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Implications from customer behavior for manufacturing

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Abstract Due to increasing competition caused by globalization manufacturers have to reduce costs and at the same time provide better products to their customers' individual needs. This can only be done, if the companies are able to understand the behavior of their customers and forecast the sales numbers for their individual products. One way to get a better prognosis of customer behavior patterns are observations on public market places. But the companies have to link together the observations with events influencing the decisions of customers. This can be done by using a decision support system which was developed for retailers in combination with a data warehouse. The experiences from this project can be transferred to manufacturing companies as well, helping them to achieve better planning data for the manufacturing process.

Keywords Event-based behavior · Decision support systems · Data warehouse · Public marketplaces · Demand-driven manufacturing · Knowledge management

Customer behavior in fast moving markets

Two developments are delivering the major challenges for today's manufacturing industry. The first one is globalization, which leads to a greater potential for finding customers, but as well enhances the competition for the company by opening the regional markets for foreign manufacturers.

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The second trend lies in the demand for individualization of products leading to shrinking quantities of equal products and a higher need for flexibility in the manufacturing process.

To face these challenges, different strategies have been proposed in the last years. One strategy lies in the enrichment of products with services providing a unique experience for the customer (Dillon, Lee, & Matheson, 2005). Another strategy consists of customer-oriented or agile manufacturing (BüyüKözkan, Derelİ, & Baykasoglu, 2004; Kidd, 1994). This provides a better alignment to customer needs, but is leading to great problems for the manufacturers. They are no longer able to produce their goods in advance, and have to integrate their processes with their suppliers to be able to build products tailored to individual customer needs in a very short time. This necessity has been the advent of supply chain management (An & Fromm, 2005; Becker, 2005). First starting with machine tools industry and with luxury goods, this evolution is going to comprise customer goods industry as well. Even the convenience goods industry is producing an ever growing number of product variations.

However, the reduction of stock capacities to minimize the capital binding is necessary. Thus enterprises have to change and optimize their business processes. The stock capital binding could partially be solved by introducing lean production concepts (Liker, 2004; Womack & Jones, 1996). But it may become a difficult situation: the customers have to wait for high-price products very long, and/or on the employees always have to stand by to solve customer needs quickly when they arise.

The variety of products and the resulting complexity of manufacturing processes need efficient solutions for providing products in real time.

Therefore the analysis of customer needs becomes more and more important. So every method to prognosticate the point of time, when the customer will buy some special

goods, is increasingly important and can become a competitive advantage for the manufacturing companies.

Identification of customer behaviors

There are two different means to identify customer behavior successfully. A widely practiced method to meet with general acceptance is to introduce customer relationship management (CRM). The focus of CRM lies on the identification of the individual needs and wishes of the customers to manage customer relationships and to provide a feedback channel to increase customer satisfaction (Kamakura et al., 2005). Another way is to analyze changes of demand on public market places and identify potential reasons for these changes (Liu, Hsu, Han, & Xia, 2000). This is a generic approach and uses statistical procedures for the examination of the observed behavior. In the analysis of the reasons for the changes of customer behavior, one can identify different causes, as done by Verhoef, Franses, and Donkers (2002). On one side there are common and long-term trends, influenced by fashions, technological progress, and culturally changing habits of the customers. Otherwise there are special events, which can be periodic (like onset of winter, beginning of summer, Christmas or other holidays, or even week-ends or paydays), or acyclic (like Olympics, world championships, or big pop music events). The analysis of the correlation between the influencing factors of the customer needs is the core of our research activities.

Approach on optimizing sales channels

The continuous change of market structures leads to dramatically changes of the sales channels for each company. The potential of online marketplaces for reflecting customer needs and operating all around the clock becomes more and more important. After the e-commerce hype leading to big retailers selling via individually built e-commerce systems, public market places were built to provide a tool for selling goods for everyone. This trend will continue for the next years, as forecasted by "Jupiter Research" (Salcedo, 2004): "The online commerce market in Europe will grow from €29 billion in 2003 to €117 billion in 2009, with 61% of European Internet users buying online and spending an average of €843 per buyer. Increased online tenure, growth in the online population, and improved broadband uptake will be the main drivers behind this solid growth". This tendency can be cognized in marginally differing specificity in each region of the world. A successful idea was the concept of eBay. eBay provides a platform as huge marketplace. It enables people from all over the world selling, buying or trading with things from all categories they don't need any longer. But not only private trade was enhanced by eBay. Power sellers started up their businesses on this public market place and were successfully selling goods via this channel. Lately, the huge customer base of eBay attracted big retailers to make use of this trading channel, too.

To make business on these public market places, it is not necessary having any complex e-commerce system. There are solution providers which deliver out-of-the box functionality for connecting inventory management systems with the market place. There are different web-technologies for realizing the interfaces. Presently it is favorable using web services, a very flexible and light-weighted connection method for web-based information systems.

As a matter of principle the connection to the public market place like eBay as a sales channel is neither a problem nor rather expensive. But it is necessary for new participants to implement some preparations before trading on the market places and optimize the use of this kind of sales channel. There are questions like: When should one place goods on the market? How many goods should be placed? How long should the goods be placed, or which auction duration is optimal? Which is the right (starting) price for the placed goods? Which sales campaign (fixed price and/or auction) should be chosen? The right answer to these questions depends on the goals of the seller, which can be a mixture of optimizing the selling volume or optimizing the sales price or both.

But how can traders find the right answers, if these depend on experiences on such market places? Therefore in the next sections, a solution for these issues is outlined, which has been prototypically implemented by the authors as part of an industry-funded research project.

Solution for an adapting decision support system

Particularly small and medium-sized enterprises (SME) are facing up the problem of opening up the potential of new sales channels. Therefore the industrial partner AGETO has built a software system which facilitates fast and simple access to online market places. The software interconnects between existing e-commerce systems of producers or retailers and different market places like eBay. The interface works in two directions (Fig. 1). One direction is the transformation of product data from the sellers to offers, and the automatically placement of the products on the public market. In the other direction the orders on the market place are routed to the seller systems for fulfillment.

To be successful on the public market place, learning from the traders which are already prospering is required. Techniques and methods of Knowledge Management and Business Intelligence, e.g. Data Mining or Data Warehousing, can be utilized to generate the essential decision knowledge.

Fig. 1 Architecture of AGETO eBay web service

Sellers make decisions by using the collected knowledge, being supported by artificial intelligence methods.

So the first step in the project consisted of utilizing the knowledge of diverse power sellers. The knowledge of the power sellers should be shared by explicitly including it in a common knowledge base, as proposed by Sol (2002).

For this purpose an expert system was built using the open source shell Mandarax (Dietrich, 2004), which provides an infrastructure for defining, managing, and rule-based queries. The main functions of the expert system are the determination of the amount of goods to be offered on the market place as well as the exact point in time for the placement. The rules of the expert system reflect experience knowledge of power sellers. As an important influencing factor for the placement of offers on the market, facts and rules on external incidents like special events were included in the knowledge base from the beginning (Fig. 2).

Furthermore the data from all sales activities and transactions were collected and prepared to be utilized. A data warehouse has been built to hold internal data of the market place as well as external data of different data bases delivering information on events which were supposed to be influential for the sales success. This data warehouse, which has been built as a PostgreSQL database, was the first step towards business intelligence, enabling the enterprise to set up a successful customer relationship solution including the analysis of cross selling opportunities, as described by Vitt (2002). Detailed steps for building the data warehouse from the location of the data sources to the analysis and reporting tools are shown in Fig. 3.

Basically, the extraction and collection of prices over time, auction length, placement time, and external factors like seasons, weather, holidays, were included in the data base. From the basic data, classification numbers were derived to provide compact information on sales success from different perspectives. These classification numbers were related to the external events to determine possible correlations between the external events and the internal sales data.

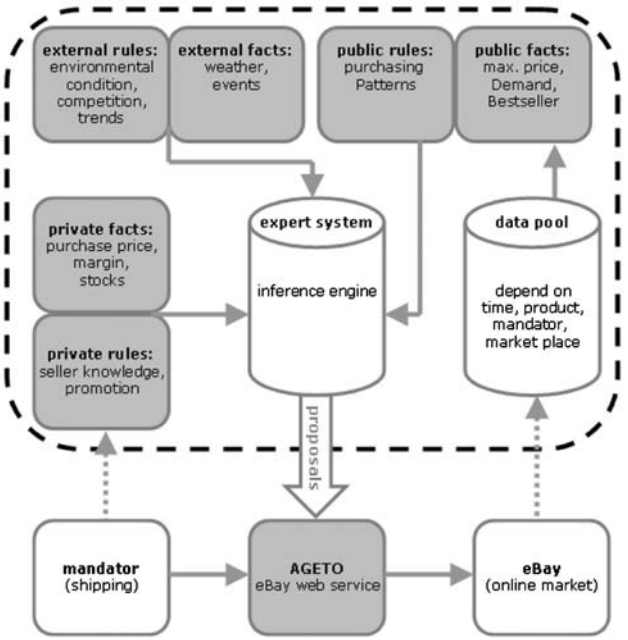

Fig. 2 Architecture (Kassel et al., 2005)

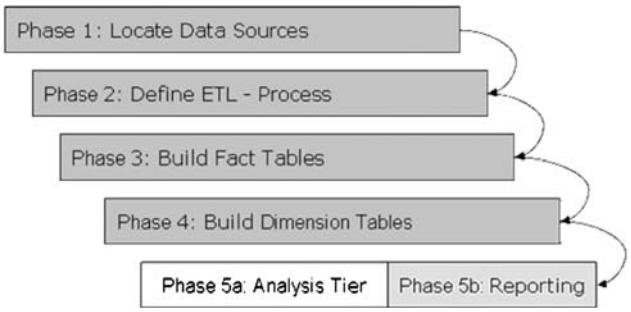

Fig. 3 Progress-model of data warehousing

After building the data warehouse and performing initial correlation analysis, the expert system and the data warehouse had been coupled to provide a closed loop application. This allowed for the automatic adjustment of the expert system rules to the feedback of the classification numbers leading to a higher conformance of the expert system with the changing behavior of the customers. Thus, recurring trends could be computed and used for a better prognosis of market activities.

Lessons learned

In the project a prototypical implementation of a knowledge-based decision support system has been built and field-tested. Within the scope of this project an expert system has been created containing a set of rules depicting the knowledge of power sellers for placing auctions and fixed-price bids

on public market places. After the development period this expert system finally was coupled with the AGETO eBay web service system to provide sellers with assistance in placing their offers on the public market. This part of the work could be achieved well by using a public domain expert system shell.

The planning and implementation of the data warehouse has been challenging, caused by the vast amount of data collected from the user behavior on the market place. It was necessary to transform numerous log files to provide the data needed to measure the success factors of a bid. In extension, the external data, like weather forecasts, had to be condensed and classified. This classification was not easy, and had to be adjusted depending on the correlation quality which can be achieved with the classification.

In this phase of the project the analysis of the data warehouse for finding correlations between external events and sales figures has been done manually. Classification numbers have been built and were used together with the external event data as input for some statistical measures. The found correlations were promising, but further analyses have to be done to find other connections as well. The fundamental experiences in the analysis of the trading-relations are the foundation for raising the quality of the analysis by data mining technologies.

Finally, connecting the data warehouse with the expert system could be done easily; the expert system Mandarax has a data base interface and could be enhanced to use some of the classification numbers as facts, leading to new results.

Transfer of the concept to manufacturing

The solution presented in this paper offers a tool for the combination of observation of special markets and the analysis on sales figures on these markets with external events influencing customer behavior. Supplementary, a feedback system for producers can be developed to predict demand for the manufactured good more precisely. Useful for this analysis are especially the open public marketplaces, where you can achieve and extract a multitude of data concerning preferences of customers in correlation to the specific market situation. Additionally, the sales channel of public markets is rather fast. You can identify trends from the beginning, because the goods are rapidly traded, and the prices of auctions are market driven. This advantage of public market places is already utilized by big online retailers leveraging this sales channel as an ideal test market for new products, which are not announced with expensive marketing campaigns. This can be done anonymously, so the retailers get immediate response on customer affectations.

This analysis and cognition of the market trends could be used by the manufacturers as well; they could sell prototypes via this channel and get immediate customer feedback. Manufacturers can optimize their products and production processes.

By further enhancing the system with a direct connection to the production planning system, a demand driven manufacturing could be established, which is depending on the predicted customer demand. Together with the more direct interaction with the customers by using public markets, this behavior can bear advantages in some industries, because the trade margin can be transformed to customer service and lower prices, further enhancing customer satisfaction and retention (Kassel, Schumann, Grebenstein, & Tittmann, 2005).

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