Usage and evaluation of Supply Chain Management Software – results of an empirical study in the European automotive industry

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Abstract. This paper presents an evaluation of Supply Chain Management Software. For this purpose, we conducted an empirical study in the European automotive industry among car manufacturers, suppliers, distributors, and logistic service providers from 25 countries. In particular, we analysed the objectives these companies are trying to achieve by using Supply Chain Management Software and evaluated to what extent these objectives have been accomplished. Our results show that the companies have been able to reduce both their costs and lead times and to improve their service levels. The survey also reveals, however, that until now, the cooperative potential of Supply Chain Management Software has not been utilized effectively.

Keywords: automotive industry, empirical study, Supply Chain Management, Supply Chain Management Software

1. INTRODUCTION

Supply Chain Management aims to integrate all key business processes throughout the entire supply chain (Oliver & Webber, 1982; Cooper et al., 1997; Handfield & Nicols, 1999; Helms et al., 2000; Knolmayer et al., 2002). Some of these processes can be supported by ERP (enterprise resource planning) software. However, these software solutions are usually insuf-

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icient to represent interorganizational processes among supply chain partners. This fact caused software vendors like i2, Oracle, or SAP to develop Supply Chain Management Software.

Considering the high costs involved in the implementation of Supply Chain Management Software (Gouldson, 2001, p. 19; VanScoy, 2001/02, p. 87), the objective of our paper is to analyse and evaluate the usage of such software solutions. For this purpose, we conducted an empirical study in the European automotive industry. We questioned 1000 car manufacturers, suppliers, distributors, and logistic service providers from 25 European countries.

We will briefly introduce the objectives of Supply Chain Management and Supply Chain Management Software (Section 2) and then present the results of our survey (Section 3). Our main focus is to analyse the objectives companies attempt to achieve while using Supply Chain Management Software and to evaluate to what extent these goals have been accomplished. The survey intends to not only analyse the subjective level of satisfaction, but also seeks to quantify savings and improvements. Finally, Section 4 provides a conclusion and an outlook for future research.

2. SUPPLY CHAIN MANAGEMENT SOFTWARE – OBJECTIVES AND CONCEPT

Supply Chain Management focuses on all of the integrated aspects which are contained in the entire supply chain from the first supplier to the end customer (Hulihahn, 1985, pp. 51–66; Anderson et al., 1997; Cooper et al., 1997, pp. 1–14; Christopher, 1998, pp. 12–23; McIvor et al., 1998; Simchi-Levi et al., 2000). The major objectives of Supply Chain Management are (Simchi-Levi et al., 2000, p. 4; Walters & Lancaster, 2000, pp. 167–177):

- reduction of production costs (Heizer & Render, 1999; Morton, 1999; Shim & Siegel, 1999; Waller, 1999, pp. 329–358; Stevenson, 2002, pp. 174–195);
- reduction of lead time (Markland et al., 1998, pp. 602–606);
- reduction of transportation costs (Ballou, 1999; Toomey, 2000, pp. 125–126);
- reduction of purchase costs (Simchi-Levi et al., 2000, pp. 241–242; Monczka et al., 2001, pp. 410–517);
- improvement of supplier evaluation and selection (Christopher & Jüttner, 2000, pp. 8–9; Monczka et al., 2001, pp. 225–265);
- improvement of service levels (Simchi-Levi et al., 2000, pp. 208–211; Knolmayer et al., 2002, pp. 21–23; Tan, 2002, p. 43); and
- improvement of cooperation (Lee et al., 1997).

Today, information and communication technologies play a key role in Supply Chain Management. In addition to electronic data interchange (EDI) and related technologies like XML/EDI, Supply Chain Management Software has become more important. For example, AMR
Research Inc. estimates that the market volume of such software will continuously increase from approximately $5 billion in 2002 to about $8 billion in 2007 (Lapide & Davis, 2003, p. 3).

While ERP software primarily provides inbound oriented functions (Premkumar, 2000, pp. 63–68; Yellurkar, 2002), Supply Chain Management systems focus on both intra- and interorganizational processes. Currently, most Supply Chain Management Software vendors provide supply chain planning functions which are based on ERP systems to carry out the execution of the planned tasks (see Section 3.5.1). Figure 1 illustrates the complementary application of ERP systems and Supply Chain Management solutions.

For our analysis, we have assumed that Supply Chain Management Software solutions are implemented to achieve the above mentioned Supply Chain Management objectives. Furthermore, the implementation of Supply Chain Management Software often leads to organizational changes. In this case, the software may be considered a trigger for a supply chain redesign.

3. USAGE AND EVALUATION OF SUPPLY CHAIN MANAGEMENT SOFTWARE IN THE EUROPEAN AUTOMOTIVE INDUSTRY: AN EMPIRICAL STUDY

This section presents the results of our empirical analysis. We commence with a description of the research design (Section 3.1) which is followed by an examination of the cur-
rent status of Supply Chain Management Software usage in the European automotive industry. In a first step we analyse the diffusion rate of Supply Chain Management Software (Section 3.2). Next, we examine the objectives of implementing Supply Chain Management Software (Section 3.3). Section 3.4 studies the benefits the companies derived from the usage of these software solutions. Finally, the implementation process is analysed in Section 3.5.

3.1 Research design

As far as we know, this is the first paper which provides a broad empirical study on the usage of Supply Chain Management Software in the European automotive industry. Our survey is essentially descriptive. The study was carried out between February 2002 and June 2002. Information about 1000 companies was acquired through research on the Internet, company registers, the embassies of European countries as well as the government agencies responsible for trade and international relations. By focusing on the automotive industry, we were able to ensure a concentrated analysis of research questions because interindustry variations were thus eliminated. We selected the automotive industry for our study mainly due to the fact that it assumes a leadership role in implementing new technologies. In addition, the decreasing manufacturing penetration of car manufacturers (McIvor et al., 1998; Mathisson-Öjmertz & Johansson, 2000) calls for corresponding Supply Chain Management and Supply Chain Management Software solutions.

Our sample included car manufacturers, suppliers, distributors, and logistic service providers from 25 European countries. Because small companies are still less likely to have Supply Chain Management Software implemented (Darrow, 2002; Lapide & Davis, 2003, p. 21), companies with an annual turnover of less than €10 million were excluded from our sample. As a consequence, we decided not to further differentiate between smaller and larger companies.

Initially, we approached the companies either via email, phone, or fax and asked them to name the responsible person for the logistics or Supply Chain Management departments/activities. The companies were supplied with the hyperlink to our online questionnaire or received the questionnaire via Fax or mail. After two follow-up procedures, we achieved a total of 178 useful answers. This translates into a response rate of 17.8%.

3.2 Current application status of Supply Chain Management Software

First, we analysed the diffusion rate of Supply Chain Management Software. We therefore asked the participants if they had implemented a Supply Chain Management Software solution or if implementation was in progress or at least planned.

Figure 2 shows that at present, 20.2% of the companies apply Supply Chain Management Software solutions and 14% run an implementation project, whereas 14.6% plan to implement a software solution in the future. Thus, 117 (65.8%) of the sampled companies neither use nor implement Supply Chain Management Software.
We then asked the 61 companies using or implementing Supply Chain Management Software to name the selected vendors and software solutions. In our sample, SAP (23%), Oracle (13.1%), i2 (11.5%), and Baan (8.2%) were the vendors of the software programs used most often. A fairly high percentage of companies chose to develop individual software solutions (26.2%) whereas more than one-third of the companies applied various other Supply Chain Management Software solutions.

The next step was to examine the reasons why a large portion of companies still refrains from implementing Supply Chain Management Software (Figure 3).

Figure 2. Current application status of Supply Chain Management Software.

Figure 3. Reasons for not using Supply Chain Management Software (multiple answers were allowed).
As Figure 3 shows, the main reason for not implementing Supply Chain Management Software was that companies were unable to quantify the benefit for their organization. About 16.2% of the companies believed that Supply Chain Management Software was not necessary for them. Only 10.3% of the companies named the high software cost as being one of the main reasons for not using it. In addition, 11.1% expected the implementation process to be too costly, and finally, 8.5% of the companies could not find a suitable solution on the market.

These results accentuate a well-known and hard-to-solve problem: usually, it is more difficult to evaluate the potential benefits than it is to estimate the costs of information technology. Given this problem, it is particularly interesting to examine which objectives companies seek to achieve with an implementation of Supply Chain Management Software.

### 3.3 Objectives of implementing Supply Chain Management Software

Section 2 of this paper describes the objectives of both Supply Chain Management and the usage of Supply Chain Management Software. In our survey, we asked the participants to evaluate these objectives as either ‘very important’, ‘important’, ‘not important’, or ‘irrelevant’ when deciding to implement Supply Chain Management Software or not.

Figure 4 shows that 85.2% of the companies considered it to be either very important or important to achieve reductions in terms of inventory and shortfall. This result indicates that issues like service level improvements and the Bullwhip Effect (Lee et al., 1997) are increasingly becoming focus of attention of decision makers within the supply chain. Studies show that the revenue share of Inventory Management applications within the total license revenue of Supply Chain Management Software has recently increased (Lapide & Davis, 2003, p. 19). The second and third most important objectives were the reductions of production costs and lead time.

![Graph showing pursued objectives – reductions](image)

$N = 61$

- □ very important
- □ important
- □ not important
- □ irrelevant
- □ not specified

**Figure 4.** Pursued objectives – reductions.
More than half of the surveyed companies considered the objective of reducing their purchase costs as being very important or important. About 50% of the companies considered transportation cost reductions as a very important or an important objective. However, almost 40% of the companies regarded transportation cost reductions as either not important or irrelevant.

What are the objectives in the field of improvements? Figure 5 shows the results of our study. We found that 72.1% of the companies rated service level improvements as objectives which are very important or important for the implementation of Supply Chain Management Software. This corresponds with our finding that shortfall reduction – as a crucial measure to guarantee or improve the service levels – is considered to be the most important reduction goal (see Figure 4). Our survey showed that supply chain redesign is the second most important objective when it comes to improvements. Almost 46% of the companies considered it as being very important or important to improve both the supplier evaluation and selection.

The least important objective is to improve cooperation: only 27.8% of the surveyed companies considered it to be either very important or important. This corresponds with the results of case studies which show that today Supply Chain Management Software like SAP APO is primarily used at an intraorganizational level (Buxmann et al., 2004). This is somehow surprising, because companies are dependent upon each other as they are all part of a supply chain and may actually achieve competitive advantages through cooperation (Schmitz Whipple & Gentry, 2000; Helms et al., 2000). Furthermore, it is generally accepted that cooperation in supply chains needs to be supported by corresponding software solutions (Chu et al., 2002). The cooperative potential of Supply Chain Management Software, however, has not yet been utilized.

We also questioned the participants of our study what they would understand to be the challenges of using Supply Chain Management Software in an interorganizational context. As a result, 50% of the companies considered the unclear cost/benefit ratio as a main obstacle.

Figure 5. Pursued objectives – improvements.
3.4 Benefits from using Supply Chain Management Software

In this section we evaluate the benefits obtained by the 36 companies who are using Supply Chain Management Software (see Figure 2). Some of these companies did not quantify all of the benefits. Hence, we have to be careful with our interpretation of the results. However, our findings may provide an insight into potential benefits and, thus, be of particular interest to both companies who are still undecided whether or not to implement Supply Chain Management Software and to software vendors.

Despite the small number of companies that provided information on this subject, the results indicate that the use of Supply Chain Management Software can help companies achieve cost and time reductions as well as service levels improvements.

Figure 6 shows the absolute frequency of answers in the corresponding classes. It turns out that companies which quantified their benefits obtained average reductions of 14.3% in their inventory and shortfall and reductions of 13.7% in their lead time. Moreover, transportation costs were reduced by an average of 8.8%, production costs by 9.4%, and purchase costs by 8.5%. and the service levels could be improved by an average of 15.6%.2

Improvements in cooperation, supply chain redesign, as well as supplier evaluation and selection are even harder to quantify. Thus, the participants were asked to rate the results they achieved in this respect as either 'very good', 'good', 'average', 'bad', or 'very bad'.

The results in Figure 7 show that 31 out of 36 companies evaluated their improvement of cooperation as at least 'average'. None of the surveyed companies indicated that their software performed badly or very badly in this respect. Eleven companies assessed their Supply Chain Management Software as being good and 12 companies even considered it to be very good.

2Regarding the class '>25', we multiplied the frequency of answers with the value 25.0001 instead of the mid-point of class to get a conservative estimate.
All in all, our results indicate that it is not the bad performance of Supply Chain Management Software that prevents companies from cooperating with others. In fact, the usage of Supply Chain Management Software appears to play a significant role in improving the cooperation in supply chains.

Only three companies rated their improvements in the field of supply chain redesign as very good, 14 participants evaluated their improvements as good. So far, 14 companies were able to improve their supply chain design to an average degree. If we review the results for supplier evaluation and selection, we see that five companies evaluated their respective solution as very good and seven as good. However, six companies stated that their solution worked badly. This dissatisfaction might be due to the fact that supplier evaluation and selection has been a common strategic technique in the automotive industry for a long time and has thus been already improved and adapted to the needs of the companies in such a way that standardized software, such as Supply Chain Management Software, is not yet capable to fulfil existing requirements.

In addition to the benefits of using such software solutions, an evaluation of the implementation process can be relevant in deciding whether or not to implement Supply Chain Management Software. Section 3.5 outlines the experiences the participants of our survey made in this regard.

### 3.5 Implementation process

Below we analyse the selection parameters of Supply Chain Management Software solutions and evaluate the implementation process.
3.5.1 Selection criteria for the specific Supply Chain Management Software solution

Regarding the selection criteria for the particular Supply Chain Management Software solutions, we asked the participants of our survey to evaluate different criteria as either ‘very important’, ‘important’, ‘not important’, or ‘irrelevant’ (Figure 8).

The results show that functionality and price/implementation costs as well as compatibility within the company play key roles in the decision-making process: more than 80% of the companies evaluated these factors as being very important or important selection criteria. By comparison, criteria relating to network effect utility (Katz & Shapiro, 1985), such as compatibility with business partners as well as the diffusion rate of a software solution, are considered less important. Thus, the selection of Supply Chain Management Software seems to be influenced primarily by the requirements of intraorganizational processes.

In addition, it appears that companies tend to choose the Supply Chain Management Software from the vendor who supplies the in-house ERP system (see Table 1).

For example, 21 of the sampled companies that have implemented SAP’s ERP software solution also use a Supply Chain Management Software. and while two-thirds (i.e. 14 companies) use SAP APO, only six companies have decided to develop their individual software solution, four companies complement SAP’s ERP software with Baan’s Supply Chain Management

![Figure 8. Selection criteria for Supply Chain Management Software solutions.](image-url)
A similar situation can be found with other ERP solutions: for each ERP software solution, it turned out that the majority of companies chose to implement the Supply Chain Management Software solution offered by the respective ERP vendor. Likewise, those companies with individual ERP software solutions chose to develop in most cases their own individual Supply Chain Management Software.

Again, our results indicate that compatibility within the companies seems to be more important than interorganizational compatibility and cooperation. These findings are corroborated by other studies, which show how big ERP systems vendors grow above average in the Supply Chain Management Market due to their installed bases in the ERP market (Lapide & Davis, 2003, p. 2, p. 29).

Table 1. Dependencies ERP – Supply Chain Management (SCM) Software solution*

<table>
<thead>
<tr>
<th>Software vendor</th>
<th>Number of implementing firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP</td>
<td>14</td>
</tr>
<tr>
<td>Individual</td>
<td>6</td>
</tr>
<tr>
<td>Baan</td>
<td>4</td>
</tr>
<tr>
<td>I2</td>
<td>3</td>
</tr>
<tr>
<td>Oracle</td>
<td>2</td>
</tr>
<tr>
<td>Brain</td>
<td>1</td>
</tr>
<tr>
<td>J.D. Edwards</td>
<td>1</td>
</tr>
</tbody>
</table>

Oracle

<table>
<thead>
<tr>
<th>Software vendor</th>
<th>Number of implementing firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oracle</td>
<td>7</td>
</tr>
<tr>
<td>SAP</td>
<td>2</td>
</tr>
<tr>
<td>Baan</td>
<td>2</td>
</tr>
<tr>
<td>I2</td>
<td>2</td>
</tr>
<tr>
<td>Individual</td>
<td>1</td>
</tr>
</tbody>
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Baan

<table>
<thead>
<tr>
<th>Software vendor</th>
<th>Number of implementing firms</th>
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<tbody>
<tr>
<td>Baan</td>
<td>5</td>
</tr>
<tr>
<td>SAP</td>
<td>3</td>
</tr>
<tr>
<td>I2</td>
<td>1</td>
</tr>
</tbody>
</table>

*Because companies may use several Supply Chain Management Software solutions and also several ERP systems, multiple answers were allowed.
3.5.2 Evaluation of the implementation process

Large software projects often cause various changes. Supply Chain Management Software implementation processes are no exception to the rule: Figure 9 shows that only 11.5% of our participants using or implementing these software solutions ($N = 61$, see Figure 2) had no need for hardware or software changes; 47.5% of the companies had to both redesign their hardware infrastructure and customize their Supply Chain Management Software. In addition, 29.5% of the companies customized their software, and 6.6% had to alter only their hardware infrastructure.

These results show the importance of not only considering the software license costs when deciding about the implementation of Supply Chain Management Software. Like most projects that implement standardized software solutions, the implementation of Supply Chain Management Software involves expensive alterations and customizations. For example, AMR Research shows that in 2002 the licensing revenue in the Supply Chain Management Software market made up only 32% out of the total revenue (Lapide & Davis, 2003, p. 19).

4. CONCLUSION AND OUTLOOK FOR FUTURE RESEARCH

Considering the attention Supply Chain Management Software has received over the past few years, it seems of particular interest to investigate the potential benefits and problems of implementing such software solutions.

To our knowledge, this is the first paper which offers a broad empirical study on the usage of Supply Chain Management Software in the European automotive industry. Our sample included 1000 companies and generated a response rate of 17.8%.

The results of this survey indicate that Supply Chain Management Software is becoming more important. However, there are still some serious barriers to overcome in its diffusion. It
turns out, though, that high costs are not the main reason why companies refrain from implementing Supply Chain Management Software. Instead, the results show that it is the unquantified benefit of such software that causes companies not to implement it.

Considering these results, one significant objective of our survey was to quantify cost reductions and improvements which were achieved due to the implementation of Supply Chain Management Software. We discovered, for example, that the companies of our survey reduced their average inventory and shortfall by 14.3% and their average lead time by 13.7%. Moreover, transportation costs were reduced by an average of 8.8%, production costs by 9.4%, and purchase costs by 8.5%. In addition, the service levels were improved by an average of 15.6%.

However, the cooperative potential of Supply Chain Management Software has not yet been utilized effectively: an improvement in cooperation was considered to be less important than other objectives. Companies ranked the unclear cost/benefit ratio as a major problem when applying these software solutions at the interorganizational level.

Hence, a challenge for research is to assess the benefits obtained in supply chain cooperation. When it comes to demand and inventory planning, for example, some advanced approaches exist already (Lee et al., 1997). We are currently developing a prototype for simulating the effects of cooperation in the field of distribution planning. The objective of that research is to estimate the benefits of cooperative planning scenarios compared to results of non-cooperative planning. This added value of cooperation could serve as a basis for the decision whether or not to implement Supply Chain Management Software.

REFERENCES


Biographies

Peter Buxmann received a diploma in Business Administration in 1991 from Frankfurt University. At the same university, he was awarded the PhD degree in 1995 (‘Standardization in Information Systems’) and completed his habilitation thesis in 2000 (‘Economic Evaluation of Information Systems’). In 1997 he was Visiting Scholar at the Haas School of Business at University of California, Berkeley. From 2000 until 2003, he was Professor of Information Systems at Freiberg University of Technology, Germany. Since 2004, Peter Buxmann is Professor of Information Systems at Darmstadt University of Technology. He is leader of several research projects and author of a variety of books and articles (mostly reviewed double blind) which are among others published in journals like International Journal of Electronic Commerce or in Conference Proceedings, e.g. European Conference on Information Systems. His research fields are Supply Chain Management, Economics of Standards, Cooperation, and Digital Commerce in the Media Industry.

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