Journal of Enterprise Information Management

Procurement of a supply information system: Lessons learned from the purchase of an inventory management system for C-parts

Michael Essig Andreas H. Glas Josef Gutsmiedl

Procurement of a supply information system

Lessons learned from the purchase of an inventory management system for C-parts

Michael Essig
Department of Logistics Management and Distribution, Bundeswehr University Munich, Munich, Germany
Andreas H. Glas
Department of Competence Network Performance Based Logistics, Bundeswehr University Munich, Munich, Germany, and
Josef Gutsmiedl
Department of Logistics Management and Distribution, Bundeswehr University Munich, Munich, Germany

Received 26 January 2014
Revised 5 June 2014
17 October 2014
Accepted 17 October 2014

Abstract

Purpose – Given the high importance of information systems for procurement, surprisingly there have been little efforts to analyze the process and the relevant reasons for the procurement decision of such systems from a stakeholder perspective. The purpose of this paper is to explore these aspects in the context of low-value (C-)parts.

Design/methodology/approach – Research is based on a case study in a pre-fabricator company in Germany and analyzes the process to procure a system for sourcing low-value parts.

Findings – As a finding, the procurement process and decision attributes have been integrated into a framework which supports corporate decision-making considering the procurement reasons of all involved stakeholders (internal departments, external customers and suppliers).

Research limitations/implications – Research is based on case study analysis. Findings are specific to case companies and the environment in which they operate. The framework should be tested further in different contexts.

Practical implications – The developed decision frame supports the evaluation of different sourcing information systems, including clearly measurable criteria but also qualitative or company-strategic decision attributes.

Originality/value – The combination of financial and other perspectives (operations, information technology (IT)-administration, system users, etc.), is used to evolve a robust ex-ante instrument for supporting buying decisions for procurement information systems. The case description also illustrates the findings and develops new insights about stakeholders and buying groups decision-making for information systems.

Keywords C-parts management, IT-based procurement, Procurement instrument, Stakeholder decision-making

Paper type Case study

1. Introduction

Strategic information system planning has been identified as a critical management issue (Bechor *et al.*, 2010). Particularly for the purchasing and supply management function, strategic planning of an information system, its selection, and implementation is of importance to transfer complex information accurately, to reduce time and transactional costs as information passes up and down the supply chain (Gunasekaran

Journal of Enterprise Information Management
Vol. 28 No. 3, 2015
pp. 377-399
© Emerald Group Publishing Limited
1741-0398
DOI 10.1108/JEIM-01-2014-0008

and Ngai, 2004). The possible cost reduction across a supply chain through information systems is in particular relevant for the procurement of low-value and high-volume goods (Essig and Amann, 2013). Those goods are required in a high quantity, what leads to many order transactions (high volume), while the transactional costs are relatively high compared to the product price (low-value). Additionally this product category is highly diverse, as there are many different goods belonging to this group, e.g. screws, nails, etc., which supplements process and coordination effort. For this paper we will call the product category of low-value and high-volume goods "C-parts," which will refer to the cluster groups of a logistics ABC-analysis as explained later (Smith, 2011; Molenaers *et al.*, 2012). Obviously this product category requires an appropriate information system to manage demand analysis, bundling, supplier selection, catalogue buying, order placement and logistics with the objective of achieving an effective and well-connected supply chain (Gunasekaran and Ngai, 2004). As a consequence, the adoption of information systems for the procurement of C-parts is accelerating. This paper addresses the challenges in selecting an appropriate C-Parts information and management system (CP-IMS).

Not only selection but also procurement and later operation of an effective CP-IMS pose numerous challenges. Most of them have their origins in the make-or-buy-decision and the tasks fulfilled by a CP-IMS provider (e.g. hardware operation or content management). Either the buying company takes over all of the tasks like the implementation, operation and content management, or it outsources the task partly or completely to an external service provider. An external solution for a CP-IMS promises less administrative costs, less initial investment costs, and less fixed capital costs for the hardware. Another possible benefit is the reduction of the supplier base (Gunasekaran and Ngai, 2004; Vömel, 2009; Sackstetter and Schottmüller, 2001). On the other hand, there are also downsides to totally outsourcing, which might be, loss of market knowledge, loss of control, dependence on one supplier, loss of flexibility and disagreements to list only a few arguments against a complete outsourcing (Charaus, 2004; Hirschsteiner, 2002).

Yet another challenge is about the content of the information system, particularly the listed C-parts and their suppliers. One specific information system is highly likely not to include all appropriate C-parts for a specific product category, but only products from some listed suppliers. Therefore, the CP-IMS might recommend offers to the user, which in fact are not the most-economic ones or are not from the best-suiting supply partner. The buying company must be aware of the fact that through selecting a specific CP-IMS and a distinctive provider, it does not only procure an information system, but rather the access to a particular supply network. As supplier selection constitutes one of the most strategic tasks of a company's purchasing function (Choi and Hartley, 1996; Kaufmann and Carter, 2006; Ellram and Carr, 1994) and access to a supply case strongly influences a company's supply risk and its innovative capacity (Azadegan and Dooley, 2010), the choice for a specific CP-IMS is crucial for the overall success (Palanisamy *et al.*, 2010).

Although there seems to be a trend in outsourcing a CP-IMS in many industries, there are still a lot of companies that do not go toward this trend. The outsourcing decision for a CP-IMS is currently embedded in an increasingly dynamic context, e.g. the technical developments of cloud or mobile services (Ellis *et al.*, 2010) or the increasing complexity of global supply chains (Wu and Pagell, 2011). The decision depends often on incomplete or outdated data (Miller, 2008). In total the decisions are not only based on analytical processes, but may resort also on intuition or previous experiences (Burke and Miller, 1999). Due to this, the research objectives of this paper are to explore the problem of CP-IMS selection, what means to identify decision criteria which should be taken into account when procuring a CP-IMS, to operationalize these criteria to measure performance of different CP-IMS offers, and to develop a decision support framework which gives an indication about the most advantageous CP-IMS offer to procurement decision makers.

For these purposes, we used empirical insights from an in-depth case study. The German case company from the prefabricated housing industry decided to outsource its tasks for C-parts procurement and to use a CP-IMS in the future. However, the company faced the problem to do the sourcing decision from a holistic perspective, taking analytical and intuitive criteria into account. In particular the case company was interested to analyze the later, highly intangible information such as internal stakeholder perspectives from users to administrators or future supply dependencies. We accompanied the case company and used it to illustrate the procurement process and decisions for the procurement of a CP-IMS.

According to our research aims, the paper is structured as follows: in the following section we describe and discuss the research approach and methodology. Then a brief review of supply information systems, C-parts management, and their procurement decision criteria is presented. Next, we conceptualize the decision framework for CP-IMS selection and use the case study to exemplify the findings. Finally, we summarize and discuss the results and conclude with an outlook on further research.

2. Research approach

The applied methodology for this paper is twofold: First, the relevant criteria for the procurement decision about a CP-IMS are identified on the basis of the literature. To identify relevant literature, the scientific databases Ebsco Host and WISO have been searched. For this search, word combinations have been used to form Boolean search strings. Initially the search was conducted as an abstract and title search in academic peer-reviewed journals. Later we expanded the scope and searched in all text. Examples for words which were combined to these search strings are "C-parts," "low-value," "parts," "material," "procurement," "purchasing," "acquisition," "supply," "information system," "IT," and "software." The search has been flanked with similar search on Google Scholar internet search engine and a snowball approach – following the quotations and literature references of identified and relevant papers. The problem of the review was, that combinations such as "purchasing software" (> 390 hits in EBSCO Host) show numerous results, while almost all of them are not relevant to the problem of CP-IMS. Most of them focus on the problem how to purchase software, but not on the issue how software can support purchasing of a company and which decision criteria are of importance.

This paper is not solely about a literature review on purchasing software, but tries to identify relevant decision criteria. Therefore, the focus was set relatively strict and narrow. So only contributions which explicitly address CP-IMS, have been included in our analysis. Finally, only eight papers could get through the filtering. Nevertheless, it was possible to identify over 20 decision criteria from these papers. After identification, the next step was to integrate and conceptualize the decision criteria in a decision framework. This is part of an analytical research strategy and aims at linking the criteria constructs with measureable indicators. At the end, the result is a decision model for the CP-IMS selection.

Second, the empirical part of this work follows the case study methodology and applies a single case study design (Yin, 2009). As the concept of a selection model for a CP-IMS is still an organizational and unstructured problem, case study design suits to explore and operationalize the identified criteria. Also the case company is used to illustrate the procurement process and decisions for the procurement of a CP-IMS. Finally, the case could show, that the developed criteria, their operationalization and the framework in total provides information about the most advantageous CP-IMS offer. Figure 1 illustrates and connects the guiding research questions with the applied methodology approach.

To guarantee case study quality, the quality criteria of Yin (2009) were regarded (construction and external validity; reliability). In the context of the construction validity, different data were gained through interviews, process observations, data analysis, and group meetings (triangulation of data). High external validity is guaranteed by the applied decision support framework, which can be used independently from the case, company or product category. To enhance reliability, all relevant steps of the research were documented or audio taped.

3. Supply information systems for C-parts management

A CP-IMS is an instrument to manage C-parts along the supply chain considering all related processes, instruments and strategies (Hirschsteiner, 2002). It is important to understand CP-IMS as a coordination instrument along the supply chain from the suppliers through the company to the customer. The ambition to integrate supply management into an information management system is not limited to C-parts, as we also have low-volume, high-value goods (A-parts) and these must be managed through the supply chain as well. However, the use of modern information technologies promise lower transactional costs, which is particularly relevant for high-volume products (C-parts), as the CP-IMS supports the information quality and the information availability for these parts as a precondition for cost-efficient procurement and logistics decisions (Sackstetter and Schottmüller, 2003).

However, there are only some contributions in the literature which help to select a provider for a (CP-)IMS with detailed and operationalized criteria (Palanisamy *et al.*, 2010). Literature sources for the procurement of an information technology (IT)-based C-parts management system are still scarce. But, there are sources available dealing with the evaluation of enterprise resource planning (ERP), enterprise application (EA) or information technology-systems (Das and Buddress, 2007).

In the literature review, a narrow focus on the topic has been applied, only considering papers which explicitly address C-parts (or low-value parts) and information systems. Finally, eight contributions were identified, which explicitly address the topic of CP-IMS and provide information about criteria for the procurement decision. Later in this paper (Section 5.1), each decision criteria is explained and discussed in detail in order to prepare their operationalization into performance indicators. Table I gives an overview of the literature and the found criteria.

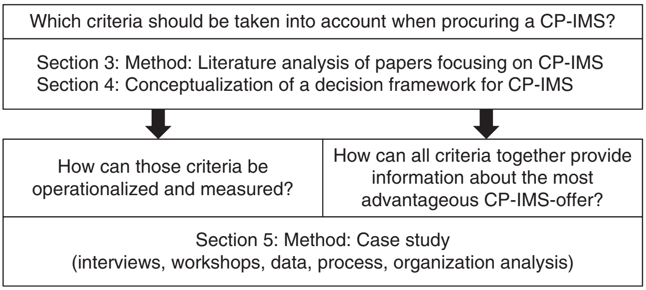

Figure 1.
Methodology of this paper

	Andressen (2008)	Das and Budress (2007)	Fitzgerald (1998)	ISO/IEC 9126	Sack-Stetter/ Schott-Müller (2001)	Shankarnarayanan (1999)	Schwarze (1991)	Teltumbde (2000)
System quality								
Suitability		X		X		X	X	X
Interoperability		X	X	X	X	X	X	X
Safety		X		X			X	
Reliability				X			X	
Usability				X		X	X	
System-Efficiency				X	X		X	
(Geographical) Extension		X	X	X				
Provider quality								
Market share								X
Turnover								X
Equity ratio					X			
Proportion of CP-IMS					X			X
Industry experience								X
Reputation					X			
R&D-budget					X			X
Service level								X
Network								
Customer site	X						X	
Supplier site	X						X	
Efficiency								
Cost		X	X		X	X	X	X
Benefit						X	X	X
Risk		X	X					X

Note: X, Criteria is considered in the contribution named in the columns

Table I.
Criteria to evaluate (CP-)IMS

As can be seen in Table I, every contribution to CP-IMS uses a different set of decision criteria/quality attributes to evaluate a CP-IMS. An early work from Schwarze (1991) lists 11 criteria, what is equal to Teltumbde (2000), but different in content. Relatively contemporary contributions on the topic focus on few criteria. Andressen (2008) only addresses two attributes, while Das and Buddress (2007) uses six different decision criteria. In total only one criteria is used in every contribution (besides Andressen, 2008): "interoperability." Even the costs of an CP-IMS are only regarded by six out of eight contributions. In total, we perceive the knowledge base for the procurement decision on CP-IMS as rather diverse.

This surprises, as a large body of research exists on the relative importance of evaluation criteria for EA software (Benlian and Hess, 2011).

For the purpose of clarity and controllability, it is important to keep the number of decision criteria in a manageable frame while their content should be clearly defined and differ from other criteria (Arnold and Kasulke, 2007; Bahli, 2005). In another context, Verville *et al.* (2005) discuss, for example ten critical factors for successful IT acquisitions, and Baray *et al.* (2008) analyzes factors responsible for the effective implementation of ERP systems. Here, all procurement decision criteria were categorized in the aspects system quality, provider quality, network size, and efficiency. This represents a basic framework to differentiate criteria for the CP-IMS procurement decision. Within those criteria groups, several criteria can be subsumed (Güthoff, 1998). This follows the relatively early work from Schwarze (1991) who focussed on the evaluation of software and IT-systems and distinguishes between two main categories, monetary and qualitative criteria. Another approach is from Das and Buddress (2007), who present in an empirical research an overview about the existing criteria for e-providers in the literature. They divide them into tangible and intangible criteria categories. The fundamental aspect for their work was given by Fitzgerald (1998), Shankarnarayanan (1999) and Teltumbde (2000). These authors helped to get an insight of the procurement of an ERP-system and they showed relevant criteria for the selection process along with ex-post criteria. However, ex-post criteria were not used for this work, as the aim is to support an ex-ante procurement decision. Andressen (2008) adds one special aspect called network size. This criteria addresses the fact that market-size and supplier-access is crucial for a CP-IMS provider. Only provider with a relatively high network size could provide a broad access to numerous suppliers and/or can benefit from bundling effects. Another source, Sackstetter and Schottmüller (2001), provided evaluation criteria explicitly for providers of C-part-management systems. However, detailed explanations for each criterion were missing. Thus, there is still a missing link to operationalize criteria to really support procurement decisions. In addition to academic literature, this work also considered international standards, here the ISO/IEC 9126. This norm outlines some more criteria, but originally focusses on the evaluation of software not on its procurement. As almost every source addresses different criteria (categories), it seems as if a combination of the above-mentioned criteria is useful, objective and practicable for companies to procure information and management systems.

4. Procurement decision framework for CP-IMS and its operationalization

4.1 The elements of the decision framework for CP-IMS

Following the decision criteria identified in Section 3, our approach basically distinguishes two elements in order to identify the most advantageous offer of an CP-IMS. In order to relate CP-IMS costs to its effectiveness, both aspects are included according to the methodology of a cost-benefit analysis (Cellini and Kee, 2010). The first element is an utility analysis which applies a scoring model. The second element is the calculation of the net present value (NPV). Both aspects are linked with a weighting factor. We implement this weighting factor for several reasons, which are further explained in the case study section (Figure 2).

The first element of the decision framework is an utility analysis applying a scoring-model. A scoring model allows the user to consider quantitative but also qualitative criteria which cannot be measured in a financial way. It is a classical evaluation method for a multi-dimensional decision situation with more than one alternative. To calculate the overall score, each decision criteria is multiplied with a weight. It is the specialty of this paper, that each criteria is operationalized and a score is investigated through the case study. In order to aggregate scores for single criteria, all criteria are weighted.

There are loads of methods to weigh the criteria, but the authors tried to apply a method, which allows the separation of stakeholder groups. Therefore the authors applied the Bordacount method (Emerson, 2013, method origin: de Borda, 1781). This method asks stakeholders of the procurement decision (e.g. involved management, IT, controlling, production, or other departments) to rank the criteria in a hierarchical order. Each ranking can also be weighted, what means that, e.g. the IT or the procurement department gets a higher influence on the procurement decision than another stakeholder group, e.g. production. Bordacount method suits for this research, as it allows the participation of numerous stakeholders and it is possible to get a weight ranking of procurement decision criteria, adapted to the real needs of the procuring company (BMI, 2010). Besides companies that have cross-functional involvement of their departments, have a higher ex-post satisfaction, if stakeholders are able to bring in their experience and expectations (Das and Buddress, 2007). Utility analysis finally calculates the overall score of each CP-IMS alternative and thus provides a result, which stands for the overall benefits of a specific CP-IMS.

The second element of the decision framework is the consideration of economic efficiency, what takes into account the planned costs of an investment and the planned benefits (Samadhiya *et al.*, 2010). From this point of view, economic efficiency is the relation of the benefit of a system and the necessary input (employees, hardware, procurement staff, etc.) with all related costs (non-recurring costs, running costs). As IT-based projects are often not fulfilling their expectations (Trepper, 1999; Al Kilidar *et al.*, 2005), risks and dynamics should be considered in efficiency analysis. Therefore the authors propose the use of the NPV.

The NPV represents the basic method to calculate IT-investments. Expenses and their connection to the investment object, here the procurement of a CP-IMS, are of importance. Similar to Neef (2001), Das and Buddress (2007), and Arndt and Betz (2004)

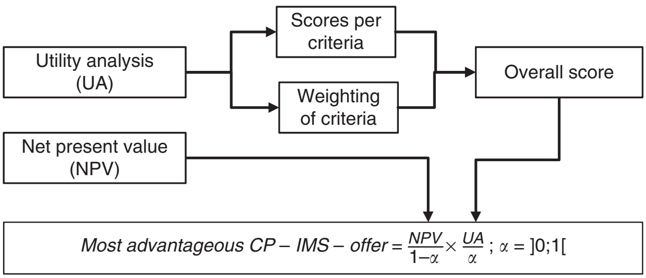

Figure 2.
Elements of the decision framework

all costs are divided into non-recurring and current costs. Finally, the NPV provides the difference of discounted costs for each CP-IMS offer. In order to support the procurement decision, the framework combines the utility analysis and the NPV.

However, this combination requires additional weighting of both elements with a weighting factor α. This reflects that decision makers and the departments which prepare the decision are normally not the same (Bannister and Remenyi, 2000). The final decision "pro or con" a specific CP-IMS should not be seen as a common sense as it is always branded by the subjective and qualitative opinion of the decision makers (Sackstetter and Schottmüller, 2001). "It is this ability to make intuitive leaps which often distinguishes the great manager from the competent functionary" (Bannister and Remenyi, 2000). Therefore the last element of the decision framework considers this "intuitive element" through the weighting factor. This complements the instrument in a way that practitioners can bring in their strategic procurement perspective with either a stronger focus on the NPV (and costs) or on the utility analysis (and quality).

4.2 The operationalization of single decision criteria of the utility analysis

For application of the utility analysis, all decision criteria must be operationalized. The criteria refer either to the CP-IMS quality or its network size. However, the term quality is dependent on the circumstances where it is used (Garvin, 1984). For this work, two main quality aspects are separated, system quality and provider quality, and used for the utility analysis together with network size, (Verville and Halingten, 2002). Each category is operationalized with several criteria, whereas for each criterion a distinct measurement and calculation method is set. As identified in the review, system quality aggregates seven criteria: suitability, interoperability, safety, reliability, usability, system efficiency, and the geographical extension. Provider quality comprises eight criteria: market share, turnover, equity ratio, proportion of CP-IMS, industry experience, reputation, research and development budget, and additionally offered service support. Network size represents the amount of existing users and suppliers for the CP-IMS and its prospective future growth. Each criteria is defined in detail and a distinct measurement formula provides the score, which is later further used in the utility analysis. As the number of different criteria is too high for detailed presentation, this paper presents three examples in order to get an impression of their operationalization. All other measurement approaches are presented in Appendix.

System quality and the criteria reliability. The quality of a system is decisive for the success of itself (Al-Kilidar *et al.*, 2005). A proper evaluation of system quality is difficult and is based on the perspective of the user (Samadhiya *et al.*, 2010). System quality in the meaning of this paper "is the totality of features and characteristics of a product or a service that bears on its ability to satisfy the given needs" (ANSI/ASQC-A3, 1978). This is similar to the customer-based view (Garvin, 1984). As example for the operationalization of system quality, the criterion of reliability is chosen. Reliability describes the stability of a system, more specific, how good a system could fulfill the needs of a company under different circumstances, how many mistakes are made by the system and how reliable is it after a breakdown (Behkamal *et al.*, 2009). The proper operation of the system is an important fact for the decision phase and is very difficult to measure ex-ante (Das and Buddress, 2007). Therefore the approach to operationalize reliability (and some other criteria) was to ask the reference companies using a specific CP-IMS to fill out a reliability questionnaire. Questions about system availability, downtimes, time-delays, breakdowns, etc. had to be answered on a Likert-scale (0 = totally disagree; 10 = totally agree). Additionally to that, the reliability should be tested with a (demo) version/(demo) account. The testers then also had to answer a questionnaire on a Likert-scale, e.g. if any mistakes occurred or dysfunctions occurred in a test run. Both aspects are weighted, as identified mistakes in test runs are crucial aspects compared to the references of other companies. Operationalization of system reliability:

$$Reliability = 5 \times \left(1 - \frac{Occurred\ mistakes}{Test\ run(s)}\right) + 0.5 \times Reference\ reliability\ score$$

Provider quality category and the criteria industry experience. As many investments in IT-based systems are big disappointments (Lavelle, 2002), the system itself is a complicated and very sensible product, and it is likely not to work properly or efficiently after a long operational trial period (Schwarze, 1991). That is why it is expedient to not only look at the system quality but also at the provider quality, who might improve the system quality over time. In this work eight criteria are subsumed under this category. As example for the operationalization of provider quality, the criterion of industry experience is chosen. Mainly because market share, turnover, and equity ratio indicators which the procuring company itself is able to retrieve the information from provider web sites or published annual reports. Another criterion, reputation is measured in almost the same way as reliability – through the questionnaire to reference companies. Therefore we present here industry experience as an example for the evaluation of the provider quality.

A lack of industry experience of the management of C-articles is a good criterion for the evaluation of a provider a priori (Das, 2004). Sackstetter and Schottmüller (2003) state that the first time where an IT-based C-article-management is explicit mentioned in a meaningful way was in 1997. Due to this, there is only a maximum of industry experience of not more than 16-20 years that can be expected from the most experienced providers. (Of course, C-part management exists much longer, but without help of information systems.) Industry experience is measured by retrieving information about the company's age, respectively their time in CP-IMS-business. For practical reasons, the maximum experience time was set – also for the latter application in the case – to 16 years. The operationalize industry experience score is calculated through dividing the time in business of the company firm through the maximum experience time. All scores of the category provider quality have to be normalized in order to enable aggregation, therefore this score is also scaled. Operationalize of industry experience:

$$Industry\ experience = \frac{Time\ in\ business\ (years)}{Maximum\ experience\ (15\ years)} \times 10$$

Network size. The last criteria category for the evaluation of a CP-IMS is the network size. Many authors do not refer explicitly to this category (Das and Buddress, 2007; Teltumbde 2000). This might indicate that they include this into their view on the criteria of market share. However, this would not meet the significance of this category. Network size cannot be clearly characterized as a part of the provider nor the system quality, which is why in this work it is in its own category. Most of the companies will make a decision for a certain system if they are convinced that the system will have a perspective in the future (Picot *et al.*, 2003). Traditional products and services have an original benefit for the customer/buyer. An extra benefit can be generated via the amount of users (network size) (e.g. better service network for a special car brand, if the amount of customers increases). Network size plays a decisive role for systems like

CP-IMS (Katz and Shapiro, 1986). There have to be enough users on the demand site to be attractive to new users.

An important fact in the context of the network size of CP-IMS is, that you cannot only focus on the amount of existing users but also on the amount of integrated suppliers, which are or can be integrated in the system. The less suppliers are willing to offer their products via the CP-IMS of a provider, the less attractive the system is for the potential customers (Andressen, 2008). There are a lot of methods to measure network effects, but they are mostly focussed on very complex IT-systems. For calculation, it is necessary to separate the network size of the using companies, which have already installed the CP-IMS, and integrated suppliers, which are already working with the CP-IMS (Hutchinson, 2001). To get a comparison of different systems, an interval scale was used to measure network size. The several intervals were identified by the company (Hutchinson, 2001). The provider who fulfills the maximum demand of the company got ten points whereas companies with less than the maximum demand got points dependent on the interval they were positioned at. An integration of new suppliers/users is not to be taken into consideration, because of the measurement of the integration of endless suppliers. Operationalization of network size:

$$Network\ size = \frac{Maximum\ demand\ of\ user\ companies}{Maximum\ points + 1\ (here\text{: } 11)}$$

5. Case study findings

The presented decision framework and its operationalization has been adapted and implemented onto a real CP-IMS procurement case. The German case company has 4,000 employees in the prefabricated housing industry and separates its business into branches: wood products, building components and construction management. The company intended to outsource its CP-IMS to a service provider (Verville and Halingten, 2002). C-parts in the company are products with a price below five Euros. Reasons to choose this company were:

(1) C-parts are of high importance for the prefabricated housing industry.

(2) Hitherto, the procurement of C-parts had significant influence on the procurement process and organization of the company.

(3) It was the first time for the company to procure a CP-IMS.

(4) The company lacked a decision support instrument to procure such a CP-IMS.

5.1 Measurement of the criteria in practice

In the run up to the use of the decision instrument it was necessary to identify corresponding providers. Only those providers should be considered which are really interesting for the case company (Koppelmann, 2004). With help of questionnaires, 20 relevant providers were asked via e-mail to answer different questions in between 12 days. Only six were able to answer the questions in a satisfactory way. In the average 86.64 percent of the questionnaire was filled out. The case company then limited the providers. At the end of the initial selection process, three systems were interesting for the case company and the providers were invited to the company to present their systems. The combination of the questionnaire and the onsite presentation made it possible to complete all criteria for the decision instrument. The utility analysis therefore was scaled in a range of 0-10 points with 0 being the lowest achievement.

Utility analysis on basis of 17 evaluation criteria. Suitability. In the context of this criterion, it is necessary to specify the term suitability. Suitability describes the features which the customer is expecting. Kano (1984) separated therefore three different types of requirements for a customer, must-be, one-dimensional and attractive requirements (Kano, 1984). For a comparative view of C-parts-management systems only the must-be and the one-dimensional requirements are meaningful. Because of the very specific needs of each company, these requirements have to be formulated as the case arises by the particular company (Schwarze, 1991).

The case company had thirteen performance requirements, which the system should fulfill. Examples for these requirements were the control of the bills by the system provider, the real time data exchange with the existing ERP, the integration of new article in a maximum period of three days and the integration of new product suppliers which is done by the provider. For each achieved requirement, 0.77 points were given ($= 1/13 \times 10$ points).

Interoperability and safety. Interoperability addresses the problem of multiple hard-/software-interfaces, lacking or different standards and the need for integration (BME, 2012). Interoperability describes the compatibility with existing systems, e.g. data bases or ERP-systems, (Behkamal *et al.*, 2009) and is a critical success factor for the implementation of a CP-IMS. Interoperability prevents media disruptions between logistical interfaces. It is important that such systems are harmonizing with the existing systems for finance, controlling and warehouse management in a company (Nekolar, 2003). Besides, interoperability also addresses the need to integrate with systems of existing or potential suppliers (Teltumbde, 2000). Sophisticated CP-IMS then also leverage the value of existing systems, particularly ERP-systems (Piller, 1997). However, the level of interoperability is highly important for safety and security issues. "Whereas the traditional notion of trust primarily focuses on trust in a trading partner, trust in e-business also incorporates the notion of trust in the infrastructure and the underlying control mechanism (technology trust) which deals with transaction integrity, authentication, confidentially and non-repudiation" (Ratnasingam *et al.*, 2002). For example, the transmitter of an order via the system has to be the one who really sent the order (Bogaschewsky and Müller, 2002). In the case, the flow of goods via the CP-IMS should be completely transferred to the existing ERP. This criterion was to be fulfilled by each provider. Similar to interoperability all providers could guarantee a safe data exchange with different technical possibilities.

Reliability and usability. With a new system, the user is confronted with new demands, informations and strains. Therefore every system should be user friendly (Shankarnarayanan, 1999). The user-friendliness plays an important role for the acceptance of new systems in a company. However, many companies claim about the user-friendliness (Davis *et al.*, 1989; Mertens, 2010). Usability describes the features of the system, which are demanded by the different users (ISO/IEC 9126, 2001). For the regarded case, all three provider companies were asked about the reliability and usability of their system with the help of a questionnaire. Different questions for each criteria had to be answered on a Likert-scale ($0 =$ totally disagree; $10 =$ totally agree). Additional to that, the usability was tested by the case company with a demo version. The employees had to answer on a Likert-scale if the system was very user-friendly ($= 10$) or very user-unfriendly ($= 0$).

Efficiency. Efficiency describes the performance of a system in relation to the used hardware resources in the environment of the company (Behkamal *et al.*, 2009). In the context of the C-article management, it is necessary to have quick response times, because of the huge amount of C-article orders. Also the amount of data which can be operated and the reserve capacity of the system for the growth of a company are important (Schwarze, 1991). With the help of a system demo version, the case company could compare the time used in the original system for the procurement of C-parts with the demo version for identical procurement orders. Combined with the savings for the process times a score has been calculated, as is shown together with all other operationalized formula in Appendix.

(Geoprapхical) extension. Companies often are interested in ordering and tendering worldwide (Bogaschewsky and Müller, 2002). With this in mind, the criterion of geographical extension means, that the system is able to be operated not only in the headquarters of the case company but also in different regions or countries (e.g. branches in foreign countries) (Behkamal *et al.*, 2009). The resulting flexible usage of the system in an international environment is an important point for the acceptance of the system (Fitzgerald, 1998). Therefore it is important that the system itself can be adapted to different languages. In the case it was important to consider Eastern Europe and their personnel, which hardly speak English fluent. The goal of the case company is to install the system throughout the whole group. Therefore it was necessary to satisfy special demands for the system language (e.g. German, French, Italian, and Slovak). In total, ten languages were of importance for the group. For every language supported by the system, one point was given.

Market share. Market share plays an important role for the evaluation of the economic strength of a vendor company. Especially new age companies with only a small market share are expected to be possible takeover candidates of bigger CP-IMS providers and not reliable on the long run (Sackstetter and Schottmüller, 2001). In the case, the market share was measured with the help of the estimated market shares of the provider in percent and was multiplied with 10.

Turnover. Identical to the market share, the turnover of the provider was assessed in order to get information about the development in the market (Sackstetter and Schottmüller, 2001). The data regarding growth in the last years were important for the case company, so they could see if the system has taken its ground in the market. Growth over 100 percent was scored with 10 points, a decrease was scored with 0 points.

Equity. Potential providers should have a healthy equity ratio. With help of this, the possibility that the company is acting economical sustainable on the long run is increased. Also new investments or unforeseen market development (e.g. warranty cases) can be financed with a financial solid root (Kahraman *et al.*, 2003; Finkel, 1996). Data for this criterion was collected in the provider questionnaire.

Proportion C-parts-management and industry experience. The amount of employees in a provider company gives an example how many resources the company has in this sector (Hutchinson, 2001; Jones *et al.*, 2011). The amount of employees who are focussed in the maintenance and development of CP-IMS in a company indicates the focus of a CP-IMS provider and its service potential to the case company. In the case, two companies were specialized CP-IMS provider (100 percent of employees are concerned with such a system), while the third firm did not give any information about this criterion. Also industry experience indicates the CP-IMS provider's know-how and resources. The first time CP-IMS was mentioned in literature was in 1997, that is why a maximum of 16 years was chosen to measure industry experience (BME, 2012).

Reputation. Ex ante procurement decision, it is interesting to know how reliable a promising offer really is. The intangible fact "feelings of trust" toward the vendor plays an important role. Therefore it is helpful to get knowledge of the reputation from other companies (Ellram, 1990). Reputation of the system provider is the consistent and reliable performance for a certain period of time (Knemeyer and Murphy, 2005). In the case, other companies were asked to provide information how reliable the provider was and if the promised saving potential was achieved (Finkel, 1996). To measure this criterion a questionnaire was developed. A Likert-scale with seven items was used to determine the score. It was necessary to identify the right persons in the reference companies who could provide reliable answers to the questionnaire. To avoid a one sided opinion from one company, a minimum of three references per CP-IMS provider where asked to get a reliable score.

R&D. IT-based applications evolve in a fast-paced and changing environment. Therefore it is necessary, that the systems are adapted to the latest developments in this sector. This guarantees that the system will be sustainable (Teltumbde, 2000). Investments in R&D are showing that the provider is willing to develop his system (Das and Buddress, 2007; Jones *et al.*, 2011). Another important fact is the original development of a system. Is the provider a pioneer and not only an imitator of another system, it is a good start for further development and growth (Hutchinson, 2001).The degree of innovation of a CP-IMS provider is measured. The amount of employees in the R&D department is defined by the questionnaire which was send to the companies in the first step.

Service. Information systems are complicated and very sensible products. That is why it is important to have support from the provider which exceeds the normal warranty (e.g. free software updates). They must have enough service capacity, to satisfy the customer's needs (Schwarze, 1991). Das and Buddress (2007). For the case, the judgment of the service also was measured with the help of requirements, established by the company. Service requirements include a 24/7 service contact, free training videos, and a services response time to system problems within 120 minutes.

Network size. To get a comparison of the different systems, the company used an interval scale. The several intervals were identified by the company (Hutchinson, 2001). The provider who fulfills the maximum demand of the company got ten points whereas companies with less than the maximum demand got points dependent on the interval they were positioned at. An integration of new suppliers/users is not to be taken into consideration, because of the measurement of the integration of endless suppliers.

Economic efficiency analysis based on the NPV. The procurement of a CP-IMS poses several risks for the procuring company, as the buying power might decrease while prices and process costs might increase. Those risks are taken into consideration by discounting the expected cash flows with risk-adjusted interest rates. Obviously, it is essential for this task, that the cost structure is clearly defined for the implementation. Das and Buddress (2007) divide the costs into implementation costs, integration costs, maintenance costs, training costs and the anticipated costs on a scale, with the individualization and the upgrades. The expenses are a combination of the non-recurring launch, provision costs and the maintenance costs of a system. The implementation of a new system only makes sense, if the expected benefits are larger than the costs. In general, if the NPV is positive, the possible new system is economically useful for a company.

Neef (2001) remarks that the NPV should be positive within two years after implementation and all costs of ownership must be regarded. Formula for calculating the NPV for a CP-IMS is as follows. Operationalization of NPV to CP-IMS:

$$
\begin{aligned}
&\textit{Net present value}\ (CP-IMS)\\
&= -\sum_{n=3}^{3} \textit{Invest}\\
&+ \sum_{y=1}^{\textit{years in-service}} \frac{1}{(1+\textit{interest rate})^{y}}\\
&\times \left(\textit{orders}_y \times \textit{process savings}_y - \sum_{n=1}^{3} \textit{Running costs} \right)
\end{aligned}
$$

For the NPV-calculation expenses and their estimation are very important. Arndt and Betz (2004) divide these costs into non-recurring costs and current costs. As mentioned before, it is necessary to confront the costs with the expected benefits. A huge cost savings potential can be found in the transactional costs for a procurement process in a company. The saved costs are the result of the savings with the new system compared to the classical manual procurement process. The benefit is the multiplication of saved process costs per procurement cycle and the amount of procurement cycles being done. It is essential that only these costs are taken into consideration, which can be defined ex-ante. That is why aspects like cheap purchasing prices by grouping of demands, article quality and article availability are not relevant for the further proceeding.

Costs were measured and estimated along the procurement process. A simplified procurement process model should serve as a basis (Vömel, 2009). It consists of the following steps: request, quotation processing (quotation analysis and quotation comparison), negotiation procedure, decision to order, order, order confirmation, delivery and control. With this process in mind, current expenses without and future costs with the use of a CP-IMS can be compared. The monetary value for each process step is compared with the calculated value for the new C-article management. The difference is then the benefit of the system for each task. The providers had to estimate the savings for each procurement process for the case company. The alternative market interest rate was 5.50 percent. Finally, the estimated savings of the providers were reduced to 30 percent to face the risk in the promises of the providers. Also alternative risk scenarios were generated. In principle, the case company wanted to assess the systems very conservatively to reduce the financial risk of a poor system integration. The observation period for the NPV was two years, based on Neef (2001). With the help of the presentations, the running costs and the investment costs could be estimated.

Selection of most advantageous CP-IMS. Without acceptance and involvement of the employees, it is difficult to introduce a new system (Finkel, 1996). For this reason, the involved departments and their key members were asked to fill out a form at the case company, where they had to order the different criteria from the decision instrument. The most important criteria was ranked at number one and the most unimportant was ranked at 17. With this help method for the Borda Count, the different emphases of the criteria were part of the result. In summary, 20 persons from the department's management, procurement, IT, controlling and accounts, warehouse and production were asked, whereas the department leaders and management got more influence than normal store personnel.

With the help of the above shown criteria, the company could fill out the decision-support instrument with all sub-criteria (see Table II). At the end of the selection phase, it was necessary to adopt a decision on the basis of the NPV and the economic utility analysis. This decision was made by the management and the purchasing manager. They did not rely on the basis of an overall score of "Z" which tried to combine both facts. The company separated both values and decided to implement system Golf, because of the NPV and the overall score P_n, in which system Golf dominated the other systems. Also an alternative way via Z, ($\alpha = 0.6$, domination of the NPV) would have come to this result. So both decisions would have come to the same conclusion, which underlines the practical feasibility of the instrument in the company.

5.2 *Findings and discussion*

By analyzing eight contributions on CP-IMS evaluation and by applying and operationalizing these in an in-deep case study, this study could derive several implications that both complement and extend existing research on CP-IMS-procurement.

Research implications can be separated in three parts. First, this study identified 20 different criteria for evaluating a CP-IMS. This consolidates the findings of eight different contributions, of which each addresses only some criteria. Second, all criteria have been integrated into a decision framework based on a utility analysis and a NPV analysis of CP-IMS. Third, each criteria and the overarching calculation of weights and scoring points has been operationalized and applied to a case company.

While there is an increasing knowledge base on procurement of software and enterprise application systems (e.g. Sen *et al.*, 2009; Abdelilah and Mohammed, 2013), there are only few contributions focussing on the procurement situation for a CP-IMS. This paper intended to focus on CP-IMS, that is why the basis of this contribution is narrow and integrates relatively old contributions (e.g. Schwarze, 1991) or specific (German) book publications on CP-IMS (e.g. Sackstetter and Schottmüller, 2001). It is highly likely, that findings from studies analyzing software procurement or EA systems more general could be used to refine the decision criteria of this work. Not every evaluation criteria found in the reviewed literature plays really a significant role in the case, e.g. the criteria (geographical) extension.

Nevertheless, this paper achieved to integrate the findings of eight focus contributions on CP-IMS into one model and proved its applicability in the case company. The analysis of the decision criteria and their operationalization in a case study are seen as very important outcomes of this work. They revealed managerial implications, as the applied support framework has created transparency for the involved procurement decision makers and provided a procedure and measurement instrument for evaluating CP-IMS in practice. The higher level of decision transparency is not only relevant for the case company, but could also be transferred to other CP-IMS-procurement situations. One important lessons learned is that the procurement decision for a CP-IMS is highly linked to the supply chain management perspective. Wrong or misguided choice for a specific CP-IMS might exclude high-value sources/

Table II. Decision-support instrument fort the case company

	Valuation category	Valuation criterion	Emphasis	System Foxtrott		System Golf		System Charly	
Utility analysis	System quality		$G_{sys} = 62.23\%$	P_F	$g_i \times P_F$	P_G	$g_i \times P_G$	P_C	$g_i \times P_C$
		Suitability	10.41%	4.6	0.48	8.5	0.88	7.7	0.80
		Interoperability	9.21%	10	0.92	10	0.92	10	0.92
		Safety	8.52%	10	0.85	10	0.85	10	0.85
		Reliability	10.19%	8	0.82	8.9	0.91	8.7	0.89
		Usability	9.98%	6.4	0.64	7.8	0.78	5.8	0.58
		Efficiency	9.09%	3	0.28	6.4	0.58	5.9	0.53
		Geographical extension	4.83%	5	0.24	2	0.10	10	0.48
	Provider quality		$G_{Anb} = 29.88\%$						
		Market share	1.76%	4	0.07	0.3	0.01	0.5	0.01
		Turnover	1.19%	3	0.04	3.5	0.04	10	0.12
		Equity ratio	1.51%	4.1	0.06	10	0.15	3	0.05
		Proportion C-parts-management	2.71%	0	0.00	10	0.27	10	0.27
		Industry experience	4.67%	10	0.47	8	0.37	6	0.28
		Reputation	4.90%	6.9	0.34	8..6	0.42	7.7	0.38
		R&D	5.98%	1.3	0.07	10	0.60	2	0.12
		Service level	7.15%	5	0.36	10	0.72	7.5	0.54
	Network size		$G_{NG} = 7.89$						
		User site	2.95%	10	0.30	0	0.00	10	0.30
		Supplier site	4.94%	0	0.00	2	0.10	10	0.49
		Overall score P_N		81.3	5.92	113.9	7.69	104.8	7.60
Net present value		NPV (basic expectations)			−15,923.47 €		181,874.17 €		122,144.66 €
Most advantageous offer		$Z = \left(\frac{NPV}{1-\alpha} \times \frac{P_N}{\alpha}\right)/10.000$	$\alpha = 0.6$		−39.28		582.76		386.79

suppliers for required C-parts. This is why this work explicitly includes "network size" as one important decision criteria.

Other managerial implications are that different stakeholders should be involved into the decision process but with a regulation of their influence on the final procurement decision. The proposed decision framework is able to differentiate criteria weights and stakeholder weights. Each criteria got a weight which was calculated on the basis of a survey (Bordacount) method and the responses of involved stakeholders (departments, e.g. management, procurement, IT, controlling and accounts, warehouse and production). However, it was possible to emphasize responses of different stakeholder groups. The differentiation of rankings by departments provides one possibility to emphasize some specific perspectives, respectively to limit the influence of another stakeholder. Of course the influence of each stakeholder group should be set ex ante the evaluation of criteria weights to prohibit bias.

Overall, the effort to measure preferences of each stakeholder group, to assess their expectations and performance estimation for each regarded CP-IMS is considerably high. This poses the question of decision process economy and practicability. Also in the regarded case some involved employees acted quite reluctant and skeptical at the beginning. Even the management was not always convinced by the applied methodology. It is an important managerial implication that on the one hand involved departments were convinced by a strict and transparent methodology to measure and assess weights and scores. On the other hand, management appreciated that the proposed framework integrates the utility analysis and the NPV by using a factor α. The calculation of the final result with different values for α provided a sensitivity analysis for the management and showed the robustness of the framework, respectively, of its recommendation for a "most advantageous CP-IMS offer." Decision makers are able to challenge the result by adapting and comparing different results of the framework for alternative α values. This supports not only formal but also intuitive management decision making.

6. Conclusion

The research objectives of this paper were to explore the problem of CP-IMS selection. As a result, this work developed a support framework for evaluating CP-IMS, which is exemplified through an in-depth case study. The CP-IMS problem is conceptualized using a supply chain framework, whereby the high importance of information for C-parts management is elaborated. Furthermore criteria for the procurement decision of a CP-IMS are derived from a literature review. The concept uses on the one hand monetary information (NPV) and qualitative information (utility analysis). This approach had been applied to a case study and addresses the challenge to incorporate analytical and intuitive information from multiple stakeholders into one supplier selection model.

Referring to the findings, the model could provide a clear indication for the CP-IMS choice in the case and proved its usefulness. Also, the model can be easily adapted to other situations, as the implementation of a CP-IMS is not part of the daily business of a company and there is often not enough time and resources for a structured preparation. The content of the proposed model (utility analysis, NPV) regards enough different criteria on the other hand practicability issues are regarded (Beer, 2007). Of course it is difficult to develop an instrument which can be used in general. The variety of company environments and specifics underlines this fact (Stefanou, 2001). If necessary, the developed model was designed in a very general way and therefore eases adaptation. In this form it is a first step to bridge the gap between conceptual constructs and operationalized evaluation criteria of CP-IMS.

Nevertheless, there are also limitations of the study. First of all, the literature basis of only eight papers is a clear limitation. Even if this paper applied a narrow focus only on CP-IMS and provided a first basis for further research on the topic, a broader literature base would leverage the impact of the theoretical and managerial implications. The same is for the case study approach, which provided a lot of insights and allowed to operationalize each decision criteria. Nevertheless, a broader data base is appreciated. Another limitation is, that the decision concept focusses on ex-ante criteria only. Especially soft skill criteria, e.g. ex post satisfaction with support services, friendliness of provider personnel, etc., were not considered, because of their measurement difficulties.

Further research might address these limitations and conduct a literature review researching the broader topic of software procurement and procurement information systems. Also it is recommended to explore (single) decision criteria by applying them to other cases in order to broaden the empirical basis. Another starting point for further research could be the comparison of decision criteria for a CP-IMS with criteria for other IT (e.g. application or cloud software). Finally, an interesting topic would be to analyze the satisfaction of companies using this framework for CP-IMS procurement decisions.

References

Abdelilah, K. and Mohammed, A.J.I. (2013), "A semi-structured methodology for ERP system selection based on MACBETH and choquet integral applied to small and medium sized enterprises", *International Journal of E-Entrepreneurship and Innovation*, Vol. 2 No. 4, pp. 1-19.

Al-Kilidar, H., Cox, K. and Kitchenham, B. (2005), "The use and usefulness of the ISO/IEC 9126 quality standard", in ISESE (Ed.), *International Symposium on Empirical Software Engineering, Noosa Heads*, *November 17-18*, pp. 126-132.

Andressen, T. (2008), "Kritische masse – wie viele lieferanten und nutzer benötigt ein desktop purchasing?", in BMEnet (Ed.), *eBusiness Guide 2008, Bericht der BMEnet GmbH*, Würzburg, p. 60.

ANSI/ASQC-A3 (1978), *Quality Systems Terminology*, American Society for Quality Control, Washington.

Arndt, M. and Betz, S. (Eds) (2004), *e-Business im Industriellen Management – Theoretische Fundierung und Praktische Umsetzung im Mittelstand*, Duehrkohp & Radicke, Göttingen.

Arnold, U. and Kasulke, G. (2007), *Praxishandbuch Innovative Beschaffung - Wegweiser für den Strategischen und Operativen Einkauf*, Wiley-VCH, Weinheim.

Azadegan, A. and Dooley, K.J., (2010), "Supplier innovativeness, organizational learning styles and manufacturer performance: an empirical assessment", *Journal of Operations Management*, Vol. 28 No. 6, pp. 488-505.

Bahli, B. (2005), "Validating measures of information - technology outsourcing risk factors", *Omega*, Vol. 33 No. 2, pp. 175-187.

Bannister, F. and Remenyi, D. (2000), "Acts of faith - instinct, value and IT-investment decisions", *Journal of Information Technology*, Vol. 15 No. 11, pp. 231-241.

Baray, S., Hameed, S. and Badii, A. (2008), "Analyzing the factors responsible for effectiveness of implementation and integration of enterprise resource planning systems in the printing industry", *Journal of Enterprise Information Management*, Vol. 21 No. 2, pp. 139-161.

Bechor, T., Neumann, S., Zviran, M. and Glezer, C. (2010), "A contingency model for estimating success of strategic information systems planning", *Information and Management*, Vol. 47 No.1, pp. 17-29.

Beer, A. (2007), "C-teile-management – ursprung, chancen, risiken und ansatzpunkte", in Dickmann, P. (Ed.), *Schlanker Materialfluss – mit Lean Production, Kanban und Innovationen*, Springer, Berlin, pp. 272-277.

Behkamal, B., Kahani, M. and Akbari, M.K. (2009), "Customizing ISO 9126 quality model for evaluation of B2B applications", *Information and Software Technology*, Vol. 51 No. 3, pp. 599-609.

Benlian, A. and Hess, T. (2011), "Comparing the relative importance of evaluation criteria in proprietary and open-source enterprise application software selection - a conjoint study of ERP and office systems", *Information Systems Journal*, Vol. 21 No. 6, pp. 503-525.

Bogaschewsky, R. and Müller, H. (2002), *B2b-Marktplatzführer – Erfolgreich handeln auf Online-Märkten*, Verlagsgruppe Handelsblatt, Düsseldorf.

Borda, P.M.d. (1781), *Mémoire sur les élections au scrutiny*, N/S, Paris.

Bundesministerium des Innern (BMI) (2010), *UfAB V – Unterlage für Ausschreibung und Bewertung von IT-Leistungen, 2. Version*, Bundesministerium des Innern, Bonn.

Bundesverband Materialwirtschaft, Einkauf und Logistik e.V. (BME) (2012), *Elektronische Beschaffung 2012 – Stand der Nutzung und Trends 2012*, BME & Universität Würzburg, Würzburg.

Burke, L.A., Miller, M.K. (1999), "Taking the mystery out of intuitive decision making", *Academy of Management Executive*, Vol. 13 No. 4, pp. 91-99.

Cellini, S.R. and Kee, J.E. (2010), "Cost-effectiveness and cost-benefit analysis", in Wholey, J.S., Hatry, H.P. and Newcomer, K.E. (Eds), *Handbook of Practical Program Evaluation*, 3rd ed., Wiley, San Francisco, CA, pp. 493-530.

Charaus, S. (2004), "Absatz und e-Business", in Arndt, M. and Betz, S. (Eds), *e-Business im industriellen Management – Theoretische Fundierung und praktische Umsetzung im Mittelstand*, Ruprecht, Göttingen, pp. 55-72.

Choi, T.Y. and Hartley, J.L. (1996), "An exploration of supplier selection practices across the supply chain", *Journal of Operations Management*, Vol. 14 No. 4, pp. 333-343.

Das, A. (2004), "e-provider evaluation – an exploratory study", *International Journal of Technology Management*, Vol. 28 No. 1, pp. 46-61.

Das, A. and Buddress, L. (2007), "Evaluating prospective e-providers – an empirical study", *The Journal of Supply Chain Management*, Vol. 43 No. 4, pp. 31-46.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989), "User acceptance of computer technology – a comparison of two theoretical models", *Management Science*, Vol. 35 No. 8, pp. 982-1003.

Ellis, S.C., Henry, R.M. and Shockley, J. (2010), "Buyer perceptions of supply disruption risk: a behavioral view and empirical assessment", *Journal of Operations Management*, Vol. 28 No. 1, pp. 34-46.

Ellram, L.M. (1990), "The supplier selection decision in strategic partnerships", *International Journal of Purchasing and Materials Management*, Vol. 26 No. 4, pp. 8-14.

Ellram, L.M. and Carr, A. (1994), "Strategic purchasing: a history and review of the literature", *International Journal of Purchasing and Materials Management*, Vol. 30 No. 2, pp. 9-18.

Emerson, P. (2013), "The original Borda count and partial voting", *Social Choice and Welfare*, Vol. 40 No. 2, pp. 353-358.

Essig, M. and Amann, M. (2013), "E-Procurement and its role in supply management and supplier evaluation", in Harland, C. *et al.* (Ed.), *The SAGE Handbook of Strategic Supply*, SAGE Publication, Thousand Oaks, CA, pp. 422-441.

Finkel, K. (1996), "How to launch a successful warehouse management system", *IIE Solutions*, Vol. 28 No. 2, pp. 16-20.

Fitzgerald, G. (1998), "Evaluating information system projects – a multi-dimensional approach", *Journal of Information Technology*, Vol. 13 No. 1, pp. 15-27.

Garvin, D. (1984), "What does 'product quality' really mean?", *Sloan Management Review*, Vol. 26 No. 1, pp. 25-43.

Gunasekaran, A. and Ngai, E.W.T. (2004), "Information systems in supply chain integration and management", *European Journal of Operational Research*, Vol. 159 No. 2, pp. 269-295.

Güthoff, J. (1998), "Dienstleistungsqualität als strategischer Wettbewerbsvorteil", *Wirtschaftswissenschaftliches Studium*, Vol. 27 No. 12, pp. 610-615.

Hirschsteiner, G. (2002), "C-artikel-management – direct purchasing for peanuts?", *Beschaffung Aktuell*, Vol. 49 No. 6, p. 78.

Hutchinson, A. (2001), *Industrial e-Sourcing - What Customers Need to Know*, Cartegic Group Inc., Newton.

ISO/IEC 9126 (2001), *Software Engineering – Product Quality – Part 1: Quality Model*, 1. Ed., International Organization for Standardization, Geneva, Switzerland.

Jones, D., Ross, C.F. and Stanton, R. (2011), "The Forrester Wave – eProcurement solutions", available at: www.forrester.research.com

Kahraman, C., Cebeci, U. and Ulukan, Z. (2003), "Multi-criteria supplier selection using fuzzy AHP", *Logistics Information Management*, Vol. 16 No. 6, pp. 382-394.

Kano, N. (1984), "Attractive quality and must-be quality", *Journal of the Japanese Society for Quality Control*, Vol. 14 No. 2, pp. 39-48.

Katz, M.L. and Shapiro, C. (1986), "Technology adoption in the presence of network ex-ternalities", *Journal of Political Economy*, Vol. 94 No. 4, pp. 822-841.

Kaufmann, L. and Carter, C.R. (2006), "International supply relationships and non-financial performance-a comparison of US and German Practices", *Journal of Operations Management*, Vol. 24 No. 5, pp. 653-675.

Knemeyer, A.M. and Murphy, P.R. (2005), "Is the glass half full or half empty?: An examination of user and provider perspectives towards third-party logistics relationships", *International Journal of Physical Distribution & Logistics Management*, Vol. 35 No. 10, pp. 708-727.

Koppelmann, U. (2004), *Beschaffungsmarketing*, 4th ed., Springer, Berlin.

Lavelle, L. (2002), "Today's tech mantra - reduce, reuse, recycle", *Business Week*, Vol. 11 November, p. 39.

Mertens, P. (2010), *Grundzüge der Wirtschaftsinformatik*, 10th ed., Springer, Berlin.

Miller, C.C. (2008), "decisional comprehensiveness and firm performance: towards a more complete understanding", *Journal of Behavioral Decision Making*, Vol. 21 No. 5, pp. 598-620.

Molenaers, A., Baets, H., Pintelon, L. and Waeyenbergh, G. (2012), "Criticality classification of spare parts: a case study", *International Journal of Production Economics*, Vol. 140 No. 2, pp. 570-578.

Neef, D. (2001), *E-Procurement – From Strategy to Implementation*, FT Press, Upper Saddle River, NJ.

Nekolar, A.-P. (2003), *E-Procurement – Euphorie und Realität*, Springer, Berlin.

Palanisamy, R., Verville, J., Bernadas, C. and Taskin, N. (2010), "An empirical study on the influences on the acquisition of enterprise software decisions: a practitioner's perspective", *Journal of Enterprise Information Management*, Vol. 23 No. 5, pp. 610-639.

Picot, A., Reichwald, R. and Wigand, R.T. (2003), *Die grenzenlose Unternehmung – Information, Organisation und Management; Lehrbuch zur Unternehmensführung im Informationszeitalter*, 5th ed., Gabler, Wiesbaden.

Piller, F. (1997), *Das Produktivitätsparadoxon der Informationstechnologie – Stand der Forschung über die Wirkung Stand der Forschung über die Wirkung von Investitionen in Informations- und Kommunikationstechnologie*, Lehrstuhl für Betriebswirtschaftslehre und Industriebetriebslehre an der Universität Würzburg, Würzburg.

Ratnasingam, P., Pavlou, P.A. and Tan, Y.-H. (2002), "The importance of technology trust for B2B electronic commerce", *15th Bled Electronic Commerce Conference, Paper 43, Bled, June 17-19*.

Sackstetter, H. and Schottmüller, R. (2001), *C-Teile-Management – Umsetzung von C-Teile-Management-Projekten*, Dt. Betriebsw. Verlag, Gernsbach.

Sackstetter, H. and Schottmüller, R. (2003), "C-teile-management – kernstrategien des einkaufs", *Der Betriebswirt*, Vol. 44 No. 1, pp. 13-17.

Samadhiya, D., Wang, S.-H. and Chen, D. (2010), "Quality models – role and value in software engineering", in ICSTE (Ed.), *2nd International Conference on Software Technology and Engineering*, *Puerto Rico, October 03-05*, pp. 320-324.

Schwarze, J. (1991), *Einführung in die Wirtschaftsinformatik*, 2nd ed., Herne, Berlin.

Şen, C.G., Baracli, H. and Sen, S. (2009), "A literature review and classification of enterprise software selection approaches", *International Journal of Technology and Decision Making*, Vol. 8 No. 2, pp. 217-238.

Shankarnarayanan, S. (1999), "ERP systems – using IT to gain a competitive advantage", available at: www.expressindia.com/newads/bsl/advant.html

Smith, A.D. (2011), "Inventory management and ABC analysis practices in competitive environments", *International Journal of Procurement Management*, Vol. 4 No. 4, pp. 433-454.

Stefanou, C. (2001), "A framework for the ex-ante evaluation of ERP software", *European Journal of Information Systems*, Vol. 10 No. 4, pp. 204-215.

Teltumbde, A. (2000), "A framework for evaluating ERP projects", *International Journal of Production Research*, Vol. 38 No 17, pp. 4507-4520.

Trepper, C. (1999), "ERP project management is key to a successful implementation", available at: www.datamation.com/entdev/article.php/614681/ERP-Project-Management-Is-Key-To-A-Successful-Implementation.htm, (accessed August 1, 1999).

Verville, J. and Halingten, A. (2002), "An investigation of the decision process for selecting an ERP software: the case of ESC", *Management Decision*, Vol. 40 No. 3, pp. 206-216.

Verville, J., Bernadas, C. and Halingten, A. (2005), "So you're thinking of buying an ERP? Ten critical factors for successful acquisitions", *Journal of Enterprise Information Management*, Vol. 18 Nos 5/6, pp. 665-677.

Vömel, C. (2009), *C-Teile-Management*, VDM Verlag, Saarbrücken.

Wu, Z. and Pagell, M. (2011), "Balancing priorities: decision-making in sustainable supply chain management", *Journal of Operations Management*, Vol. 29 No. 6, pp. 577-590.

Yin, R.K. (2009), *Case Study Research – Design and Methods*, 4th ed., Sage Publications, Thousand Oaks, CA.

Further reading

Schulze, U. (2009), *Informationstechnologieeinsatz im Supply Chain Management - Eine konzeptionelle und empirische Untersuchung zu Nutzenwirkungen und Nutzenmessung*, Gabler, Wiesbaden.

Appendix. Operationalization of evaluation criteria

$$Suitability = \frac{\sum System\ capability}{\sum Company\ requirements} \times 10$$

$$Reliability = 5 \times \left(1 - \frac{Occurred\ mistakes}{Test\ run(s)}\right) + 0.5 \times Reference\ reliability\ score$$

$$Usability = 0.5 \times \frac{\sum Test - score\ (by\ internal\ personnel)}{\sum Number of tests} + 0.5 \times\ evaluation\ score\ by\ reference\ companies$$

$$Efficiency = 0.75 \times Savings\ in\ process\ time\ (percent) \times 10 + 0.25 \times (1 - \frac{\emptyset average\ procurement\ time\ with\ CP - IMS}{Status\ quo\ procurement\ time} \times 10$$

$$Geographical\ extension = \frac{Supported\ languages\ of\ thesystem}{Required\ languages} \times 10$$

$$Market\ share = Estimated\ market\ share\ of\ the\ provider\ (in\ percent) \times 10$$

$$Turnover = Estimated\ growth\ rate\ in\ CP - IMS\ branch\ for\ last\ three\ years\ (in\ percent)$$

$$Equity = \frac{Equity\ ration\ of\ the\ provider}{Total\ capital\ of\ the\ provider} \times 10$$

$$Proportion\ C - Parts = \frac{Number\ of\ employees\ in\ CP - IMS}{Total\ number\ of\ provider\ employees} \times 10$$

$$Industry\ experience = \frac{Time\ in\ business\ (years)}{Maximum\ experience\ (15\ years)} \times 10$$

$$Reputation = \frac{\sum Reputation\ score\ (from\ questionnaire)}{Number\ of\ received\ answers/questionnaires}$$

$$Research\ \&\ Development = \frac{Number\ of\ employees\ in\ R\&D}{Number\ of\ employees\ in\ CP - IMS} \times 10$$

$$\frac{Service\ level = \sum Offered\ services}{\sum Required\ services}$$

$$User\ size = \frac{Maximum\ demand\ of\ user\ companies}{Maximum\ points + 1\ (here\ 11)}$$

$$Supplier\ size = \frac{Maximum\ demand\ of\ user\ companies}{Maximum\ points + 1\ (here\ 11)}$$

About the authors

Professor Michael Essig holds the Chair for Materials Management & Distribution at the Bundeswehr University Munich and is the Co-Director of the Research Center for Law and Management of Public Procurement as well as the Transfer Center for Defence Supply Chain Management and the Competence Network Performance Based Logistics. From 2009 to 2012 he acted additionally as the Vice President for Research at the Bundeswehr University. Michael Essig is a University Professor at the Bundeswehr University Munich. Michael published more than 200 books and articles in the field of purchasing and supply chain management and acts on the review board of several scientific journals in the field of supply chain management. Besides other memberships he is also a member of the Scientific Board of the German Purchasing Association.

Dr Andreas H. Glas is the Head of the Competence Network Performance Based Logistics at the Bundeswehr University Munich. In this function he coordinates all defence supply chain management projects at the Chair for Materials Management & Distriubtion. His academic carreer started with an MSc degree in business adminstration followed by lecturing and a PhD thesis about performance based contracting. His current research focusses on performance based contracting – with a focus on defense, aerospace and security industries. He also acts on the review board of several journals. Dr Andreas H. Glas is the corresponding author and can be contacted at: andreas.glas@unibw.de

Josef Gutsmiedl is an Officer in the German Bundeswehr and a Researcher at the Chair for Materials Management & Distribution. His research focusses on industrial supply networks, particularly for the supply with "C-Parts" – high volume, low cost – parts. Besides he also worked on a research project analyzing agile supply networks in crisis, immediate relief, or defense scenarios.

This article has been cited by:

1. Ahmed Altayyar, John Beaumont-Kerridge. 2016. External Factors Affecting the Adoption of E-procurement in Saudi Arabian's SMEs. *Procedia - Social and Behavioral Sciences* **229**, 363. [CrossRef]