coordinates (cardinalities (1,n)).	
Reference Object, Combined Reference Object, Dimension-Object	Subordination: A reference object is a vector and then specialized as combined reference object. Additionally a reference object can have the role of an dimension object and then is used to define dimensions and as coordinates for combined reference objects. Nevertheless any dimension object is a reference object. The specialization of reference objects thus is not unequivocal (symbol n) but total (symbol t).	

²⁹ Riebel (1979), p. 869

Conceptual Language Aspect	Linguistic action and statement	Meta Model Component (cf. Figure 12)
RO-Structure (Reference Object Structure)	Composition: Recursive relationship from concept Reference-Object to itself. Logically this relationship defines the space of all reference objects management views can be composed of. Any reference object may have zero or many higher reference objects (cardinalities (0,n)) and zero or many subordinated ones (cardinalities (0,n)).	
Ratio	Subsumption: Ratios are the instruments to measure management relevant aspects of the value of an enterprise, the business performance and the financial situation.	
Basis Ratio, Calculated Ratio	Subsumption and Subordination: The concept Ratio is unequivocally and totally (symbols u and t) specialised in the concepts Basis Ratio and Calculated Ratio. Basis ratios are defined by means of statements. Calculated ratios are additionally defined by means of algebraic calculation expressions. Every ratio used to define a calculated ratio must be defined in advance.	
Ratio Structure	Composition: Recursive relationship from concept Ratio to itself. Any ratio can become part of an algebraic expression to calculate another ratio (cardinalities (0,n)) and any ratio can be explained algebraically based on a possible empty set of other ratios (cardinalities (0,n)).	
Operator	Subsumption: Operators are used in algebraic expressions to define ratios.	
Calculation Expression	Composition: Relationship between concepts Operator and Ratio-Structure. Since ratio structures are parts of algebraic expressions there must be an unequivocal association of a given ratio structure to one operator (cardinalities (1,1)) whereas any operator can be used in zero or many calculation expressions (cardinalities (0,n)).	
CE-Sequence (Calculation Expression Sequence)	Composition: Recursive relationship from concept Calculation Expression to itself. To explain an algebraic expression an unequivocal sequence of calculation expressions is required. Any calculation expression must have zero or one predecessor and zero or one successor (cardinalities (0,1) on either side).	
Ratio System	Subsumption: A ratio system is a set of ratios which enables the analysis of different meaningful aspects of a business situation.	

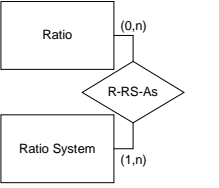
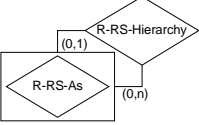
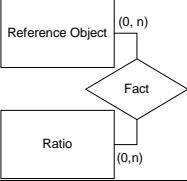

Conceptual Language Aspect	Linguistic action and statement	Meta Model Component (cf. Figure 12)
R-RS-As (Ratio Ratio System Association)	Composition: Relationship between concepts Ratio and Ratio-System. A ratio system comprises one or many ratios (cardinalities (1,n)) and a ratio may be member of zero or many ratio systems (cardinalities (0,n)).	
R-RS-Hierarchy (Ratio Ratio System-Association Hierarchy)	Composition: Recursive relationship from concept R-RS-As to itself. Ratios which are part of a ratio system are organized hierarchically. Any ratio as member of a given ratio system may have zero or one higher ratio (cardinalities (0,1)) and zero or many subordinated ones (cardinalities (0,n)).	
Fact	Composition: Relationship between concepts Reference-Object and Ratio. Any reference object can be combined with zero or many ratios and vice versa (cardinalities (0,n) on either side).	
Information Object	Composition: Relationship between concepts Ratio System and Dimension Scope Combination. Set of facts relevant for a management user. One ratio system can be combined with none or many dimension scope combinations and vice versa (cardinalities (0,n) on either side).	

Table 1: Linguistic actions and statements for the construction of the conceptual language aspect of the MetaMIS Modelling Technique

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