Provision of Customer Knowledge to Supply Chains[1]

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Abstract

Knowledge about customers is vital for supply chains in order to ensure customer satisfaction. In an ideal supply chain environment, supply chain partners are able to perform planning tasks collaboratively, because they share information. However, customers are not always able or willing to share information with their suppliers. End consumers, on the one hand, do not usually provide a retail company with demand information. On the other hand, industrial customers might consciously hide information. Wherever a supply chain is not provided with demand forecast information, it needs to derive these demand forecasts by other means. Customer Relationship Management provides a set of tools to overcome informational uncertainty. We show how CRM and SCM information can be integrated on the conceptual as well as technical levels in order to provide supply chain managers with relevant information.

Keywords

Supply Chain Management, Customer Relationship Management, Customer Knowledge, Information Sharing

Introduction

Deriving knowledge about customers is one of the main challenges confronting analytical Customer Relationship Management (CRM). This knowledge is used mainly by companies in order to provide customers with what they require at a given time and place. Furthermore, this knowledge is useful for manufacturing industries, because they can adjust their product development to the requirements of markets.

Whereas retailing companies interact with end consumers, their suppliers and the entire supply chain interact with industrial customers. However, applying analytical CRM methods at the end of the retail chain will not usually help suppliers to satisfy their own customers' needs. Furthermore, there are different problems, e.g., the bullwhip effect in the case of increasing or decreasing demand. Methods of Supply Chain Management (SCM), such as Collaborative Forecasting, Planning, and Replenishment (CFPR) or Vendor Managed Inventory (VMI) are intended to solve these problems. Nevertheless, these concepts imply that customers do not interfere with the replenishment planning of their suppliers by means of spontaneous or uncoordinated orders.

Regardless of whether the customer includes his supplier in his replenishment planning process or not, information on customers demand is vital for the supplier to reduce costs and delivery times. Depending on the degree of information sharing, either SCM methods or CRM methods may provide this information. Both concepts need to be integrated to enable a collaborative planning process within supply chains which deals with different degrees of information sharing. This paper addresses the integration of SCM and CRM. For this purpose, we introduce some related work in the next section. The third section shows how

SCM and CRM information can be integrated on a conceptual level. This is in Section 4 followed by the technical integration of SCM and CRM data. The paper closes with a summary and a brief description of our planned ongoing research.

Related Work

Supply Chain Management

The objectives of supply chain management are design, operation and maintenance of integrated value chains so as to satisfy consumer needs most efficiently by simultaneously maximizing customer service (Bechtel & Jayaram 1997, Christopher 1994, Hewitt 1994). SCM is currently accepted as a concept integrating inter-organizational business processes. In order to fulfill its objective, it must include other concepts such as Efficient Consumer Response, Quick Response, Continuous Replenishment and Customer Relationship Management (Bechtel et al. 1997, Stadtler 2000). The design of supply chains requires the specification of business processes and supply-chain-wide planning routines as a special component of the development of information systems which form the backbone of any supply chain integration (Miller 2001, Rohde & Wagner 2000). Information technology is widely perceived as the enabler of supply chain integration (Bechtel et al. 1997, Hewitt 1994, Meyr, Rohde & Wagner 2000). Partners in a supply chain have to perform their activities in the most efficient way by concentrating on their core competencies (Christopher 1994).

The Supply Chain Operations Reference (SCOR) Model provided by the Supply Chain Council is a reference model for structure, processes, and information flows within an inter-organizational supply chain (SCC 2001). The SCOR Model contains measures for operational control and best practices for supply chain design. Five main processes characterize the SCOR Model: Plan, Source, Make, Deliver and Return. The SCOR Model is structured in four hierarchical levels. The main processes are defined at the top level (level one). At the second level, these main processes are clustered into process categories which depend on the underlying process model. There are three relevant business categories for the SCOR Model at this level. These are "Make-to-Stock", "Make-to-Order", and "Engineer-to-Order". Additionally, at level two, some enabling processes are identified.

The highest level of detail within the SCOR Model is the third level where each process category from level two is refined by inter-related process elements. The processes and their relationships are defined by means of tables. Level four is not covered by the SCOR Model, since it would contain a detailed description of the internal business processes of the cooperating enterprises. As a result, the SCOR model needs to be extended by a framework adjusting internal and external business processes, in order to align an existing process infrastructure with inter-organizational processes that result from the SCOR approach.

Customer Relationship Management

The shift to a buyer's market and the loss in relevance and explanatory power of the classical marketing paradigm, the 4 Ps, in the 1990's, led to a new strategic approach called relationship marketing. Originating in the service or industrial marketing literature, relationship marketing focuses on the development and cultivation of long-term profitable relationships (Berry 1983, Grönroos 1994, Peck, Payne, Christopher & Clark 1999).

Following Payne, et al. (Payne, Christopher, Clark & Peck 1998), relationship marketing considers relationships "in every direction". The customer relationship management (CRM) approach, focuses on profit-enhancing relationships with customers only (Ahlert & Hesse 2002). Based on the motion of a customer life cycle (Ives & Learmonth 1984), a relationship can be seen as an investment, where, for example, customer relationship campaigns are conducted to achieve positive customer values at the end of the life cycle. Considering the special needs of customers, combined with individualized marketing campaigns, leads to higher sales (Gillenson, Sherrell & Chen 1999, Stone, Woodcock & Wilson 1996) and retaining an existing customer is about five times more profitable than finding a new one (Buchanan & Gilles 1990, Reichheld 1996).

Conceptual Integration of SCM and CRM Information

Impact of Information Sharing on Supply Chain Management

Evidence of the positive effects of information sharing can be found through various approaches, where savings are estimated in an information sharing supply chain environment using simulation models (Aviv 2001, Cachon & Fisher 2000, Gavirneni & Fisher 1999, Lee, So & Tang 2000). The focus of this section is not to quantify the effect of information sharing along supply chains and thus proving the effect, but to assume a positive effect and justify it with simple model-based explanations.

The integration level of material and inventory management and the structure of order costs are the main parameters of supply chain management (Christopher 1998). We illustrate this using a simple model of inventory development and the effects of an integrated material and inventory management on order costs (see Figure 1). Three variables are relevant in calculating the economic ordering quantity. These variables are warehousing costs, costs per unit, and costs per order. In the interest of simplicity, costs per unit are assumed to be constant (the results would be the same if discounts on certain order sizes were deducted). Warehousing costs increase linearly with increasing order quantities, since they are linked directly to the inventory level. Costs per order decrease with an increasing order size, because fixed costs are spread over more units. The total cost function is the sum of these three functions as shown in the top left model of Figure 1.

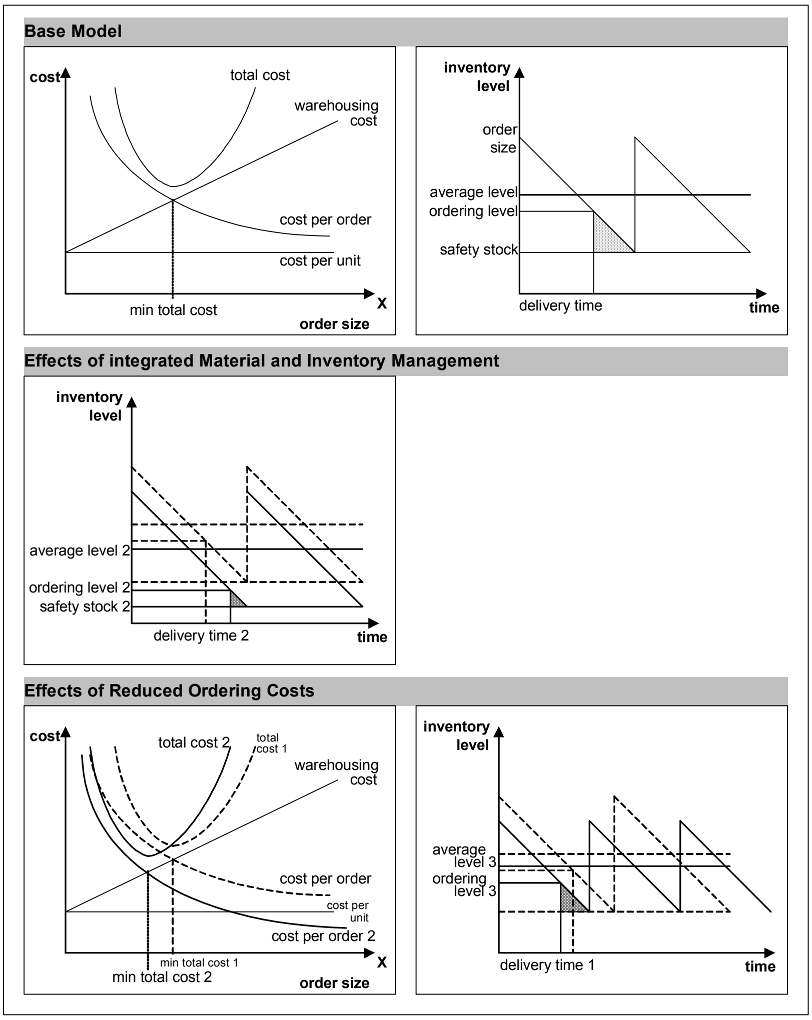

Figure 1. Effects of information on material and inventory management and ordering costs (based on Holten, Dreiling, zur Muehlen & Becker 2002)

The development of inventory over time is shown in the top right model of Figure 1. A certain safety stock is required to guarantee production in cases of supply shortages. For a start, we assume a stock above this level. Furthermore, we assume a linear consumption function over time. Based on a given delivery time, we can determine the reorder point for the economic ordering quantity.

It is important to understand that information itself never has a direct business value. Effects of information on business are always indirect. Two relevant effects of improved information availability for the management of supply chain processes can be explained using the simple model in Figure 1. Firstly, information availability enables an enterprise to reduce the average stock level by reducing safety stocks and delivery times. Secondly, information availability enables an enterprise to reduce the average stock level by increasing order frequency.

Using information correctly ensures that required materials can be delivered on time. This effect is based simply on the exchange of information between partners during the course of the business process (see the center model in Figure 1). If production planning systems of manufacturers and scheduling systems of suppliers are provided automatically with point-of-sale information of the retail partner, planning tasks can be performed with improved quality. The result is a reduction of delivery times, since this is not only the shipment time, but also the time used to organize the entire business transaction, which can be decreased dramatically. The effects discussed so far, clearly provide a case for an integrated material management.

The second effect is based on the duration of contracts between supply chain partners. Based on long-term agreements, the costs per order can be reduced, because some uncertainty for suppliers and manufacturers is eliminated. In the simple model introduced in Figure 1, this results in a shift to the left of the total cost function and a reduced minimum economic order quantity (see bottom left model in Figure 1). This implies increasing order frequencies, which is economically logical (see bottom right model in Figure 1). To benefit from this effect, which leads to a reduced average inventory level because of reduced order sizes, an integration of material and finance management is necessary.

Impact of CRM Information on SCM

The concept of advanced planning incorporates integrated supply chain planning as a core concept. Advanced planning systems (APS) support this integrated planning task (Rohde 2000). Demand planning and demand fulfillment data at the sales stage is fed back into distribution planning and transport planning at the distribution stage. Industrial customers are able to provide their suppliers with relatively precise demand information, obtained from collaborative forecasting with their industrial customers. End consumers do not provide retail companies with demand information. This leads to different forecasting methods at the retailing stage.

Customer Relationship Management provides a set of tools for increasing the forecasting quality of retailers. Using CRM information within the supply chain potentially maximizes the end consumer's satisfaction in several respects. Firstly, efficiently derived high-quality forecasting information shared with suppliers enable stock and cost reductions within the SCM. Secondly, the out-of-stock problem can be reduced with a higher quality of demand data, given that demand will be satisfied. Thirdly, the bullwhip effect resulting from non-stationary demands can be reduced, if the entire supply chain is provided with high-quality demand data for the final supply chain partner. If the quality of forecasted customer demand is sufficiently high as to almost correspond with actual demand, the effects of sharing this information will be as they have been proven for information sharing supply chains (Aviv 2001, Cachon et al. 2000, Gavirneni et al. 1999, Lee et al. 2000).

Apart from customer-related information gained by CRM, market-related information is required within the strategic planning of a supply chain. Market research is a tool for decreasing the risk of marketing and resulting product development decisions (Proctor 1997). Whereas CRM focuses on forecasting demands of non-anonymous customers, market research provides information on markets. Both CRM information and market research information need to be provided to the preliminary supply chain, in order to increase the quality of demand-planning processes at an operational as well as tactical level. For this purpose, CRM should be applied to industrial customers within the supply chain. Additionally, market research is required at every stage of the supply chain. Figure 2 contains information the flows necessary to implement this concept.

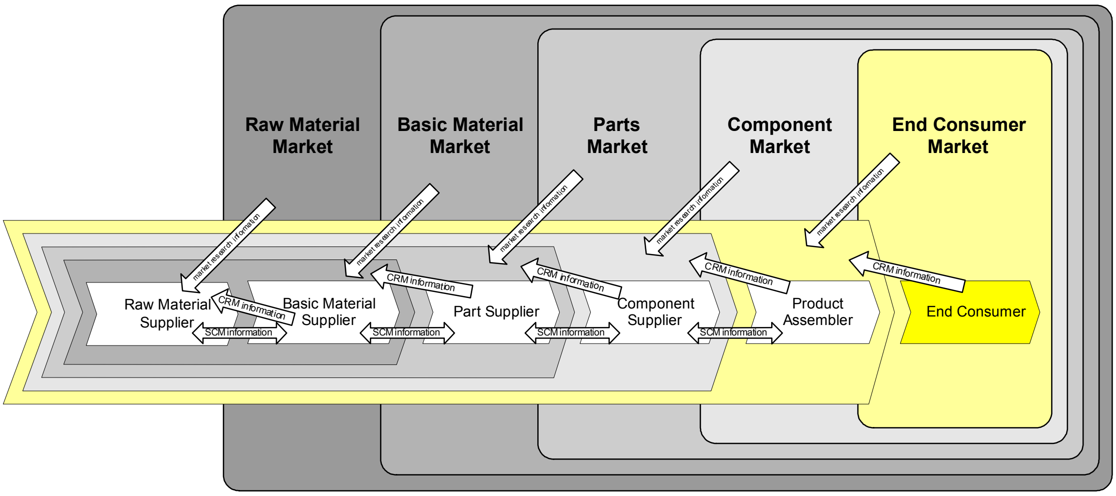

Figure 2. Supply Chains and Markets

Technical Integration of SCM and CRM Data

Specification of Management Views

To achieve the combined goals of SCM and CRM management, information must be provided which is based on specifications of management reports. For this purpose the MetaMIS approach has been developed (Becker & Holten 1998, Holten 1999, Holten 2003). Incorporating the MIS meta model as the core concept, the MetaMIS Toolset has been developed as a prototype to support the development of information warehouses (Holten 2000). It consists of six different tools which enable the user to express the business requirements of management and then use this meta data to build an entire management information system environment. The MetaMIS approach allows the generation of data mart schemas based on user-oriented specifications of management views (Holten 2003).

The MetaMIS approach has been improved continuously, so as to form to a method which combines a language for the specification of management views (defined by a language-based meta model) and guidelines on how to use it (defined by a process-based meta model) (The language-based MIS meta model is shown in Appendix A). The MetaMIS approach is a general approach to specifying management views. It has been extended to conform to the specific requirements of CRM (Becker, Dreiling & Ribbert 2003). Especially qualitative information which is vital to express, e.g., preferences of customers has been added. The language-based meta model containing the extension, is shown in Appendix B. The MetaMIS modeling approach has been validated with the Swiss reinsurance company Swiss Re, one of the world's largest reinsurance companies. The validation contained a set of models of information spaces which are required to perform the Swiss Re managerial activity "Group Performance Measurement" (GPM) (Holten, Dreiling & Schmid 2002). The following brief example illustrates how the extended MetaMIS specification language can be applied to specify analytical CRM systems.

MetaMIS commences with the definition of dimensions. Dimensions are defined by hierarchically ordered dimension objects (e.g. products, customers, points of time, or customer sales representatives). Based on the enterprise theory of Riebel (Riebel 1979), dimension objects can be understood as entities subject to managerial analysis. In case of an industrial company structuring its knowledge about their *Automotive Supplies* division a customer dimension helps to perform analyses about customers or groups of customers. The *Automotive Supplies* division consists of two subdivisions which are *original equipment* (delivery of automotive parts to car producers) and *replacement* (delivery of parts to end consumers or retailers). According to the company's structure, customers and products as dimension objects of the dimensions *Customer* and *Product* are ordered hierarchically. Both dimensions are shown in Figure 3. Other dimensions could be time (days hierarchically ordered by months and years) or version (optimistic, pessimistic, actual).

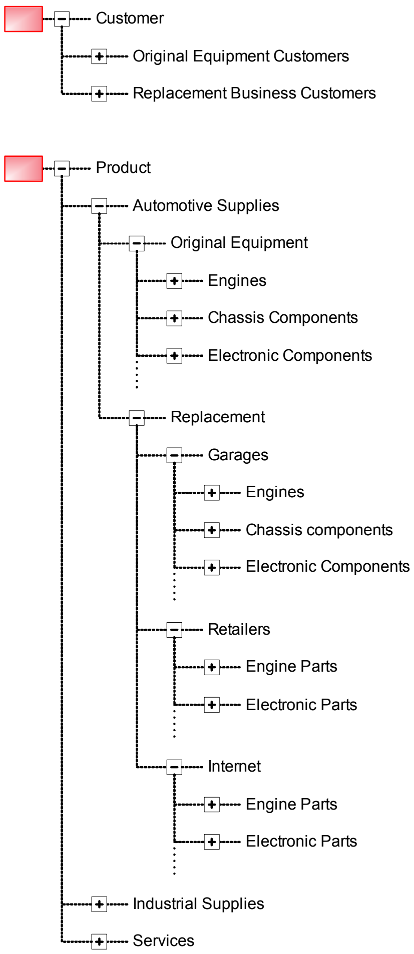

Figure 3. Dimensions "Customer" and "Product"

Since *Automotive Supplies* is only one of the divisions of this company and the managerial activities to perform are only within the *Automotive Supplies* division, the total set of products and customers can be reduced to the relevant entities for these managerial activities. In the case of automotive customers (non-consumers), this leads to two dimension scopes, one that contains all products sold within the subdivision *Original Equipment* and one that contains all customers (car producers) of the subdivision. These dimension scopes are created from the complete dimensions *Product* and *Customer*. No other analysis dimensions of the company have to be reduced in this case. Both dimension scopes together with the dimensions not explicitly mentioned here (they are denoted by the dotted line) are grouped together in the dimension scope combination *Subdivision Automotive Supplies Original Equipment* shown in Figure 4.

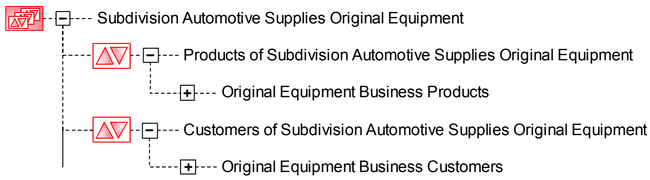

Figure 4. Dimension Scope Combination "Subdivision Automotive Supplies Original Equipment"

Having defined the dimension scope combination which reduces the total set of reference objects to one relevant set, we can now specify qualitative and quantitative information about the customers. We can divide qualitative information into customer preferences and customer master data (Becker, Ribbert & Dreiling 2002). Customer preferences are explicitly mentioned preferences such as type of food on scheduled flights, type of rental cars, or features of hotel rooms. Starting with customer preferences, we can define mandatory conditions for conducting any business, as well as weaker customer preferences. Preferences can be organized into preference systems to allow broad analysis at a glance. A set of delivery conditions negotiated with industrial partners, for instance, might contain EDI standards with which the company has to comply, INCO terms for the delivery of certain automotive supplies, and payment conditions. This preference system is assigned to the dimension scope combination shown in Figure 4 allowing to specify customer preferences within the preference object *Delivery Conditions Automotive Supplies Original Equipment*. Figure 5 contains the preference system *Delivery Conditions* and the preference object *Delivery Conditions Automotive Supplies Original Equipment*.

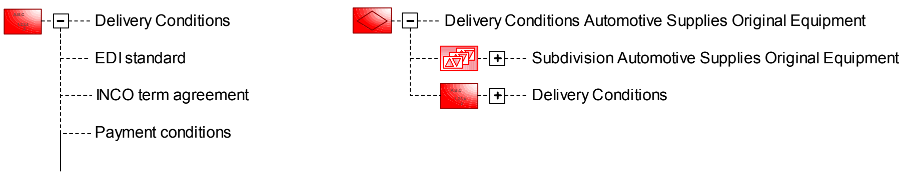

Figure 5. Preference System "Delivery Conditions" and Preference Object "Delivery Conditions Automotive Supplies Original Equipment"

The next aspect of customer knowledge is customer master data. Master data as well as customer preferences, can be organized in master data systems reflecting their interdependencies or allowing holistic analyses. Several master data such as delivery address components (street, postal code, country, or P.O. box) or payment information (credit card number, expiration date, bank account number, Swift Bank Identifier Code) can be subsumed into a master data system *Delivery and Payment*. As in the preference system case, a master data system is assigned to a dimension scope combination resulting in a master data object. Figure 6 shows the master data system *Delivery and Payment* and the master data object *Delivery and Payment Automotive Supplies Original Equipment* where it is assigned to the dimensionn scope combination *Subdivision Automotive Supplies Original Equipment*.

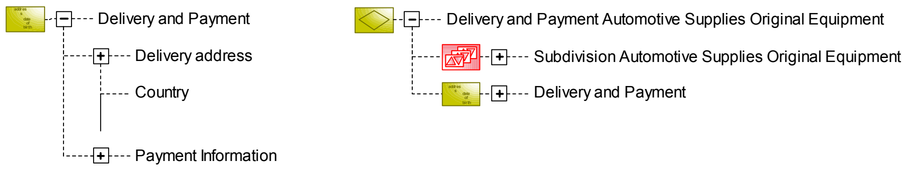

Figure 6. Master Data System "Delivery and Payment" and Master Data Object "Delivery and Payment Automotive Supplies Original Equipment"

After having specified all qualitative information about customers, we can also specify quantitative information. For this purpose, we need to define ratios which are organized into ratio systems. Ratio systems can reflect calculative interdependencies between ratios, but usually ratios are hierarchically organized in ratio systems from a business perspective according to their importance for a managerial activity. High-level ratios might be profitability, order frequency, and service utilization, allowing to drill-down to less important ratios explaining these high level ratios. Ratio systems are assigned to dimension scope combinations in order to create business facts.

Business analyses usually require a comparison of business facts. In order to conduct such dynamic analyses, fact calculation expressions can be defined, involving a variable number of business facts which are processed by means of algebraic expressions (Holten & Dreiling 2002). Examples of fact calculation expressions are the profit growth rate of a business group or the variance between planned figures and actual figures. In contrast to ratios, fact calculations are algebraic calculations of business facts (Holten et al. 2002). Whereas a ratio can be assigned to a reference object and thus forms a business fact, fact calculations are performed with business facts with different reference objects assigned to one ratio.

Fact calculation expressions as well as a ratio system and a dimension scope combination are part of the definition of information objects. Figure 7 shows the ratio system *Performance Measurement* and the information object *Performance Measurement Automotive Supplies Original Equipment*.

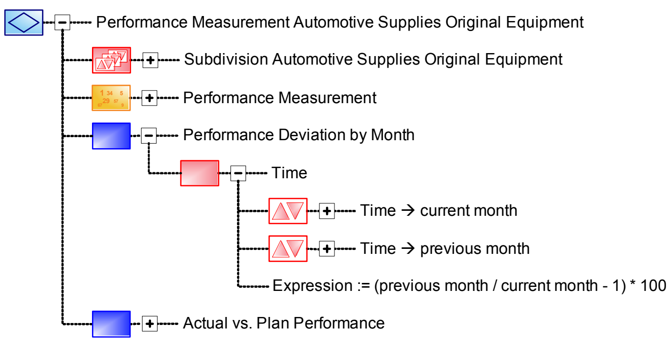

Figure 7. Ratio System "Performance Measurement" and Information Object "Performance Measurement Automotive Supplies Original Equipment"

The defined preference object *Delivery Conditions Automotive Supplies Original Equipment*, master data object *Delivery and Payment Automotive Supplies Original Equipment*, and information object *Performance Measurement Automotive Supplies Original Equipment* form the customer knowledge object *Automotive Supplies Original Equipment Customer*

Knowledge which is shown in Figure 8. It incorporates all qualitative and quantitative information we can derive from operational data sources.

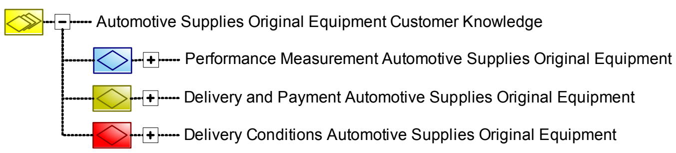

Figure 8. Customer Knowledge Object "Automotive Supplies Original Equipment Customer Knowledge"

The introduced specification language can be used to model all information about customers along the entire supply chain. The example so far, dealt with industrial automotive customers. An example of a specification of end consumer knowledge is shown in Figure 9. The relevant set of reference objects within the dimension scope combination *Subdivision Automotive Supplies Replacement,* contains all customers of the end consumer market (e.g. customers ordering tires) and products sold on this market. The preference system *After Sales Preferences* contains several preferences of end consumers such as *Notification of product innovations* or *Notification of related products* which constitute customized marketing information or *Notification of service requirements* if, e.g., a rubber hose within the engine needs to be replaced. The preference object *After Sales Preferences Automotive Supplies Replacement* assigns this preference system to the dimension scope combination *Subdivision Automotive Supplies Replacement*.

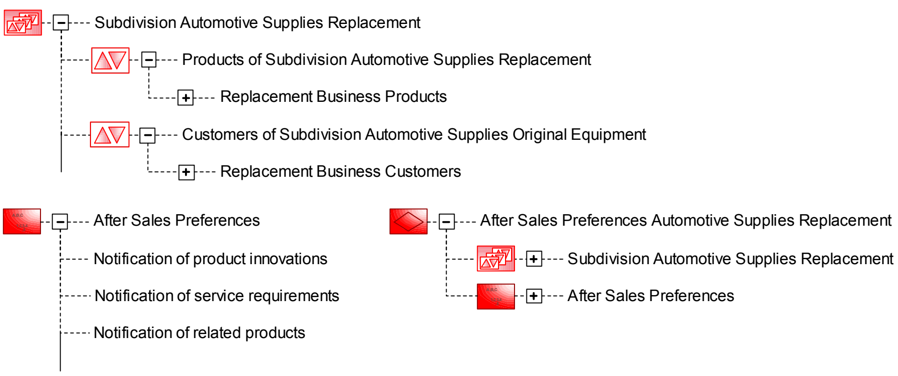

Figure 9. Specification of a Preference Object within an end consumer example

The meta data generated by applying the MetaMIS method, can be further processed to derive technical infrastructures such as data marts (Holten 2001). Thus, the customer knowledge specifications resulting in corresponding information systems on a conceptual level, support analysis as a mandatory part of managerial activities.

Technical Integration of CRM and SCM Data

The specified management views can be implemented using traditional data warehousing methods. A data warehouse is the central layer of an ideal three-layer-architecture connecting online transaction processing (OLTP) systems and components enabling online analytical processing (OLAP) (Becker et al. 1998, Chaudhuri & Dayal 1997). OLAP supports adequate navigation for management users through so called multi-dimensional information spaces. Business process data from OLTP systems are the source for OLAP analysis. Typically, the integration of OLTP systems and a data warehouse is based on tools performing extraction, transformation, and loading tasks (ETL) on the source data (Inmon 2002).

At an intra-organizational level, business supporting information systems produce data about business transactions. For the purpose of CRM and SCM, this data can be analyzed, enabling analytical CRM and SCM. Due to the fact that this data is encoded in various operational data sources, there needs to be an integrating layer to derive relevant managerial information from these data sources. This can be achieved by means of local information warehouses. Out of these information warehouses, several management reports can be generated, which support corresponding managerial activities.

To support supply chain wide information sharing, data from operational data sources of single supply chain partners need to be integrated in a supply-chain-wide knowledge warehouse. This knowledge warehouse then serves as a basis for generating managerial reports at the inter-organizational as well as intra-organizational levels. Figure 10 shows an architecture enabling the integration of inter-organizational and intra-organizational data for the purpose of analysis.

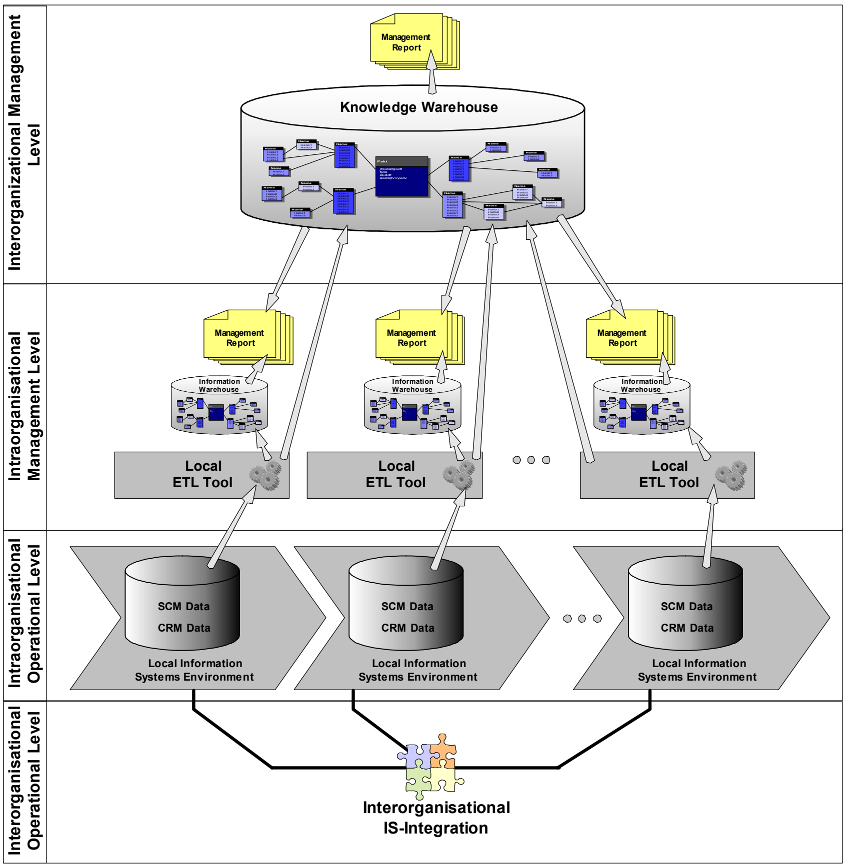

Figure 10. Technical Integration of CRM and SCM Data

The architecture serves analytical CRM as well as analytical SCM, implying operational CRM and SCM components within the local information systems environments. Thus, the management reports at the inter-organizational and intra-organizational levels contain CRM and SCM information enabling the optimization of business processes from both perspectives.

Summary and Outlook

The aim of this paper was to integrate Customer Relationship Management into Supply Chain Management, in order to achieve a higher accuracy of demand forecasting within supply chains. Because end consumers will not usually participate actively in the demand forecasting process of their suppliers, product development efforts, shipment quantities, and shipment times maybe inadequate to satisfy the customer sufficiently. CRM methods become vital for the success of the entire supply chain, because a more accurate determination the end consumers demand, potentially deceases delivery times and costs. Additionally, CRM methods are required if certain supply chain partners are unable or unwilling to share information with their supply chain. This preliminary supply chain again needs highly accurate demand data for non-information sharing customers, in order to decrease delivery times and costs.

Our further work will examine the configuration of some management reports, thus facilitating supply chain management with both CRM and SCM information. We will further examine which information is derived with SCM methods on the one hand and CRM methods on the other, if supply chain partners are unwilling or unable to share information.

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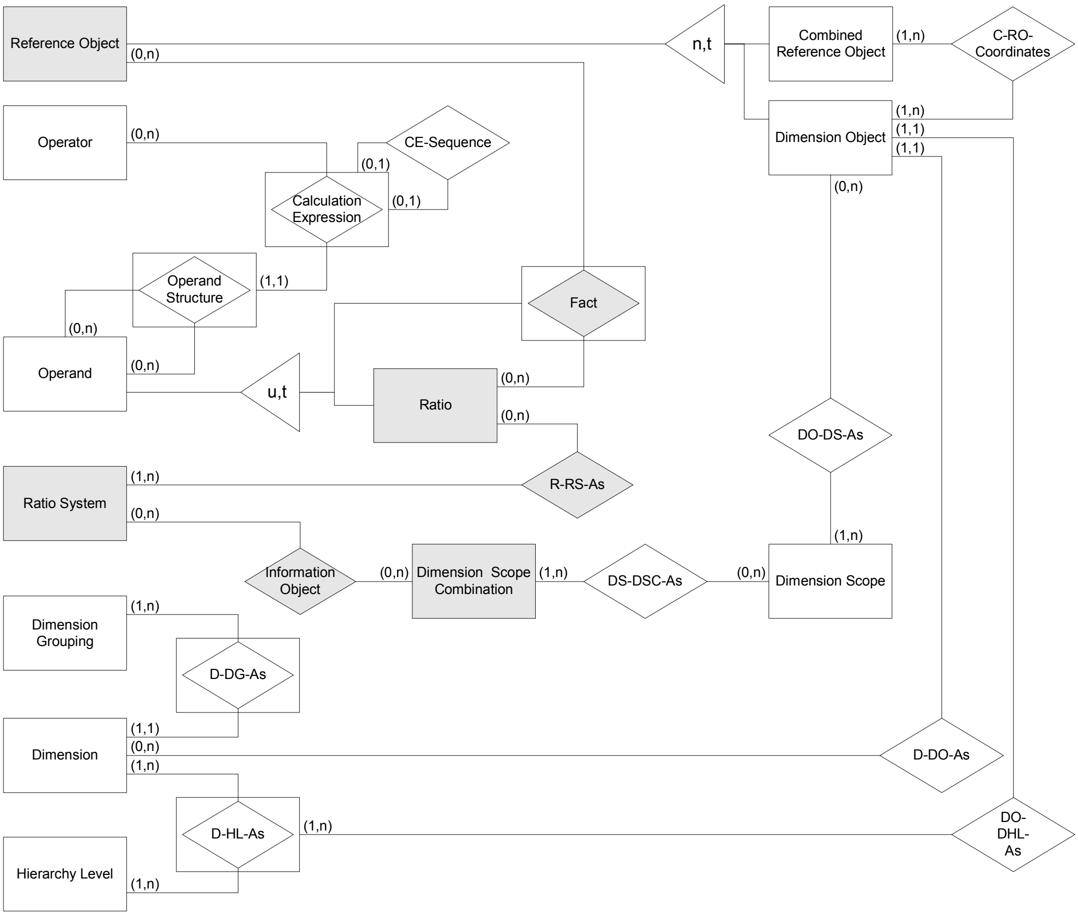
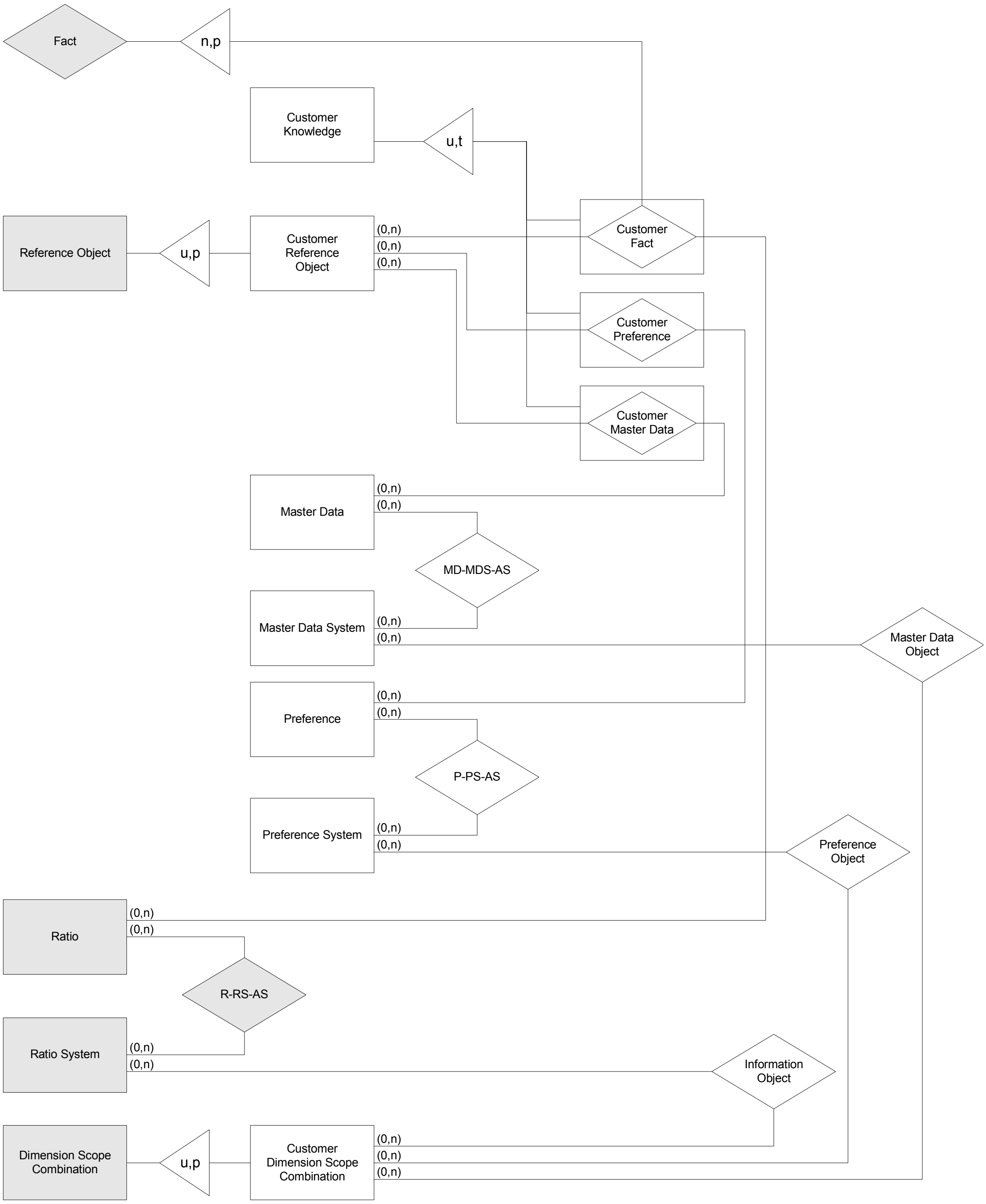
Appendix



Appendix A. Segment of the Meta Model of Management Information Systems (based on Holten 2001)



Appendix B. Analytical CRM Meta Model – Data Perspective (based on Becker et al. 2003)

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