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A benchmarking model for Maintenance and Support assignments in an ERP environment

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Abstract

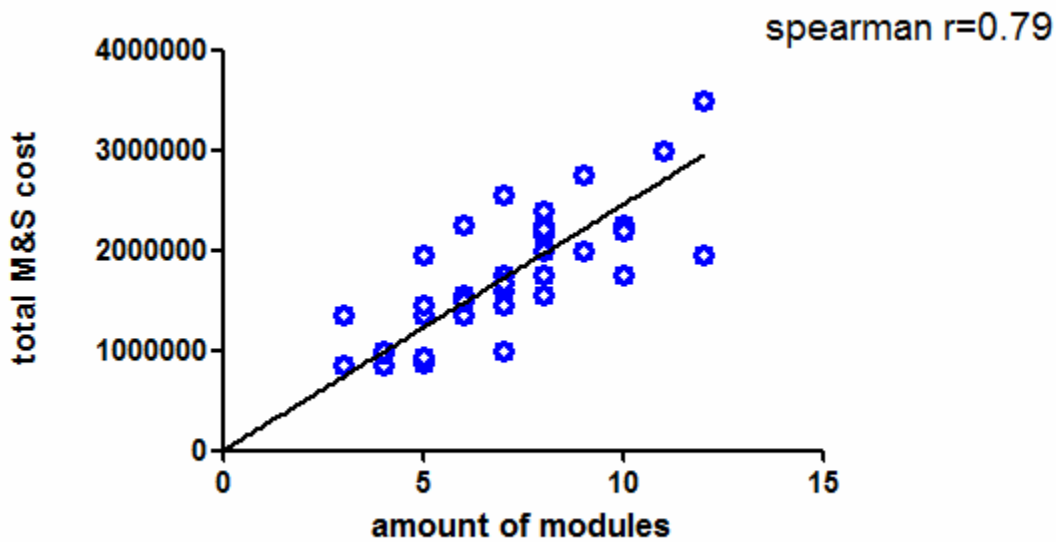
We present a benchmarking model on how to track and eliminate dissimilarities in M&S assignments, supporting different Enterprise Resource Planning (ERP) environments. ERP-user organizations, SAP systems, infrastructure and level of service quality are some examples of elements that will drive M&S effort and cost. In each of these aspects, there are cost drivers that influence the M&S process in different extents. Our model identifies the impact of the many different parameters for the uncovering of Maintenance and Support (M&S) costs and benefits within, or between, organizations. To be able to compare parameters that affect the M&S work load we have developed a complexity calculator, which work to normalize such parameters. The complexity calculator compares the parameters of interest with a mean-assignment calculated from our reference database, which will create a complexity index and, thus, enables the comparison of all factors that may be of consideration. After receiving the index, we suggest a comparison with one or several peer-groups to further remove variations between the assignments, for instance organizations with similar number of users. Furthermore, our model enables the possibility of evaluation and measurement of assignments cost, benefits, system characteristics and M&S staff productivity with the utilization of key performance indicators (KPI) on both qualitative and quantitative measures. Additionally, the model provides functionality for cost and effort prognostication. In conclusion, we show how to compare M&S assignments on several aspects, which facilitate cost and service strategies for M&S organizations. The ERP using organizations will acquire an increased awareness of M&S cost drivers, which facilitates development of cost efficient strategies. Thus, our model serves as a good ground in benchmarking assignments.

Key words

Maintenance & Support; SAP; ERP; KPI; Measurement; Benchmarking

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1. Introduction

A presentation of the background to our research question initiates this report. After the background, research question and purpose of the study we describe our delimitation and disposition and in conclusion we present VOLVO GROUP, where our study was conducted.

Enterprise resource planning (ERP) is an organization-wide software package which integrates the enterprises functional- and business areas. An ERP system is bought from a vendor and this differentiates it from in-house developed systems. Today's global economy causes enterprises to adapt their organizational structure and business processes to the reigning conditions, which have resulted in a lot of ERP implementations around the world (personal communication, project leader 2008). The situation also creates a need for customization of the systems which has led to a significant system diversification. This makes it difficult to support and maintain the systems and as a consequence, also problematic to make comparisons of the different system environments. Many companies believe that the implementation activities are finished after the ERP system has been installed. This could not be further away from the truth since ERP systems constantly add new functionality or upgrading to new versions (Stefanou, 2001).

Previous research on ERP system has mainly been focused on the implementation phase of the ERP lifecycle. ERP M&S are given more focus in organizations and research today than before, but implementation issues are still more researched. The cost for maintenance is roughly 25% of the total implementation cost every year. Given that a substantial portion of the total cost of the ERP-system occurs in the post-implementation phase, M&S should not be neglected. (Ng, et al, 2002)

Volvo IT has a responsibility to support and maintain their clients ERP systems and its surrounding environment (Personal communication with VOLVO IT manager, 2008). These responsibilities are handled in so called Maintenance and Support assignments. M&S assignments have a continuous duty which distinguishes them from projects that has a deadline. The job activities handled in the assignments usually takes less then a specified number of hours to complete for instance less than 10 person days. M&S is therefore the daily administration of the system. An activity that exceeds the time limitation is regularly handled in enhancement projects separately from ongoing M&S.

The aim of this study is therefore to examine the possibility for evaluating and comparing M&S assignments. The main research question will consequently be:

How to evaluate and compare Maintenance & Support assignments in an ERP environment.

Currently, VOLVO IT has no model for comparing M&S assignments supporting ERP systems (personal communication with VOLVO IT manager, 2007). Therefore, the purpose of our study is to aid IT departments in general and VOLVO IT in particular in

measuring and comparing different M&S assignments. It is important to understand that, VOLVO IT is seen as an internal IT department for the whole VOLVO GROUP enterprise. The measurement should result in improved performance not just locally but in an enterprise perspective.

We have proposed a solution for this by developing our own benchmarking model. The model tries to solve three (3) crucial tasks.

1. Eliminate differences between assignments supporting dissimilar ERP environments
2. Evaluation and measurement of the assignments cost and benefits
3. Comparison of the assignments

1.1 Delimitation

Our evaluation and comparison of M&S assignment will focus on the area of costs and benefits, the other dimension risk were not considered in this report. We conducted a single case study on an organization that supports SAP ERP environments, to limit the number of influencing factors. However differences between vendors could be of interest for future research. This delimitation was decided on because of the vast scope of ERP maintenance and support. ERP maintenance and support costs has many interconnected variables that has to be illuminated in order to get a valuable result, therefore, no further delimitation was made.

1.2 Disposition

This report is divided into five main chapters; method, theoretical framework, result, discussion and conclusion. The first chapter describes how the research has been carried out. In the theoretical framework we describe the case study, display previous models as well as methods relevant to the three main tasks; difference elimination, evaluation and comparison. In the result section, the results from the interviews and the questionnaire are presented along with our benchmarking model. In the discussion, our results and previous research of ERP M&S are analyzed and reflected upon. The final chapter concludes the result of our research.

1.3 Case Study: VOLVO GROUP

VOLVO GROUP is a world leading manufacturer of trucks, busses, construction equipment, marine and industry drive trains as well as delivery of components and services to the flight industry. VOLVO GROUP has production sites in 25 countries and covers 180 different markets. VOLVO GROUP has about 90.000 employees and 75% of them are employed in VOLVO's business areas. Net sales for 2006 were close to 250 billion SEK. VOLVO GROUP is divided in two organizational types; business areas and business units (VOLVO.com, 2007). VOLVO IT delivers IT solutions that support the industrial process and services in SAP solutions. In 1995, VOLVO started developing and implementing a global financial solution from SAP called Master Finance. Since

then, many of the companies in VOLVO GROUP have extended their use of the financial solution to include logistics processes as well. VOLVO IT is now a certified hosting partner to SAP which means that SAP together with VOLVO IT provide software, implementation, operation and support to the industrial industry (VOLVO.com, 2007). Figure 1 shows Volvo Groups organizational structure as well as VOLVO IT's responsible areas as one of VOLVO GROUPS business unit.

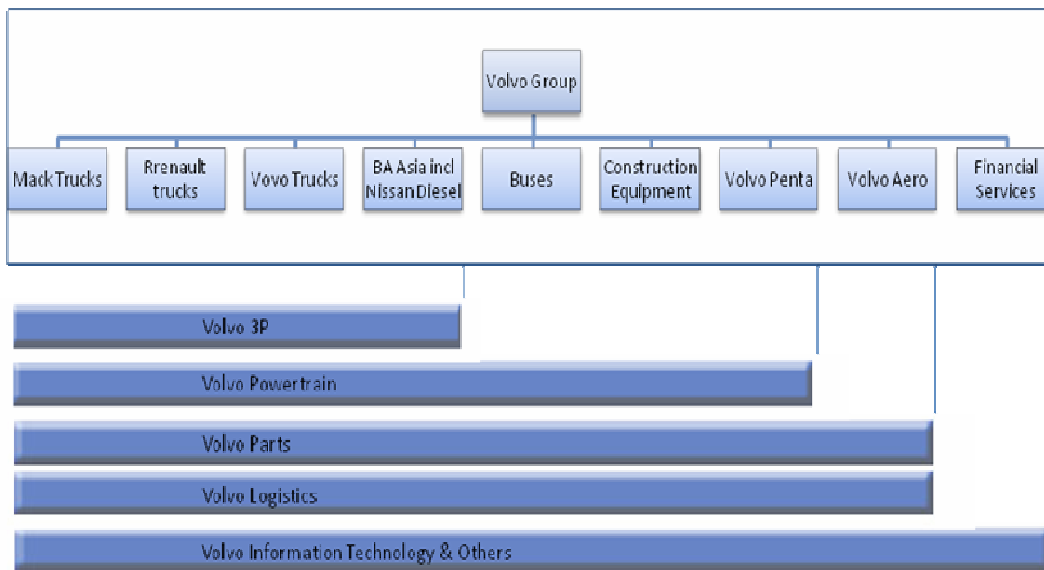


Figure 1 – Schematic picture of VOLVO GROUP organizational structure

2. Method

2.1 Literature

The complexity of the ERP environment and the lack of previous studies in the field of benchmarking ERP M&S led to a comprehensive literature study where different fields were investigated. The study started with the investigation of basic information about ERP systems, primarily SAP R/3 and ERP maintenance models. The literature study continued in the field of total cost of ownership (TCO) in ERP environments and finally benchmarking methodologies. The literature was consulted throughout the investigation. In order to get a deeper understanding of the complicated area of M&S and VOLVO's internal processes, we applied an ERP maintenance model by See Pui Ng, C et al on VOLVO IT's organization.

2.2 Scientific method

We have used a qualitative scientific method in our research paper. We think this is the best way to approach a subject like ERP maintenance and support due to the fact that there is not much previous research done in this area and the fact that we have no previous knowledge of our case study's business processes and structure.

2.3 Interviews

We have used both informant interviews and respondent interviews to gather information. These interviews have been structured, semi-structured and unstructured depending on the purpose of the interview.

In this report we have had two different interviewees:
Respondent A = SAP maintenance manager at VOLVO IT.
Informant A = senior implementation project leader at Oracle

Nr	Purpose	Duration	Type	Interviewee
1	Discuss research subject, Acquire an understanding of the organization and area of the study.	60min	unstructured	Respondent A
2	Deeper knowledge of VOLVO ITs M&S process	60min	Semi-structured	Respondent A
3	Demonstration of our model to get final input on variable relevance.	60min	Semi-structured	Respondent A
4	Interview about vendors perspective and view on M&S	60min	Structured	Informant A
5	Further validation of our model	45min	Unstructured	Respondent A

Table 1 – interview summary

The first interview was unstructured and carried out at VOLVO IT and it provided organizational information about VOLVO GROUP and about the responsibilities of VOLVO IT, the duration of the interview was 60 min and the interviewee was respondent A. The second interview was more structured than the first. This was due to our increased knowledge on the topic. The length was approximately the same as the first interview and the interviewee was also respondent A. The goal of the interview was primarily to get a profound understanding about VOLVO IT's M&S activities and to ensure an agreement between VOLVO IT and us on the research question. It was important in this stage to limit the scope of the research. The purpose of the third interview was to validate our benchmark model. Our focus in this interview was the complexity variables. This interview was carried out at VOLVO IT with respondent A. The fourth interview was structured and conducted with informant A. the length of the interview was 30 minutes, the questions and answer can be found in appendix B. The fifth interview was conducted through mail correspondence with respondent A. This interview was conducted to make a final validation of our model.

2.3 Information for model development

To be able to create a benchmark model that compares VOLVO IT's M&S assignments, we wanted a clear picture of what costs are involved in the M&S stage. We used Gartner's Total Cost of Ownership (TCO) model to get a better understanding of different types of cost in an ERP environment, this was done in the literature study after the first respondent interview. By doing a literature study and conducting interviews with VOLVO IT we acquired a more comprehensive picture of the M&S process and also of VOLVO IT's internal processes. Throughout the development of our model we have continuously consulted VOLVO IT through email to validate the model. Furthermore, under the course of the study, continuous discussions with informant A has also been conducted to validate our model and especially the variables effecting M&S effort. This contact has generated insight in the subject of ERP costs and measuring issues.

A questioner was sent out to persons working with maintenance and support on different SAP solutions within, VOLVO 3P, VOLVO GROUP HQ, VOLVO Business services, VOLVO construction equipment and VOLVO Technology. The purpose of the questioner was to collect data on different maintenance and support assignments to be able to validate our model. The questions were sorted in six different categories to get a total picture of the maintenance work and application characteristics;

- Application specification questions
- Cost related questions
- Business related questions
- System related questions
- Infrastructure related questions
- Service level related questions

The model has been validated by interviews and with the questionnaire. Informant A and respondent A have reviewed the model and discussed the validity of the different variables with us.

3. Theoretical framework

First M&S and ERP will be explained to ensure that the reader acquire a deeper knowledge in this area which is required for understanding our model. The following section will explain topics relevant to our three main tasks. To understand why we eliminate differences between assignments, the benchmarking concept is described followed by a total cost of ownership model which is relevant to our second task. Finally, evaluation and measurement are presented which are relevant to our second and third task.

3.1 M&S

M&S activities are defined as maintenance or enhancement tasks that do not affect the functionality. If they do, they are usually defined as software development of enhancements (Goyal & Sen, 2005) or just enhancements (VOLVO, 2007). We will use the latter of the two definitions throughout this paper. There are differences between management of enhancement projects and management of M&S activities. The enhancement projects are organized to deliver a specific application within a set timeframe. The management of M&S has a continuous responsibility and no end-date and is organized to deliver ongoing support on a daily basis. M&S activities include bug fixes and minor enhancements (Goyal & Sen, 2005). We define minor enhancements as less than 10 person days in line with VOLVO IT even if they change functionality.

3.2 ERP

There are many ERP vendors, where SAP and Oracle are the market leaders. (Liang et al, 2004) An enterprise may implement an SAP ERP system and integrated applications from other ERP providers, for instance CRM and PLM modules developed by Oracle. This is the case in some VOLVO companies (personal communication with project leader, 2007). The ERP systems main responsibilities are to manage reporting and analysis of business performance and increase operational efficiency by improving business processes. It also offers functionality to standardize the business processes on a global scale. A large scale ERP application consists of many components. Hardware, software and services are needed for successful systems. All these components have to be integrated which can result in a complex infrastructure (fig 2) (Esteves & Pastor, 1999).

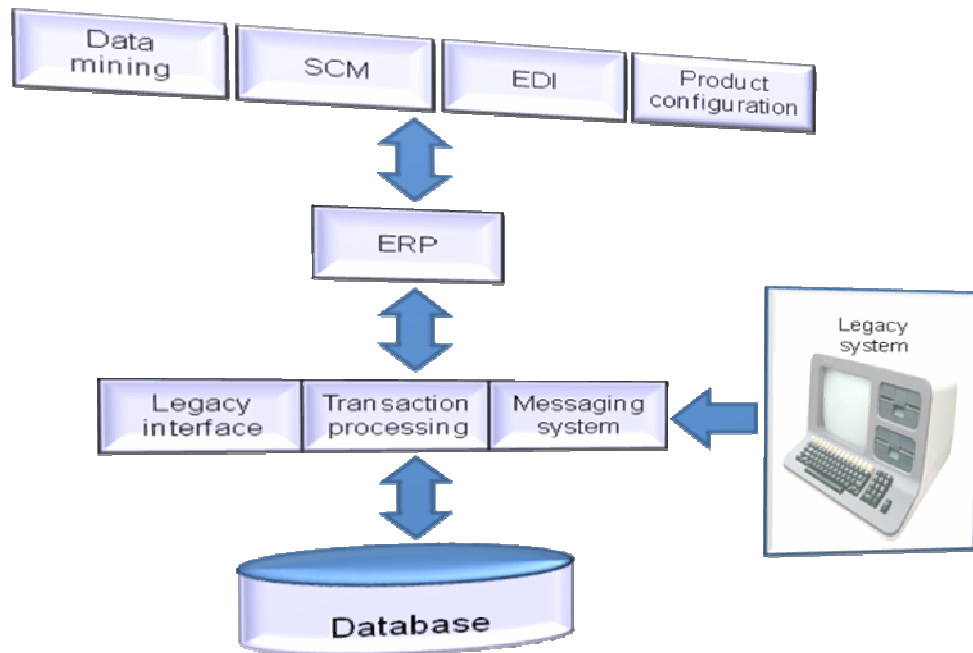


Figure 2 - Example of an ERP infrastructure

Most organization needs are fulfilled with a single ERP system because of the many applications and modules in the ERP packages. Migration and integration issues related to application from various vendors are eliminated and the information transfer between internal processes is also improved with ERP systems. ERP systems are standardized solutions, i.e. the vendor does not adapt the system after every customers need and this result in customizations and sometimes modifications of the software (personal communication, project leader 2007). Modifications are defined as changes to the standard ERP code, software properties and functionality Customizations are configurations to the ERP system to support preferred business processes, requirements and practices by the user organization all according to Esteves & Pastor (2001). Another definition of customizations is changes or enhanced functionality available in the standard ERP system (Light B, 2001).

3.3 SAP software characteristics

SAP supports many different businesses and functional areas which can lead to a complex system. With the use of relational databases all the organizations processes and transactions are integrated. Instead of rolling out an upgrade release (new SAP version) every 18 month, SAP releases enhancement packages a few times per year. The package can includes improvements, new functionality or support packages. The support package

offer bug fixes and legal changes. An ERP system can include a single or many different modules such finance or human resource modules. Modules are software applications which replace legacy systems. This means, when integrating the modules, the business processes are usually changed in accordance to the SAP software. SAP functionality covers all generic processes and transactions in a company or group of companies. SAP software is configurable and can be customized. It is possible to alter the software to meet the company's practices but at the same time it needs the organization to change to be able to function (SAP.com, 2008).

3.4 ERP implications

It has previously been shown that some companies have had problems implementing SAP standard models without making adjustments to the system (Light B, 2001). There are maintenance implications with customizations if they change functionality. Depending on what type of change is involved, maintenance effort is affected in different extent. Change of functionality is the one that leads to the most M&S effort (fig. 3).

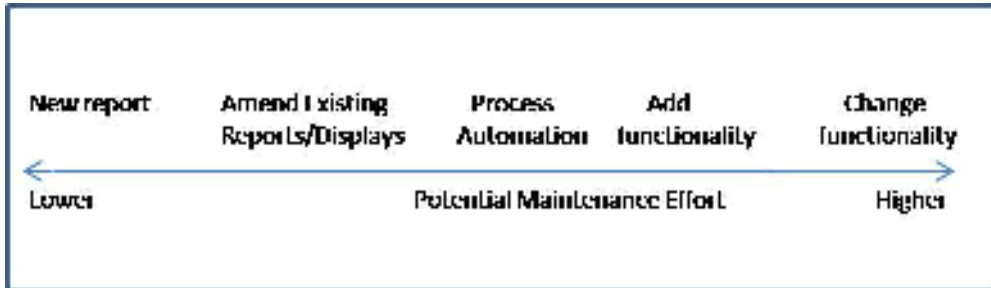


Figure 3 - Degree of influence on M&S effort with different customizations (Light, 2001)

To avoid modifications, organizations will have to accept a certain level of misfit and change the business processes to fit the system (Ng et al, 2002). Sometimes ERP functionality is too limited or too inflexible to be adjusted to fit the organizations needs. Therefore corporations use interfaces that link older systems (legacy systems) with the ERP system. A previous study has shown that the first year of production for a SAP R/3 system, a lot of M&S effort was needed. Major configurations issues emerged as well as a need for user training as well as future improvements of system efficiency were discussed (Hirt and Swanson, 2001). Previous studies have also revealed that the cost per ERP user increased when companies increased in size¹. When companies exceed USD \$50 million in annual revenue, the number of implemented modules increase significantly which implies that the ERP solution needs to be more comprehensive when companies get larger. When annual revenue surpass USD \$250 Million, the average cost per user decrease, which may be because large companies enjoy volume discounts from vendors as well as they gain bargaining power as they grow (Aberdeen GROUP, 2007). The ERP costs in different sized organizations are summarized in table 1.

Company	Average	Average # of	Average	Average SW	Average
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¹ size are here defined as annual revenue (Aberdeen, 2007)

Size	number of users	of ERP modules implemented	software \$'s per user	and Service \$' per user	Total cost per user
Under \$50 Million	38	9.9	\$6.680	\$10.651	\$13854
\$50-\$100 million	92	11.1	\$6784	\$11973	\$15304
\$100 - \$250	195	10.9	\$6933	\$13002	\$18157
\$250 -\$500	344	10.8	\$3954	\$6518	\$7738
\$500-\$1 billion	475	11.8	\$3556	\$6459	\$8712
\$1 billion-\$5 billion	2187	12.3	\$2616	\$4711	\$6025
Over \$5 billion	3365	13.7	\$799	\$1707	\$2068

Table 1 – ERP cost in different sized organizations (Aberdeen Group, 2007)

Previous studies reveal that infrastructure-related costs represent approximately 70% of the on-going costs of ERP-systems on an annual basis and 40 % of the ERP solutions total cost after three years. Furthermore, small organizations² pay three times more per user than larger organizations³ for on-going support per user (\$7870 vs. \$ 2304). Small organizations pay roughly twice as much as their large counterparts for on-going infrastructure costs (\$5138 vs. \$2338). The choice of platform affects overall support costs for ERP solutions in small organizations and the correlation remain accurate for companies up to USD \$450 million in annual revenue. By using a shared IT architecture, cost from using multiple hardware and software could be reduced. To be able to support application efficiently, system flexibility and scalability is vital. This change of the IT systems strategy may be a requirement to be able to support the ERP system and other applications (Fitzgerald 1998). Other factors influencing ERP costs are degree of centralization, management structure, the style of leadership, the rigidity of business processes and the company culture (Stefanou, 2001).

3.5 Total cost of ownership

Total Cost of Ownership (TCO) is a concept developed by the research and consulting firm Gartner GROUP in 1987. The theory was developed to clarify costs of owning and managing IT infrastructure in a business and has now evolved to Gartner's software modeling tool TCO manager. This modeling tool is the industry standard framework methodology for cost management. Gartner presents five major ERP life-cycle costs components: acquisition, implementation, operation, maintenance and replacement. In each of these components the most important cost drivers are according to Gartner: the nature of the organization (for example, a large, public, organization versus a small private organization); the quantity and types of technologies (for example, client server versus mainframe); and management practices (centralized versus decentralized IT operations). There are often acquisition costs that are the main focus for organizations

² Small organizations have annual revenue under USD \$200 million

³ Large organizations have a revenue over USD \$5 billion

when focusing on ERP costs. If the company focuses on the total cost picture, it could induce them to consider the indirect and unbudgeted costs that have a big impact on the ERP system's total cost. The largest part of ERP lifecycle costs are centered in operation and maintenance. Controlling software modification and centralizing operation can have significant effects on overall costs. (Daigle & West, 2004) Gartner's TCO methodology distinguishes costs as being either direct or indirect. Direct cost is made up by capital and labor costs, these cost is traditionally the area that organizations find easiest to measure. This often results in an excessive focus on direct costs. The impact of the indirect costs on organizations IT infrastructure are often underestimated; Gartner's surveys consistently confirm that despite difficulty of measuring indirect costs, they usually represent a considerable component, as much as 60% of the total cost of managing and owning an IT infrastructure. The most commonly referred example of indirect costs is downtime and quality of service. Indirect cost is the factor that drives and is driven by direct cost decisions. In other words, indirect costs often comes from misdirected funding in direct costs like training, technical support and helpdesk. For example, the budget for training personnel is cut down to a level that is not sufficient, the cost of training can shift to the business units, reducing available resources to perform business tasks. (Gartner.com, 2007) The model identifies ERP costs that should be measured, compared and monitored. Expenditures, staff levels and service levels should be compared to other organizations. User satisfaction and performance should be measured in relation to costs. The organization should highlight strengths and weaknesses in their total cost of ownership result (Gartner.com, 2007).

3.6 Benchmarking

Benchmarking is defined as “a systematic search for business excellence through continuous improvement, both from a strategic and an operation perspective” (Klein & Margherita, 2007). One approach is to place the benchmark's focus on key processes. By comparing key processes against a reference benchmark the goal is to uncover differences, the reasons for differences and a plan to close the performance gap. Through the use of benchmarking, organizations have been able to improve many key processes. The reasons why organizations initiates benchmarking project can vary. Reducing costs in specific areas of the organization, to better understand their market position, get a picture of how customer needs is changing, encouraging innovation or developing new strategic goals can all be motives for initiating a benchmark. The first step initially in a benchmarking project is deciding the dimension of the analysis; should the analysis be an internal or external benchmarking (Camp, 1989). When deciding what to benchmark, the strategic importance of the investigated area has to be measured but also the expected improvements in that area for overall business performance. The company must be aware of key operation bottlenecks. A narrow focus is usually the better choice, and it is also important that the project aim at manageable topics (Klein & Margherita, 2007). When the subject area has been chosen, key processes has to be identified. In order to identify key processes, the organization has to agree on critical success factors important in the pursuit of competitive advantage. Three basic steps should always be completed in a benchmarking project:

1. Study planning and targeting phase – Defining expected goals, processes and practices
2. Data collection and analysis phase – Evaluation and assessment of internal processes and differences with best practice
3. Definition of study goals – New objectives and actions are recognized and actions are carried out and results are examined.

The appropriate metrics to consider depend mostly on the object of the benchmarking. Direct observation, interviews and questionnaires are common data-collecting methods. After the internal analysis has been conducted, data is collected about the reference benchmark. A crucial factor here is data consistency. The next phase is to resolve performance gaps between the compared processes. Usually an index is used to evaluate the gap. Improvements are made by closing these gaps and identifying differences in business processes to discover reasons for performance differences. Another important process is communicating findings to top management and stakeholders in order to provide them with an update on the project to gain their acceptance and support for the implementation phase (Klein & Margherita, 2007).

3.7 Measurement and evaluation

ERP projects are complex and the cost and benefits have an intangible nature (Donovan, 2000; Remenyi, 2000). The complexity, the elusive nature of costs and benefits and organizational, technological and behavioral impact on ERP require a broad perspective when evaluating ERP. Evaluation requires an assessment of costs and benefits during the whole ERP system lifecycle (Stefanou, 2001). It is well established that IT investments have more benefits than just cost reduction (Farbey et al, 1993) and especially for ERP systems since they modify the organizational structure and make the business processes simpler and more integrated (Stefanou, 2001). An evaluation of ERP should be a comprehensive assessment of value from changes in business processes (Stafyla & Stefanou, 2000). Financial measures are necessary but are by themselves not adequate to evaluate ERP systems. This is due to the fact that costs and benefits are not easy to recognize because of their intangible nature (Stefanou, 2001). Even if they are recognized, it is still a problematic task to measure them (Powell, 1992). Furthermore a number of indicators is needed for the measurement of M&S (Goyal & Sen, 2005).

Little is known about how to measure and evaluate cost and benefits in operation, maintenance and evolution of the ERP-system. However, ERP user satisfaction and Partners/customers satisfaction are important metrics. Perceived customer satisfaction and benefits from better decision making is difficult but important to calculate. Resistance to change is another factor creating operational costs which is also very tough to measure (Stefanou, 2001).

KPI are metrics used to measure an essential task, operation or process.⁴ Selecting and defining KPI's is not simple but it is important that the KPI's lead to improved performance not just locally but in an enterprise perspective. Since all metrics are not

⁴ (Google, define: KPI).

KPI's and measurement takes time and resources, KPIs that do not lead to improved performance, consequently, needs to be removed (Bauer, 2004). ERP is both strategic and operational and assessment of strategic systems should be based on competitive impact and that is not the same thing as a cost valuation (Clemons, 1991). ERP software's operational costs and benefits are easier to recognize and measure than strategic values (Stefanou, 2001). As much as 90% of computer capitals cost and benefits are embodied in intangible resources (Brynjolfsson and Yang, 1997). These resources come from investments in software, training and organizational change because of IT (Stefanou, 2001). The right approach is for companies to put into practice corrective actions based on the measurement and then follow up with measurement of the successive results (Dekkers et al, 2005).

On top of all this, key benefits and costs do not come directly from the ERP usage but from the organizational change induced by ERP as well as implementation of new functionality (Donovan, 2000).

3.8 M&S Categorization

Software maintenance has traditionally been defined as correcting faults, improving performance or adapting the system to the changing environment. There are various classifications of maintenance, but the most cited in maintenance literature is categorized into; corrective, adaptive and perfective maintenance (Lientz and Swanson, 1993). Corrective maintenance stands for error correction in design, coding and implementation. Adaptive maintenance is activities to meet new user requirements and to satisfy a need of change in the data environment. Perfective maintenance acts to improve performance, processing efficiency and better accommodate user requirements. Two new categories have been added; user support (Abran and Nguyenkim, 1991) and preventive maintenance (Burch & Grupe, 1993). User support involves activities such as training users and help desk. Preventive maintenance is periodical inspections of the system to identify problems before they get to complex to solve. To accommodate ERP systems one more category has been added; external parties (Fui-Hoon Nah et al, 2001). External parties are coordinating activities among vendors, ERP team members, contractors/consultants and external user organization. Four identified stages of software maintenance; introduction, growth, maturity and decline (Burch and Kung 1997) which was proposed into a software maintenance lifecycle model (Kung and Hsu, 1998). The cycle has four stages introduction, growth, maturity and decline-stage. Introduction is the first few months after the system goes live. Growth is when the usage of the system grows and an improved understanding of the system functionality and an increased familiarity in general. In the maturity stage major enhancement project occur and in the last stage, decline, the system reaches the limits of software renovation required by users and the limits of the embedded technologies. Table 2 describes what categories are predominant in the stages in the maintenance lifecycle:

Stages	Characteristics
Stage 1 – Introduction	User support is largest, second most frequent activity is external parties. Adaptive, corrective and preventive maintenance take up much time and effort as well
Stage 2 – Growth	A decrease in all maintenance activities except for perfective maintenance
Stage 3 – Maturity	Perfective maintenance is predominant.
Stage 4- Decline	No data was collected

Table 2 – maintenance activities in each stage in the software maintenance lifecycle (Fui-Hoon Nah et al, 2001)

4. Research Methodology

It is vital to select the appropriate methodology to reach accurate and relevant results. The nature of the research question and the area where the study was conducted led us to do a study that can resemble a pilot study or an experimental research study. It is mainly a qualitative research, but with use of both qualitative and quantitative methods. The quantitative approach relies on deduction whereas qualitative approach relies on induction. Induction usually starts with an observation that leads to the identification of a pattern or something that resembles a pattern, which result in a generalization. The difference between induction and deduction is that induction conclusions are based on fact that is derived from observations whereas deduction derives conclusions from the theory with a logical aspect. The logic is based upon previous statements and used to create logical and valid deductions (Chalmers A.F., 2000; 1999).

4.1 Respondents

In this master-thesis, there are five respondents:

Respondent A is an SAP maintenance manager at VOLVO IT. Informant A works as a senior implementation project leader at Oracle. Respondent C work with Volvo IT's assignment for the solution SCORE used at VOLVO 3P. Respondent D work with Volvo IT's assignment for the Solution HR MASTER at VOLVO GROUP HQ and Respondent E works with Volvo IT's assignments for 3 solutions used in Volvo Technology, Volvo Business Services and Volvo Construction Equipment. We chose the Volvo IT SAP maintenance manager because of her specific information about M&S and SAP and the senior implementation project leader was selected due to his expertise in implementation of ERP, and about the vendor's role in M&S.

4.2 Research methodology

The literature study was started with aid of Google scholar, Gunda and other scientific sources. Initially, basic information about ERP, SAP and ERP maintenance models was investigated. The intricacy of the ERP topic led us to a variety of research papers, some relevant to our research question, but most of them were not or relevance. We continued the literature study to find a method to resolve our task. A wide range of methods were examined; TCO, ERP maintenance models, software models, software development models and benchmarking methodologies. At this point we decided to conduct a case study at Volvo IT to obtain more specific knowledge on how M&S was carried out in an ERP point of view. We decided to try to apply the maintenance model on Volvo IT, but it did not work as expected. However, we did acquire a deeper understanding of generic M&S processes, but what we wanted was more specific knowledge.

We decided to interview an employee at VOLVO IT responsible for maintenance and support assignments and also an implementation project leader from Oracle to broaden the perspective.

The interview with the Volvo IT M&S expert was to gather the required information and increase our limited knowledge. In addition, we came to the insight through the literature

study of the benchmarking concept that it is an absolute necessity to have thorough understanding about internal processes when conducting a benchmark and hence relevant when making a model of it. The first interview was unstructured and it provided us with organizational information about VOLVO GROUP and about the responsibilities of VOLVO IT. The duration of the interview was about 1 hour.

We gained a lot of information after the first interview, which forced us to alter our original research question. Additional literature studies were conducted once again which resulted in a need for a second interview. The second interview was more structured than the first, but still fairly unstructured. The length was approximately the same as the first interview and the respondent was the same. Additionally, we received some material in form of a SAP Benchmark model carried out by Gartner Group (respondent A).

This benchmark model helped us to better understand what we were trying to do. When searching the science literature, once more, we still couldn't find exactly what we were looking for. This led us to search in industrial reports, where we found a limited amount of information about the relevant topic and, in addition, we received one e-mailed benchmark upon our request. The material we had received at the previous interview was hard to comprehend for us and therefore we decided to have a third interview to go through the results. The interview was semi-structured and duration was about the same as the two previous ones and once again with the same respondent at Volvo IT.

Further unstructured interviews were conducted through e-mail and were focused on the development and validation of our benchmark model. When a question came up or when we added something new, we asked or verified this with either Respondent A or B. When the respondents came back with recommendations we made the suggested changes to our model. After about 5-6 emails we were satisfied with the result and with them we created a complexity calculator.

The fourth interview was structured and conducted with Informant A. The length of the interview was approximately 30 minutes (for questions and answers see appendix B), and was performed to fill in the missing gaps in our benchmark model. The fifth interview was conducted through mail correspondence with respondent A. This interview was conducted to make a final validation of our benchmarking model. In the fifth interview, we presented a draft of our benchmarking model for respondent A for a length of 20 minutes. Then we discussed the model for approximately 25 minutes. A summary of all the interviews are founded in table 3.

Nr	Purpose	Duration	Type	Interviewee
1	Discuss research topic, Acquire an understanding of Volvo Group's organizational structure. Gather information about internal processes.	60min	unstructured	Respondent A
2	Deeper knowledge of VOLVO IT's M&S process. Received benchmarking material	60min	semi-structured	Respondent A
3	Discussion about benchmarking findings	60min	Semi-structured	Respondent A
4	Interview about vendors perspective and to fill in knowledge gaps	30min	Structured	Informant A
5	Further validation of our model	45min	Unstructured	Respondent A

Table 3 – interview summary

We did not plan to have unstructured or structured interviews. It came naturally depending on where in the knowledge process we were. Along with our increased knowledge the interviews became more structured (with the exception of interview four). Furthermore, under the course of the study, continuous discussions with Informant A have also taken place for further validation of the model and also to avoid biases. Informant A has also generated insight about costs and measuring issues. These contacts have been sporadic and are therefore not considered as interviews. A questioner was formed and sent out to respondent A, who forwarded it to three other persons working within VOLVO IT. The literature study was iterative and the research question evolved throughout the entire research process. Before the discussion section was written in this master-thesis, another literature study was conducted. Previous research about KPI, benchmarking, M&S, ex-ante evaluation of ERP, TCO, costs and benefits measurements were collected and reflected upon.

4.3 Analysis

We have used quantitative methods, unstructured, semi-structured and structured interviews and qualitative methods with the use of a questionnaire. The empirical data was gathered through these interviews and by reviewing VOLVO IT's business process documentation that are related to M&S activities. VOLVO IT was chosen for the reason that they are responsible for many different types of organizations and SAP solutions, which made them a good case study since we wanted to compare dissimilar assignments in various organizations. By using only a single case study, differences between IT departments (Volvo IT) was not considered.

4.4 Development of a Benchmark Model

To be able to create a benchmark model that compares VOLVO IT's M&S assignments, we wanted a clear picture of what costs are involved in the M&S stage. We used

Gartner's TCO model to get a better understanding of different types of cost in an ERP environment (More detailed description of how the model was created see section 4.5). Due to the fact that industrial companies are ahead of the current research field we used some of their findings especially the peer-group concept from ASUG⁵, as well as their identified KPI's for M&S.

4.5 Complexity calculator

Another insight that we gained through the literature study was the fact that in a benchmarking mission all possible differences needs to be eliminated so that the comparison can be on equal premise. With this we understood that one of our problems was to resolve this task. One of the previous benchmark's had identified some cost drivers but once again, didn't explain why or how. We took all the variables, conducted more literature studies and carried out interviews to try to validate these findings. As a result some variables were changed and some was removed and, hence, we validated them in a qualitative approach. This process was repeated when other cost drivers were found and literature studies were conducted to identify previous studies discussing the cost drivers relevance. This iterative process finally gave us the end result that we used as a foundation for the benchmark model's construction (See section 4.5.1 for a more detailed description on how the tool was created).

4.6 Development of questions for the questionnaire

A questionnaire was sent out to respondent A, who forwarded it to 3 other people within Volvo IT, related with M&S on different SAP solutions. The purpose of the questionnaire was to collect data on different M&S assignments to be able to validate our model and also to collect information about the different solutions and values on each complexity variable. The questions were sorted in six different categories;

- Application specification questions
- Cost related questions
- Business related questions
- System related questions
- Infrastructure related questions
- Service level related questions

The questions for the questionnaire were a result from the comprehensive iterative literature studies in combination with interviews and e-mail correspondence with the two respondents. The model has been validated by interviews and with the questionnaire and personal communication with ERP professionals. They have reviewed the model and discussed the validity of the different variables with us.

⁵ America's SAP Users Group

4.7 Criticism of the methods

Due to the shortage of previous studies in the M&S benchmarking field we have used information from other sources than scientific literature, such as Gartner Group and ASUG benchmark, whom present their findings without any explanations. Using non-literature sources can have several weaknesses but we were unable to find what we were looking for in the literature so we decided to use this material. ASUG is a non-profit organization of SAP customer companies and Gartner is an independent research company, which we consider mitigating circumstances. Furthermore, the recognized cost drivers in Gartner's benchmark were used as hypothesis and not facts. We conducted literature studies and consulted our respondents to test our hypothesis, i.e. these findings. It should be clear though, that these findings from Gartner and AUPEC are therefore our interpretations of them. Also, we believe that a more respondent would have been good to reduce biases.

5. Result

In this section we describe the empirical findings from our study at VOLVO IT. Here we present a summary of the information collected from our interview along with a summary from our questionnaire. Finally we will propose a benchmark model for VOLVO IT's M&S assignments in VOLVO GROUP's ERP (SAP) environment.

5.1 Interviews

The results below are a summary of the interviews conducted at VOLVO IT and with the Oracle implementation senior project leader as well as e-mail correspondence with VOLVO IT.

5.1.1 M&S process in VOLVO GROUP

When enhancement projects have been developed and the application is implemented, the support for the new functionality is integrated with the existing support responsibility. M&S are defined as assignments and not projects since they are a continuous process. Enhancements are usually handled in projects and are defined as changes to the existing functionality, in addition to this the work effort for the change has to exceed 10 man days. (Respondent A). Before a maintenance and support assignment is initiated a service level agreement (SLA) is written which is the agreement between a service organization (VOLVO IT) and its customer. The agreement expresses which services and what level of service VOLVO IT will deliver during a set timeframe. In the third interview with Respondent A we were presented with a model called the MCM model which shows how M&S and enhancement project work are conducted at VOLVO GROUP. The model describes how VOLVO IT should manage the M&S process and how to deliver it to their customers. The model uses gates and decision points for the applications lifecycle. The gates handle transition from an enhancement project to M&S and also the closing point for the applications lifecycle. It establishes who is responsible for the maintenance service as well as the hand-over process from a enhancement project to M&S. Finally handing over documentation is needed for application maintenance and operation. Decision points⁶ are handled in regular meetings between VOLVO IT and its clients. Decision points are also there to mark the starting point for enhancement project and the transition back to maintenance and support (fig. 4).

⁶ Latest moment at which a predetermined course of action is (or must be) initiated. (BusinessDictionary.com , 2008)

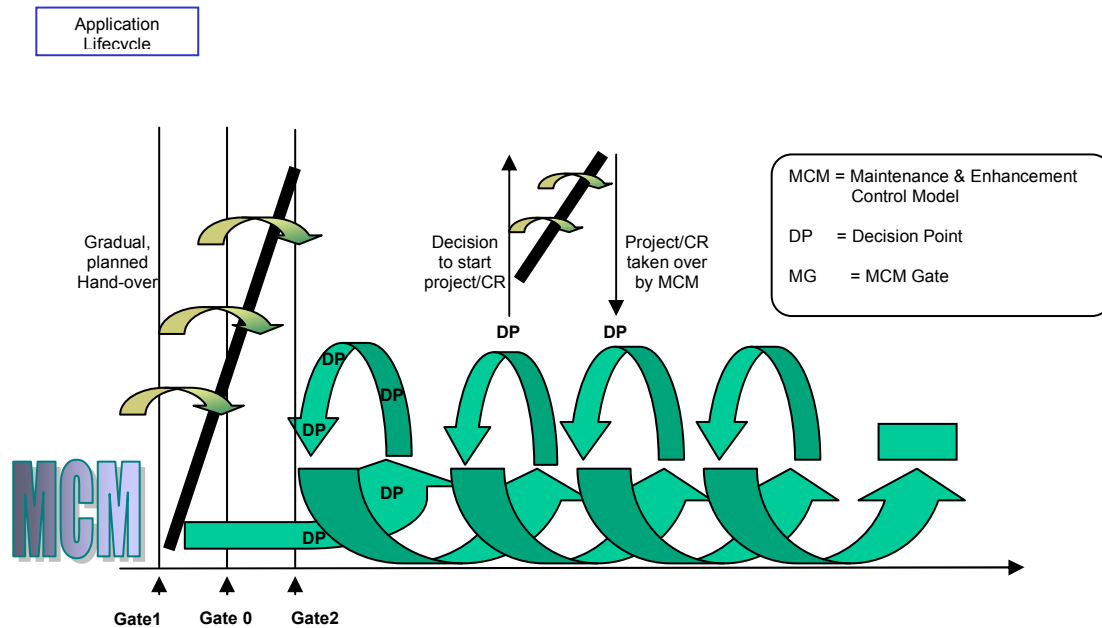


Figure 4 - Describes how Volvo IT deliver maintenance and enhancement service

According to the MCM model VOLVO IT carries out the following tasks;

(I) 'Manage Change' involves Change Management, Configuration Management and Release Management. These activities involve control and handling of every aspect of change related to the product. (II) 'Manage Service Delivery' involve Availability management (planning availability in accordance with the service level agreement), Capacity Management (determining the IT resources needed to meet the service level agreement), Continuity Management (Ensuring that the system can be started within agreed time after system failure). (III) 'Create/Modify Products & Services' involve coding, bug fixes, planning the development or modifying activities, different kinds of tests, and documentation of the product how to use it. (IV) 'Deploy Services' involves roll-out strategies, end user training, delivering of software, hardware, authorization, training maintenance and support staff on new products or software. (V) 'Operate Services' involve controlling and managing the operation of components, configurations and services. (VI) 'Handle Incidents & Problems' involve incident and problem management (minimize damages on business operations when problem occurs, identifies root problems with failed IT services. (VII) 'Provide Professional Services' involve Business Consulting, (Development support, analyzing business strategies and implementing them) IT Consulting (implementation, architectural and operational support and planning) (VOLVO.com, 2007)The following staff is responsible for delivering M&S and enhancement services and the categorization are how VOLVO IT operates. Maintenance Management (MM) is involved in activities such as configuring and implementing enhancement packages, support packages and patches. Help desk Level 2⁷

⁷ Support is sometimes categorized into different levels depending on the service request. Level 1 support is usually issues related to hardware, software or an application. Level 2 support usually demands more thorough knowledge of specific applications or systems. They are hence responsible for the resolution of

technical support for business process questions that involves assistance on tasks such as report writing, minor fixes and enhancements that takes less than 10 person days and involves SAP configuration. ABAP⁸ development support team is involved in corrections and new functionality at VOLVO IT. This includes report writing, minor fixes and enhancements that involve ABAP/ALE⁹ programming. The functional developers are responsible for corrections, configuration and implementation of new SAP functionality (enhancement and support packages released by SAP) or roll outs¹⁰ to new areas that involve SAP configuration. Change Management has responsibility for all change requests (CR) in the organization. They communicate the reason for SAP implementation to end-users and support them with the changes involved. Change request management is a standard that explains how to deal with configuration changes without disturbing the business processes. Change request management's goal is to reduce the influence of change-related incidents on the ongoing business and also provides ability to track these changes. Project CR management are involved with changes that are considered major, these activities are handled in enhancement projects.¹¹ Project CR support supports changes to the system that takes more than 10 person days. Security / user admin staff is responsible for maintaining security profiles to manage SAP access. Administration staff supports functions such as budgeting and chargeback¹². Outsourcing management supervise that outsourcing contracts are being met. Audit and control staff inspect SAP applications and includes master data review and data management to ensure data quality (consistency and accuracy of data).

5.1.2 Vendor support

The vendor deliver help desk support, patches and new versions several times every year. The cost for this is usually a fixed percentage on the license cost. The support from the vendor is optional and the length of the support is also selectable (Informant A). This support are defined by VOLVO IT as level 4¹³ support and the costs for the support goes directly from the end-user organization to SAP as a percentage of total license cost (Respondent A).

more complex problems. Level 3 support handles critical problems and develops vital corrections and Level 4 support is technical support from the vendor.

⁸ ABAP stands for Advanced Business Application Programming. The use of ABAP allows SAP customers to extend the functionality of the base software.(SAP.com, 2007)

⁹ Application Link Enabling (ALE) - Method for SAP users to integrate loosely R/3 applications across different platforms and systems. Ensure a distributed and integrated ERP system. (Ryerson Polytechnic University, 2000)

¹⁰ Roll out - Roll out is a strategy to implement the SAP system to new areas. (personal communication with project leader, 2007)

¹¹ (more than 10 days)

¹² The deduction of a disputed sale previously credited to a department's account when the department fails to prove that the customer authorized the credit card transaction.(Glossary for ISU Payment Card Merchant Agreement for Internet Transactions, 2008)

¹³ And sometimes as level 3

5.1.3 Benchmark model

In the first interview with Respondent A we were presented with a previous SAP benchmark produced by Gartner Group (2006). It focuses on factors in an SAP environment affecting the support effort. They identified and grouped these factors according to their relative influence on support activities but did not explain how or why these variables were sorted differently. Gartner’s support benchmark includes activities in an SAP environment that takes less than 10 man days to complete. The report includes definitions of costs, and complexity variables for supporting an SAP environment. They have categorized the M&S functions into business and application support, infrastructure support, training and documentation support, project support and other support. Table 4 shows software and hardware costs recognized in the Gartner benchmark. Since an explanation was missing we needed to conduct more literature studies and discuss the findings with the respondents to understand these findings. Hence the results in this benchmark are our interpretations of them.

Software Costs	Hardware costs
SAP software cost for software plus annual maintenance fee	Servers - SAP application and database servers
System Management tools - Software used for system management	Storage - Disk space for SAP
O/S	High Availability – Hardware / software / Occupancy
Utilities - Third party & in-house	Occupancy - Facility with fully burdened costs
Packages - Add in In-house developed systems	Outsourcer - Service by third party where activities are not on a daily basis
Tools - Third-party & in-house, for instance data query, reporting, OLAP, data warehouse	Disaster Recovery
Database Management System (DMBS)	

Table 4 – Direct cost supporting an SAP environment

Gartner has categorized factors that drive M&S effort into system architecture, user information, business processes, infrastructure, workload-profile and service level and called them complexity variables. The variables are considered to have a high, medium or low influence on complexity (*Gartner’s SAP benchmark, 2006*).

5.1.4 Measurement and KPI

Since industrial companies are ahead in the current research field of benchmarking M&S, we have gathered a sample of metrics from the benchmarking industry as a complement to the literature study. Table 5 shows a summary of those measures. The metric In addition to these metrics others indentified are listed in appendix A.

Metrics	Purpose	Metric	Purpose
Support and maintenance FTE ¹⁴ s per 'Standard User' ¹⁵	Measures support staff Productivity	SAP Support Costs per 1000 Business Transaction ¹⁶	measures business activity
Support Cost per standard User,		SAP Support Costs per 'Standard' User -	measures system efficiency
Support Cost per 1000 Dialog Steps ¹⁷	measures system activity	Support and maintenance costs normalised by some business factor	measures system effectiveness
Support cost per module and revenue		System support costs as a percentage of company costs	Measures system intensity
End-user satisfaction	System effectiveness	Concurrent to Named User ratio	measures System Penetration
Manpower Tariff ¹⁸		System support cost as % of of company cost	System intensity
Concurrent to named ratio	System penetration		

Table 5 – M&S measures and purpose with the measurement (AUPEC, 2006 & Gartner Group Gartner GROUP, 2006)

5.1.4 Maintenance implications

The implementation phase affects the future M&S work in many ways. It is important to train end-users in new functionality and keep modifications to a minimum (changes to the system functionality) in order to keep M&S costs down. The degree of testing is also of importance in this phase to reduce the level of bugs. After the system goes live, the initial support cost is usually higher since user's needs more training and more errors occur because of limited testing. After users progress to the comfort zone and the system become more stabilized these costs are normally reduced. When patches or new versions are installed which changes the functionality, the process starts over again, with higher support costs and more bugs. Good manuals and documentation is also vital to keep the M&S cost low. Another factor influencing the M&S process is type of module implemented. Modules used by many customers are more thoroughly tested and therefore have fewer bugs which result in a lesser burden for the M&S department. Finance module

¹⁴ Full-time equivalent is a unit for work effort on projects or tasks

¹⁵ Standard User was reached by using a proportion of named users and a proportion of concurrent user. This approach showed the lowest (residual variation (Aupec, 2006) used in statistic regression analysis to show the difference between the estimated and the real value, Körner, S., Wahlgren, L (2005)).

¹⁶ Typical transactions are issued and paid invoices, goods issued and received and also maintenance work orders. (Aupec Benchmark, 2006)

¹⁷ Dialog steps provide a measure of system activity. The number required can be extracted from the SAP system through a simple query. (Aupec Benchmark 2006)

¹⁸ Total ERP manpower cost (for SAP R/3 operations for applications, infrastructure and the helpdesk) / total FTE count. Costs of interfacing and maintenance support are excluded. (Aupec Benchmark 2006)

is an example of such a module. (Informant A) End-user competence is a key factor when implementing enhancement packages. Degree of customizations, modifications and parameterization and also size and complexity of the patch itself, plays a central role. Clear system architecture as well as no unnecessary dependencies in the system are other aspects important to keep the M&S cost and effort down. (Informant A) There are differences in supporting and maintaining different industries but what these differences are unknown. (Informant A) When it comes to measuring M&S performance, ‘Service Request response time’ and ‘Service Request resolution time’ are two metrics. It is also imperative to consider the complexity of the service request. (Informant A)

5.1.5 Validation

We presented a draft of our benchmark model for respondent A and our cost calculation was in line with VOLVO IT’s concept. The respondent had a few comments and questions about our complexity variables for the index calculation. Respondent A believes that the variable ‘Number of customizations’ may be impossible to measure. Respondent A believes when it comes to variables that affect M&S, that it is a thin line between businesses and systems. The demand on the system and the installation is dependent on the business in most of the cases (respondent A). Furthermore she pointed out that the variables ‘applications’ and ‘IT system’ has the same meaning to her. ‘Company code’ is defined “as an identifier for a system installation in one country/organization”. Production clients and instances are fundamentally the same thing (respondent A, 2007). This resulted in a recommendation from the respondent that all the variables should have a clear definition to avoid misinterpretations. A TCO model with all costs in an ERP (SAP) system was demonstrated for respondent A and she thought that costs was too detailed. VOLVO IT does not follow each cost in detail. Instead they perform follow-ups on the summarized total costs for instance ‘hardware costs’ and additionally list all associated costs. Further posts are network and disaster recovery (See Appendix C for complete lists of ERP associated costs).

5.2 Questioner summary

We used a questionnaire where we asked questions about the specific SAP solution and the organization. The purpose was to confirm the relevance of our complexity variables but also as a validation of our benchmark model in general. The result below is a summary from our questionnaire. Two respondents (C & D) answered the questions for one solution used in one organization and respondent E answered the questions for one solution used in three different organizations. The solutions/applications are:

- Score, (Step 1) used at VOLVO 3P (Respondent C)
- HR Master (HRT) used at VOLVO GROUP HQ (Respondent D)
- CATS used at VOLVO Technology, VOLVO Business Services and VOLVO Construction Equipment (Respondent E)

The following SAP modules are mentioned by the respondents in the answers from the questionnaire:

Financial accounting (FI), Controlling (CO), Project system (PS), Material Management (MM), Human Resource (HR), Personnel Administration (PA), Organizational Management (OM), Cross Application timesheet (CATS), Project system (PS), Sales and distribution (SD)

5.2.1 VOLVO 3P – Solution characteristics

The M&S assignment is for the solution Score (STEP 1) at VOLVO 3P. The solution is divided into three parts, step 1A, 1B and 1C. Score step 1A's functions are Time reporting and hours and it has been in production since May 2005. Score Step 1B functions are to follow up actual and committed costs and has been in use since July 2006. Score Step 1C is responsible for budget and planning process and has been in use since October 2006. Step 2 project is soon to be taken over by M&S. Go-live is scheduled for July 2008 and hand over to M&S is planned from September until December 2008 (Resource management & Project scheduling)¹⁹ The SCORE application has 3.700 named SAP users (licenses) and its organizational change are considered medium. When it comes to complexity of business processes at VOLVO 3P the Informant Aelieves these are very complex. The production code is therefore also complex, and what the respondent means with that is that the specifics developed for 3P in Score are complex. M&S cost for the SCORE application is 7.150 KSek, and for the operation service as defined in the assignments specification, 3 MSec which includes software, hardware and operations costs for one year. Furthermore, user-training was included in these costs. VOLVO 3P does not measure indirect costs. In nearly three years the system has had no unplanned downtime. Every planned downtime has been carried out during the maintenance window specified in the SLA. The question about downtime was answered with the help of data provided by monitoring tools and in this case the uptime for the CPU (DB included) shall be 99.9 % (during opening hours). Note that the availability is measured at the server and not at end user. Furthermore infrastructure is not included in the availability measure. SCORE processes shall have a uptime of 99.6% (during opening hours). The availability will be measured manually by VOLVO IT with the use of SCORE log files. Downtime caused by the servers and databases are included in the availability of SCORE. Total (CPU and SCORE) will therefore be (99.9% of 99.6%) 99.5%. The system downtime should be max 28min/week during opening hours.

Measurement: Data provided by monitoring tools.

Goal value: > 99.5 %

Amount of FTE²⁰s used by the different functions at VOLVO IT were as follows: MM 1 FTE, Support 1 FTE, Maintenance (support level 3, bug fixing, ABAP) 3 FTE.

¹⁹ Step 2 will be followed by a organization setup planner in step 3

²⁰ In our report 1 FTE equals an employee working fulltime in the assignment for one year

5.2.2 System

The SCORE system architecture is quite complex with one core system which is linked to quite a few other SAP applications (HRT and MF) and non-SAP systems, by several interfaces and an ALE link. Moreover, a web interface and a global Business Warehouse (BW) system are linked to SCORE. SCORE is the referential system for the project and HRT is the referential system for the Human resource (HR) data and MF for financial costs. All the data are consolidated in SCORE.

Today VOLVO 3P have the following modules implemented; FI, CO, PS, MM, HR (PA/OM) and CATS. Functionalities are Time tracking, project structure/definition, actual posting, transfer CATS to CO, payment plan, budget definition/follow up, copy actual to plan etcetera.

VOLVO 3P has four different systems today (2007), development, qualification, maintenance and a production system. For the R/3 A dev (AVD), Qualification (AVA) and production (AVP) system for BW. They use seven company codes and during the assignments duration, 36 enhancement projects have been performed and 5 roll out projects. More than average degree of customization have been carried out at VOLVO 3P²¹. Knowledge transfer²² was done in the project phase to 3P Key users. Documents have been issued from the maintenance to the key users to explain the use of certain programs and processes. System documentation came from the project to the maintenance and the quality of this documentation was pretty good according to the respondent. The system has a high availability system and the service quality are defined in the SLA. 99.5% uptime for operation (CPU and the application). Support for operation will be 2nd level support for UNIX and technical support hours are 24/7. Backup and disaster recovery systems are also in place. UNIX and windows are the platforms used in the system.

5.2.3 Service level

1st level support: Back office²³ will work in union with the central help desk and user support operation. Back office support will solve user problems and carry out predetermined activities that help desk cannot resolve. All desktop hardware, peripherals, operating systems, mail and messaging applications and office productivity tools are managed by VOLVO IT's back office in line with the SLA.

2nd level: deals with incidents²⁴ that come from back office or key users. In addition the SLA defines between which hours support is available. Service level related to 2nd level

²¹ We need to define average in the questionnaire

²² Knowledge Transfer: The act of transferring knowledge from one individual to another by means of mentoring, training, documentation, and other collaboration. (California State University, available at: <http://it.csumb.edu/site/x7101.xml>)

²³ A back office is a part of most corporations where tasks dedicated to running the company itself take place Wikipedia, (2008)

²⁴ Incident: Any event that is not part of the standard operation of a service and that causes, or may cause, an interruption to, or a reduction in, the quality of that service. (SLA between VOLVO IT and VOLVO 3P, abstract from SLA, 2008)

support, is defined as 'Resolution time' and 'Resolution rate' and is categorized into different severity levels; severe, major, minor or minimal.

5.3.1 HR Master (HRT)

The M&S assignment is for the solution HRT at VOLVO GROUP HQ. The assignment is yearly based and re conducted every year. The solution has been in use for approximately 5-6 years. The HRT solution has almost 45.000 named SAP users and the companies level of organizational change are not considered too good. Business processes are considered medium. The production code complexity is regarded as low. The support cost are 2.9M SEK and maintenance cost are 10.5M SEK which leads to a M&S cost of 13.4M SEK. The annual total cost of hardware costs related to SAP was 9.26M SEK. Indirect costs are not measured. 90% of the downtime was and planned and hence 10% unplanned downtime. When it comes to used FTE by VOLVO IT per function around 2 FTE was used by MM, 3 FTE by support and 8 FTE by maintenance.²⁵

5.3.2 System

The HRT solution has one core system with up to 100 interfaces. 18 servers for HRT is used (A dev, Qualification and production). Almost 100 enhancement projects have been carried out in the assignment and several thousands of customizations. A lot of knowledge transfer activities have been done and it is not finished. A high availability system and disaster recovery and a backup system are in use.

5.3.3 Service level

1. The question 'What level of support was agreed on in the SLA for the M&S assignment? (24/7 help desk, multilingual, system performance such as response time and % uptime)' were answered: 'all of this' by the respondent.

5.4.1 CATS

The M&S assignment are for three different solutions of CATS at VOLVO Technology (VT), VOLVO Business Services (VBS) and VOLVO Construction Equipment (VCE). Modules are PS/SD/FI/CO/HR. The assignments has been in use since August 2006 (VBS), since 2005 (VTEC) and since 2005 for VCE. VCE has about 540 named SAP users, the other two the respondent did not know. The companies' levels of organizational change are considered average. The business processes and the production complexity are not that complex. Support cost are 5K SEK per month per solution and maintenance and minor enhancement cost for 2007 were: 695K SEK (VCE), 1125K SEK (VTEC) and 859K SEK (VBS). The annual total hardware costs related to SAP were not available since they are invoiced directly through Master finance but for VCE they are estimated at 72K SEK per year and 480K SEK for VTEC. The proposed set up cost for VTEC was 2260K SEK and for VCE, 1799K SEK. Annual training costs related to SAP was

²⁵ We need to define that all cost should be annual costs

for VTEC approximation 200hrs, VCE 40 hrs (user-guides). Indirect costs are not measured. Planned and unplanned downtime was in accordance with Master Finance agreement. The work efforts are estimated as follows:

VCE : MM 0,2 CATS/PS/HR 0,2,

VBS : MM 0,15, CATS/PS/HR 0,1, SD 0,1

VTEC : MM 0,15 CATS/PS/HR 0,1, SD 0,1

ABAP and FI/CO: a few hours per month in total.

In total the roles CATS/PS/HR,SD, FI/CO and ABAP account for roughly 0,6 FTE for all three solutions. MM are around 0.5 for all three solutions.

5.4.2 System

The CATS includes has the following modules:

VTEC; FI/CO, PS, SD, HR (mini-master) and CATS

VCE; HR (mini-master), PS, CATS

VBS; SD, CATS, FI/CO, HR (mini-master), PS

The system architecture has links between the time reporting system (CATS) and HR master data (HP1) and SAP HR, SAP FI/CO are linked with CATS (fig. 5)

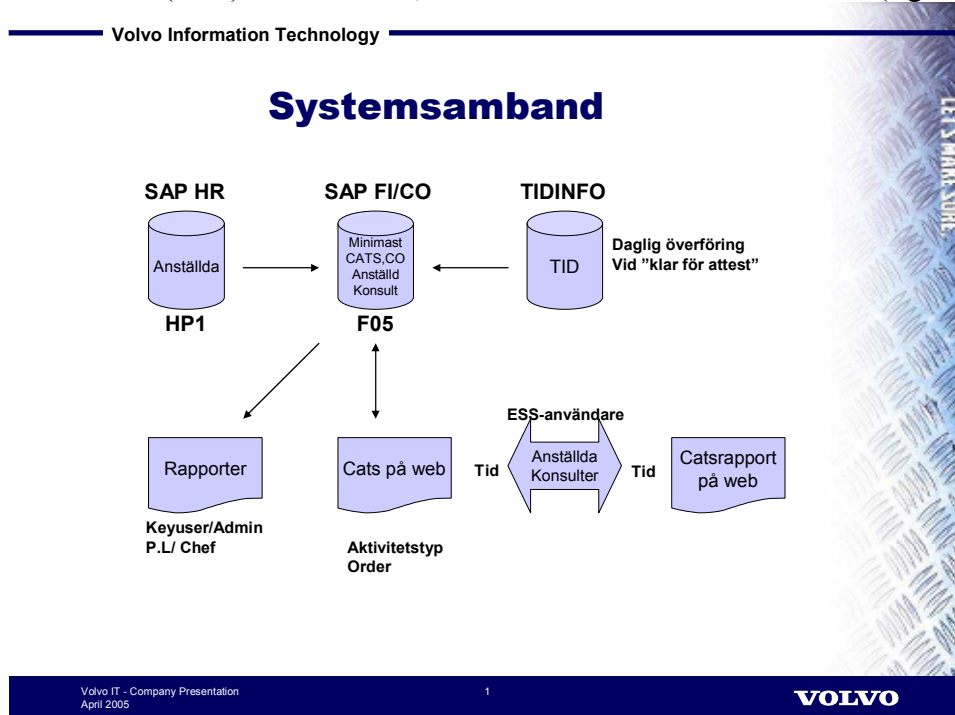


Figure 5 - System architecture for the solution CATS.

VCE has five company codes and VTEC VBS, one. One enhancement project has been conducted at VBS and no major ones at VTEC and VCE. The VCE and VTEC solution has been in use for about 3 years and roughly 18 months for VTEC, though the system itself has been in use much longer in MasterFinance. Amount of customizations are considered to be average for a solution of this size according to respondent E. At the end

of the projects (for VTEC and VCE) system documentation and end-user guides has been created. The set-up for VBS was not handled by VOLVO IT, and virtually no documentation was available at hand-over to maintenance. A specific project was initiated to create documentation and his took about 65 hrs. The respondent says that they have a normal high availability system.²⁶

5.4.3 Service level

All three solutions have the same level of service. Application support will be available 08.00-23.00. Extended support has to be requested 5 days in advance and is seen as change requests. All CATS/PS/SD/CO/PA issues will be logged in the VOLVO IT case management system (VINST) by VOLVO IT or the issuer. The issue is classified to a severity level. Response time is calculated as from the issue is logged until the issue is assigned to a so called action owner. There are different levels of severity/priority of the problem: major, high, medium and low and if the issue is classified as the highest priority, the response time needs to be lower than if classified as a lower priority (table 6a).

Response time/ Priority

Response Time / Rate, Major	30 minutes/ 90%
Response Time / Rate, High	2 hours/ 90%
Response Time / Rate, Medium	8 hours/ 80%
Response Time / Rate, Low	16 hours/ 80%

Table 6a – Response time with different levels of severity (SLA respondent C, 2008)

Resolve time is calculated as the time from which the issue is assigned until the problem is solved (time for test and approval from issuer is excluded) (table 6b).

Resolve time Incidents/ Priority

Resolution Time / Rate, Major	24 hours/ 90%
Resolution Time / Rate, High	72 hours/ 90%
Resolution Time / Rate, Medium	10 working days / 80%
Resolution Time / Rate, Low	Best effort

Table 6b – Resolve time with different levels of severity (SLA respondent C, 2008)

Performance level consists of two factors; time for restoring user data on servers and R/3 response time for online processes. User data should be restored at a rate at least 50 GB/hr, and response times should be under 1.5 seconds (calculated as monthly average excluded networks). Full backup is made for the production server and the development server once a week. The CATS/SD/PS system is up 24 hours 7 days a week, except on the maintenance window every Sunday. 2nd level support is reported to VOLVO IT SAP support via VINST. 3rd level support is delivered by SAP, and VOLVO IT is the link to SAP for questions related to Support, Maintenance and Enhancement services (note: this differs to the level 4 classification we have used for this vendor support)

²⁶ Once again, normal has to be defined in the questionnaire

If VTEC ask for a performance measure, the SAP PAUS²⁷ solution will use the following KPIs **Incoming cases per type (incident, request, question)** - Reporting number of incoming cases per type/severity level; **Resolved cases per type** - Number of resolved cases per type/severity level; **Response time:** - Per severity level.

Table 7 is a summary of our findings from the questionnaire.

Company	VOLVO 3p	VOLVO GROUP HQ	VOLVO Business services	VOLVO construction equipment	VOLVO technology
Application	SCORE(step 1)	HR Master (HRT)	CATS	CATS	CATS
M&S cost	7.150 Msek	Support: 2.9Msek Maintenance: 10.5Msek	15000/ month+ 895ksek maintenance	15000/month+ 695Ksek maintenance	15000/month 1125Ksek maintenance
Operation service (software, hardware and operation) annually	3Msek	Hardware cost: 9.260Msek		72Ksek	Hardware cost estimate: 480Ksek
Training cost			n/a	40hrs	200hrs
Implementation - cost			n/a	1.799Ksek	2.260Ksek
Downtime planned/unplanned		90/10%			
Indirect cost	No measure	No measure	No measure	No measure	No measure
High Availability	99.5%		Normal	Normal	Normal
FTE spent on Maintenance management	1	2			
FTE spent on Support	1	3			
FTE spent on Maintenance support, ABAP	3	8			
Named SAP users	3 700	45 000		540	
Organizational change	Average	Below avg.		Average	
Complex B.P	V.high	Medium		Low	
Production Code	High	Low		Low	
System architecture	High	100 interfaces			

²⁷ We have not been able to find any information about the SAP PAUS solution. (Authors of this report, 2008)

# Modules	7	+10	5	3	5
Functionality			1	5	1
Total systems	7	18			
#Company codes	7				
# enhancement projects	36	100	1 major	Na	Na
Age of system	May 2005	5-6 years	18 month	3 yrs	3 yrs
# instances			6	6	6
# customizations	More than avg	More than 1000	Avg	Avg	Avg
Knowledge transfer activities		A lot	65hrs due to no documentation (set-up not done by VOLVO IT)		
Backup	Yes	Yes	Na	Na	Na
Disaster recovery	Yes	Yes	Na	Na	Na
System landscape	UNIX/WIN	WIN/UNIX/MIXED			

Table 7 –Summary from the answers from the 3 questionnaires

5.5 A M&S benchmarking model

It is a complex task to make comparisons of assignments supporting different solutions in different organizations. Highly competitive market puts high pressure on companies to be cost-efficient and at the same time deliver high quality services. The purpose with our benchmarking model is to measure the M&S performance in these different organizations to be able to improve service quality and lower costs. By measuring the performance, VOLVO IT is able to detect anomalies in the M&S process. An awareness of what factors contribute to the M&S workload is of highest priority. By realizing this before the M&S assignment is initiated, the end-user organization has a chance to develop cost efficient strategies that are aligned with the M&S strategies. Our M&S benchmarking model proposes a solution for IT supporting organizations in general and for VOLVO IT in particular. Our proposed solution tries to solve three crucial tasks.

The first task 1) *Eliminate differences between assignments supporting dissimilar ERP environments* - will be made through the use of our own developed complexity calculator. End-user organization, SAP systems, infrastructure and service quality are all elements that will drive the M&S effort and cost. In each of these elements, there are factors that influence the M&S process in different extent. All these recognized variables will add up to a total complexity profile for the specific assignment which will be used as a

normalizing value when comparing the unlike assignments. The second task '*Evaluation and measurement of the assignments cost and benefits*' will be achieved by utilizing both financial and non-financial measures to evaluate the performance of the M&S assignment. The third task 3) *Comparison of the assignments cost and benefits* will be solved by using the complexity index in combination with the use of so called peer Group's (ASUG benchmark, 2006) to be able to compare the assignments on equal conditions feasible. The same time scope will be used (annually). Our Benchmarking prototype delivers the following functionality: a complexity calculator, cost and Full-time equivalent (FTE) prognostication, reference database, benchmark capabilities, automatic graph generator as well as a validation of the model.

5.5.1 Complexity calculator

Many factors have been identified in previous research to have an impact on M&S effort. They are recognized components that may influence VOLVO IT's work effort supporting and maintaining their clients SAP solutions.. To be able to compare the assignments on equal premise the data has to be normalized²⁸ i.e. identified differences have to be eliminated. The following are summaries from our result which we have used in our complexity calculator in order to eliminate differences in a variety of environments with a mixture of solutions.

There are many factors influencing the workload for the supporting IT organization. As companies grow, the ERP solutions become more comprehensive and thus more complex (Aberdeen, 2007). More users in the ERP system will lead to more enquires and help desk calls as well as user training activities. On top of this, infrastructure flexibility has to be guaranteed to be able to react to organizational demands. When the organization changes, the system needs to change as well which result in M&S activities such as customizations or modifications. The more prone the organization is to change the more complex it will be to support. Complex business processes may require a multifaceted system which can result in a more demanding support and a need for state of the art technology which also contributes to the overall complexity. System architecture strategy is also of importance for complexity. A consolidated system usually leads to less M&S work and hence less complexity. A clear architecture with limited dependencies also reduced the strain on the M&S department. System administration costs have to be reduced in contrast to increased change management. Assessment regarding utilization of current equipment has to be made before buying new hardware to keep these costs down. Number and type of modules is important to consider when prognosticating future M&S effort. Weighted average between amount of modules implemented and functionality utilized is calculated as used functionality multiplied with number of modules / total nr of modules available (Aberdeen, 2007). More M&S effort is required to support and maintain multiple systems compared to a single system. Reduced number of IT systems and interfaces, hence generally result in a lower M&S exertion. Each major enhancement will most often add new functionality which is to be supported by the M&S staff which results in more work for them. With time, systems degrade and become progressively

²⁸ To remove an effect biasing a statistic, for example, the influence of the size of the sample (Pearson Education, 2008)

more difficult to understand because of for example customizations and parameterizations. At the same time experience with the system are increased and cost per user decreased over time according (ASUG benchmark, 2006). Separate tasks are performed in different stages of the software maintenance lifecycle (Kung and Hsu, 1998) which also shows the importance of age of the system when comparing to other systems. The implementation of a SAP solution in many locations without centralized standardization results in various instances and configurations. Each unique ERP instance needs unique support. Customization of an ERP system leads to higher system complexity. A customized ERP system is difficult to support and particularly hard to upgrade (Hines, 2005). In many cases M&S effort is spent due to lack of good system documentation. Knowledge transfer activities can be reduced through good documentation. (Informant A) The IT organization is furthermore responsible for system solutions that have a high uptime and availability in spite of hardware failures due to isolated events or broad catastrophes. High availability system leads to less downtime but put more strain on the IT organization. The computing requirements of such businesses tend to be expensive and complicated (Kangas, 2007). A backup and disaster recovery system increases the M&S workload. Infrastructure complexity also contributes to overall complexity but a consolidated landscape generally leads to lower costs as shown in the ASUG benchmark.²⁹ Maintaining and supporting WINDOWS are considered to be less expensive than UNIX and mixed systems are considered to be most expensive (Gartner, 2006). What demand does the ERP using organization have on SAP response time? Levels agreed in agreement specification plus quality of support delivered are all factors adding to complexity (personal communication with Maintenance Manager, 2007) (table 8).

Variables	Notes
Ratio concurrent users to named SAP users	System utilization
Organizational change	Leads to Customizations, new technology
Business Process complexity	Complex infrastructure
System architecture complexity	Consolidated system? Clear with no unnecessary dependencies
Amount and type of modules	FI/CO etcetera.
Utilized functionality	More functionality = more to support
Number of total systems	Strive to reduce amount of systems and interfaces
Number of enhancements projects	Size and complexity of enhancement proj.
Age of system/System lifecycle phase	Different M&S activities effected
Number of instances	Unique configurations and parameterizations
Number and type of customizations	Degree of changed functionality
Documentation	Quality of documentation affect knowledge transferring activities
High Availability systems - Infrastructure	Less downtime, more to support

²⁹ Compared to a distributed landscape by Business Unit, the Global/Centralized approach was 29% less for Cost/Active User (ASUG benchmark, 2006)

complexity due to the system Back-up & disaster recovery System category Level of support Modifications	Direct cost vs. indirect cost WINDOWS/UNIX or mixed SLA specifics Changes to system functionality
---	--

Table 8 - A summary of factors effecting M&S effort in an SAP perspective.

All these variables were sorted into three Groups depending on how much impact they were thought on having on M&S workload (table 9). All factors considered to have high effect on complexity were placed in GROUP one, medium effect in GROUP two and low effect factors in GROUP three. Which GROUP each variable was placed in was decided after Gartner's benchmark and oral communication with VOLVO IT Maintenance Manager and Oracle senior project leader, (2007). For instance, 'customizations' is believed to have a high impact on VOLVO IT's effort and is hence placed in GROUP one. Because variables in GROUP one are considered to have the highest effect on complexity, variables in this GROUP can get a maximum score of 10 points, where 5 points is the average. In the second GROUP, maximum is 6 points (medium 3) and 4 points is maximum for GROUP 3 variables (avg. 2p).

GROUP 1	GROUP 2	GROUP 3
Support level	Weighted functionality	Number of instances
System lifecycle phase	Number of systems	Platform
Concurrent user/named user	System landscape	Backup
Customizations	Security	HA system
Modifications	Organizational change	Disaster recovery
	Enhancement projects	

Table 9 - Factors influencing VOLVO IT's maintenance and support work sorted into complexity Groups.

When conducting the benchmark, a value for each variable is needed, and when this value has been entered, the value is compared to a VOLVO reference database (rDB)³⁰. The reference database contains values from previous assignments such as values on each of the complexity factors, total complexity index, used FTE per function etcetera. Subsequently, the application queries the rDB and provides the complexity calculator with an average value. The average value is related to the assignment value and a complexity value can be calculated for this specific factor. Some factors are calculated and some are subjectively measured. The assignment's total complexity index is calculated on all variables:

³⁰ The model needs this database in order to work, so data has to be gathered and stored in the database as a prerequisite

5.5.2 An example case

An example follows to clarify the process, it should be noted that in this example all data are hypothetical and are only there in an instructive purpose since we are not conducting a benchmark.

A maintenance manager at VOLVO IT is responsible for maintenance and support for a solution and wants to know how things are going. He decides that a comparison of his assignment with some other assignment could be a good idea to find out a little bit more where he stands. He has all the collected information about the current assignment necessary for using the application. First he enters the value for the variable ‘Ratio of concurrent users to named users’, 50%, the average are 58% so the variable receives a score of 4 points (fig 6).³¹ (All data in the following examples are hypothetical and are only there in an instructive purpose since we are not conducting a benchmark.)

		C6	D6
5	Group 1 - High effect on complexity	Score highest 10 medium 5 low 0	Enter project data Avg reference project
6	Ratio of Concurrent users to Named users	4	50% 58%
7	Support Level	5	AVERAGE N/A

Figure 6 – Ration of concurrent user to named users ‘50%’ is entered by the user

Then he enters has to subjectively decide the value for the second variable ‘Support Level’. Here he has to reflect on how demanding the support level are in relation to average for the same type and size of solution. He can choose a value from “lowest, low, average, high or highest in a drop down list, and depending on the option, a score is provided by the application. He selects high and a score of 7 is calculated. (fig 7)

		C6	D6
5	Group 1 - High effect on complexity	Score highest 10 medium 5 low 0	Enter project data Avg reference project
6	Ratio of Concurrent users to Named users	4	50% 58%
7	Support Level	7	HIGH N/A
8	High Availability System	6	LOWEST 43%
9	Weighted Functionality	7	LOW 45%
10	Nr of Total Systems	6	AVERAGE 3.5
11	Nr of Individual Programs	9	HIGHEST 5.7

Figure 7 – support level ‘HIGH’ is chosen by the user

He then continues to fill in the rest of the values (fig 8).

³¹ $5 / \text{AvgRefProj} * \text{projData} = \text{Score}$, but IF $5 / \text{AvgRefProj} * \text{projData} > 10$ then 10. All values are rounded to the whole and the cell is limited to a value of max 10.

15	Organizational Change	3	12%	27.67%
16	SDP Development Program	4	40%	48%
17	Process structure	10	HIGHEST	N/A
18	Group 2 - Medium effect on complexity High scores 6 medium 3 and low 0			
19	Back-up	2	LOW	N/A
20	Disaster Recovery	0	LOWEST	N/A
21	Ratio of Production to Total Systems	2	35%	43%
22	System Landscape	6	MIX/Mainframe	WIN/UNIX MIXED
23	Nr of Total Clients	6	15	8
24	Security	6	HIGHEST	N/A
25	Peak hour dislodge steps	3	1 400.00	1 401.67
26	Seniority	3	18	18
27	Group 3 - Low effect on complexity High score 4 medium 2 and low 0			
28	SLA	2	AVERAGE	680%
29	Number of instances	2	5	4.5
30	Number of ERP systems	3	5	4
31	Platform standard	3	64%	51%
32	Total Complexity Index			
33	Complexity Index	0.98		

Figure 8 – complexity index

When all the values have been entered and calculated, he is provided with an index value. As a result the benchmarked assignment will receive an index from 0-2, where 2 is the highest (1 = VOLVO IT average) In this case the index value landed on 0.98 which indicates that the assignment has roughly the same complexity as the average assignment and as a consequence should cost about the same as the average assignment of the same size and duration.

This complexity index are transferred to the ‘Cost and FTE prognostication tool’ which is used to prognosticate FTE for each of VOLVO IT’s M&S functions. We have used the same categorization as VOLVO IT uses; Maintenance Management, Support, ABAP development, Functional development and Change Management. The maintenance manager now enters cost per FTE and the application calculates prognosticated cost for each function.³² Cost is determined by multiplying cost per FTE with prognosticated FTE. The Business & Application support staff’s total FTE are summarized and total prognosticated cost in SEK is calculated. The follow-up column is there for validating the models authenticity after each benchmark and is calculated as deviation between prognosticated and actual costs (fig 9).

³² The prognosticated FTE per function are reached by multiplying index (0.98) with average FTE per function.

Cost and FTE prognostication						
Description		M&S and enhancement Project				
27	Application Name	Jus Master SAP 4.0 (moded)				
28	BA/FIT	Virtual Boxes				
29	Business Processes	Production				
30	Modules Implemented					
31	SAP AWP Development Program / Specified	An implementation project of enhancement packages with new functionality				
32	Type of software application	Financial Human Resource/Production				
33	Scope	+10 FTE				
34	Number users	1120				
35	Complexity Index	0.95				
36	Year of study	2007				
					Follow-Up	
Business & Application Support Staff	Prognosticated FTE	Cost / FTE	Prognost. Cost	Actual FTE	Actual Cost	
38	Maintenance Management	4.00	1.700,00	6.800,00	0	0,00
39	Support of Info desk, Level 2 for UR questions	5.00	2.200,00	11.000,00	0	0,00
40	ARAP Developer - Customization & new functionalities	3.00	3.000,00	9.000,00	0	0,00
41	Functional Developer	5.00	1.100,00	5.500,00	0	0,00
42	Change Management	5.84	3.000,00	17.520,00	0	0,00
43	Total FTE (Prognosticated)	28.77	10.800,00	61.820,00	0,00	0,00
44	Total Cost for B&A support staff(Prognosticated)	61.002,00				
45	Total Cost (Actual)	0,00				
46	Deviation between prognosticated and actual cost	60,00%				

Figure 9 – Cost and FTE Prognostication: Cost/FTE are entered into the application

Enhancement projects are not based on a complexity index since they handled separately and use other models to prognosticate costs. The maintenance manager enters the prognosticated costs from these models as well as FTE used for the projects. The functionality for this is included so that VOLVO IT are able to collect the total cost for the whole M&S assignment if they want to compare the assignments in the TCO perspective. ‘Other support’ is calculated in the same manner as the ‘Business & application support’ functions. As a result, a total prognosticated FTE and cost is reached and when the follow-up columns have been filled the correlation between the models prognostication cost and the actual cost are presented. This is intended as another validation of the model. Now the maintenance manager has the prognosticated cost and FTE utilization (fig 10).

58	Enhancement Projects	Filled in FTE	Cost / FTE	Prognost. Cost		
59	Project CR management	5.00	1.700,00	8.500,00		
60	Project CR support	6.00	3.200,00	19.200,00		
61	Total FTE for enhancement projects	11,00	4.900,00	27.700,00		
62	Total Cost for project	26.900,00				
63	Other support	Filled in FTE	Cost / FTE	Prognost. Cost	Actual FTE	Actual Cost
64	Security / user-admin	2.04	2.400,00	7.065,47	1	3.213,00
65	Administration	1.00	1.200,00	2.355,75	4	3.012,00
66	Outsourcing management	3.00	2.700,00	8.117,45	3	11.856,00
67	Alert and control	1.00	1.000,00	3.504,79	2	4.029,00
68	Change	4.97	1.800,00	8.947,81	5	11.871,00
69	Total FTE for other support (prognosticated)	16,79	9.610,00	37.967,78	16,00	40.821,00
70	Total Cost for other support (prognosticated)	31.297,00				
71	Total Cost (Actual)	49.094,00				
72	Deviation between prognosticated and actual cost	-30,79%				
73	Total					
74	Total prognosticated effort in FTE for M&S	39,47				
75	Total Prognosticated Cost in SFK for M&S	89.583,00				
76	Total Actual Cost in SLK for M&S	49.094,00				
77	Deviation between prognosticated and actual cost	56,91%				
78	Total M&S and enhancement cost	117.730,00				

Figure 10 – Summary Total prognosticated cost and FTE

Now the actual benchmarking can be activated and the application has a tool that enables the comparison of the targeted M&S assignment with other VOLVO IT assignments. We have as mentioned before, used the average assignment as a reference benchmark, but may choose to compare it against so called peer Groups. Peer Groups can be assignments

that are similar in size, same amount of named SAP users or company that has about the same revenue. The index (0.98) of the targeted assignment is received from the complexity calculator, and then the actual FTEs for all staff are entered. Number of employees, annual revenue, number of active uses and number of standard users are there as a proposition as peer Groups (fig 11).

2	Business profile		
3		Assignment	
4	Enter Index for Target projects:	0,98	
5	Nr of employees	1001-5000	
6	What industry are the company in	Industrial	
7	Annual Revenue	>5 billion USD	
8	Number of active users	501-1000	
9	Number of standard users	501-1000	
10	Business & application support staff	1001-5000	
		5001-10000	
11	Total effort spented on the following activities (in FTE)	>10000	st / FTE

Figure 11 – Benchmarking with the use of peer GROUPS

To be able to compare the targeted assignment to the average assignments all data needs to be normalized. Since the Maintenance Managements FTE is 5 and the index is 0.98, 5 are divided by 0.98 and this assignment’s normalized value is 5.1. Total normalized FTE value are calculated as well as the cost (fig. 12). The same is done for the other functions and a total normalized FTE is calculated.

10	Business & application support staff						
11	Total effort spented on the following activities (in FTE)	Cost / FTE	Normalized	Normalized C	Avg FTE	Avg Cost	
12	Maintenance Management	5	1 200,00	5,10	6 122	4	5 200
13	Support	4	4 200,00	4,08	17 143	5	21 467
14	ABAP developer	2	3 000,00	2,04	6 122	4	11 000
15	Functional Developer	7	1 500,00	7,14	10 714	6	8 500
16	Change Management	5	3 000,00	5,10	15 306	5	16 333
17	Total	23	54 300	23,47	55 408	24	62 500

Figure 12 – The FTE for Business & application support staff has now been normalized

The final part of the benchmark is to decide what metrics to use, i.e. which KPI. The following metrics are supported in the application today (2008).

- Total FTE per 100 standard users
- Corrective maintenance / Total maintenance
- Perfective maintenance / Total maintenance
- Preventive maintenance / Total maintenance
- Adaptive maintenance / Total maintenance
- SAP Support cost per business transaction
- FTE used per function / Total FTE (MM/Support etc)
- Total TCO cost per standard user
- Response time per Service request (SR sorted after severity level)
- Resolution time per SR (after severity level)
- User satisfaction

Which KPI VOLVO IT chooses to use when they benchmark depends on the purpose of the benchmark. The maintenance manager are interested in a few different KPIs so he tells the application to use the following: Total FTE per 100 standard users, Percentage of corrective, adaptive, perfective, user support, preventive and external parties to total maintenance, one year TCO, three years TCO and total normalized cost per standard user. Below are graphs that our application automatically creates. Different metrics can be used, and note that all data is fictional. The data has been normalized, which in this case means that the benchmarked assignments FTE and cost is calculated depending on its complexity index (fig 13).

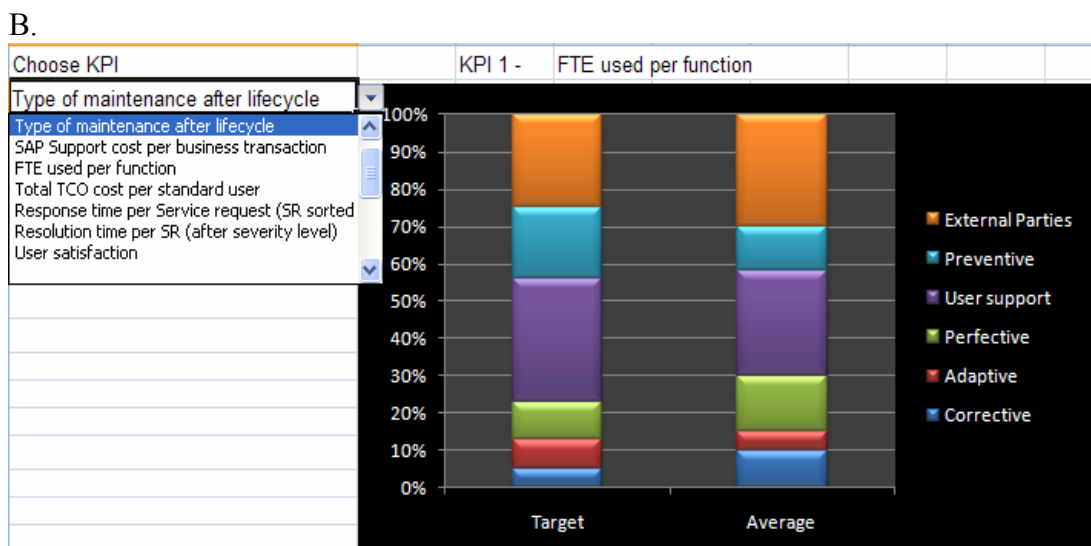
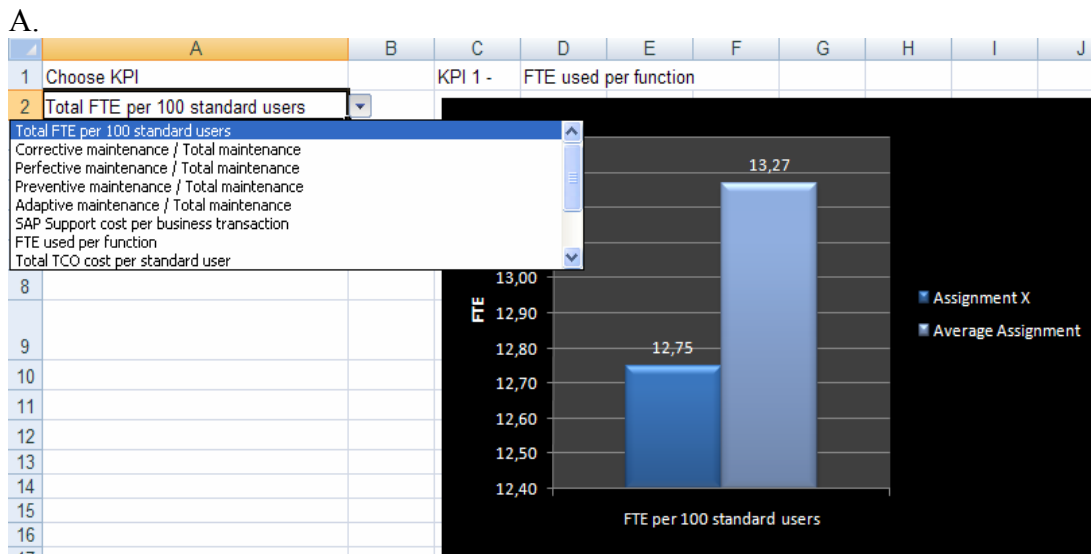


Figure 13 – Key Performance Indicators. (A) The amount of total FTE used per 100 standard users for the average assignment, compared with the benchmarked assignment. (B) The amount of total maintenance; corrective preventive user support perfective, adaptive, and corrective, in accordance with the software classification (see also section 2.8) both for average and for target assignment.

Percentage FTE used per function – shows how much effort each function use per assignment. This could show trends in specific functions for example if the support function use more FTE than expected could indicate that something is wrong there. Figure 14a and b, shows 1 and 3 year(s) TCO per standard user.

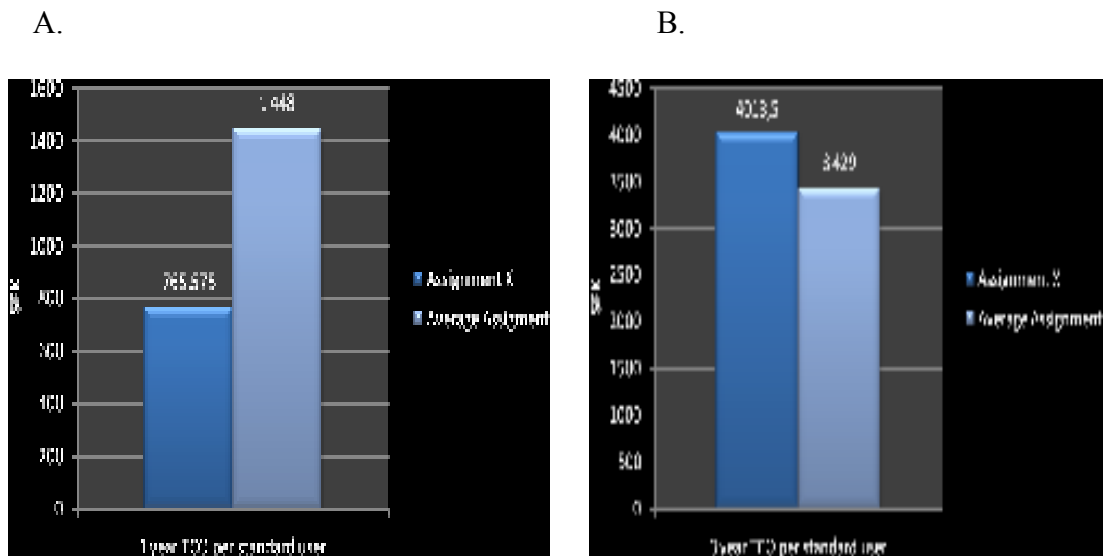


Figure 14 – (A) 1 year and (B) 3 years TCO per standard user for average assignment and benchmarked assignment

The amount of FTE used per function could also be of interest in the benchmarked assignment compared to average FTE in the reference database. The information can show trends in for example if Maintenance Management uses more FTEs than expected can indicate that something is wrong in that function. This gives an idea about the performance of the M&S assignment. The total normalized cost per standard user is lower than in an average assignment, which indicates that the assignment has a lower cost than expected. This could of course also point out that the complexity calculation maybe considered the organization to be more complex than it really was (fig 15).

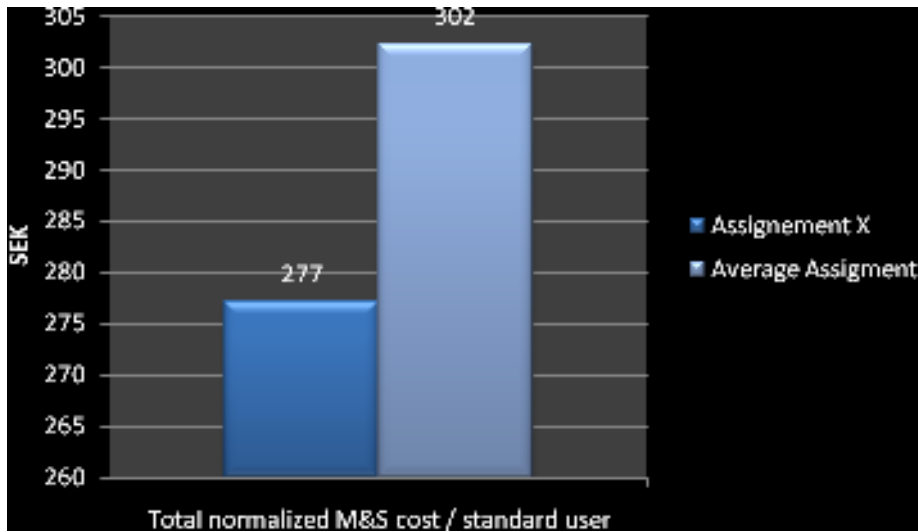


Figure 15– Total M&S Cost in SEK per standard user for target assignments and Average assignment

Figure 16 shows all the major cost categories for owning an ERP system for 1 year. Five major costs exist in an ERP environment; hardware, software, operations, administration and indirect costs (see appendix C for all costs).



Figure 16 – 1 year TCO for solution related to average solution of same size and scope after data normalization.

5.5.3 Reference Database

In this database, all data from M&S assignments should be stored. As mentioned above, the complexity calculator needs an average number for every variable to be able to relate them to the benchmarking assignment to reach a relative index. The database calculates an average for all the variables (fig. 17) and an average for each functions FTE usage (fig. 17 and table 9). Other tables include data about the M&S assignment's index; actual M&S cost, prognosticated cost, enhancement cost, indirect cost and user satisfaction which are used for the graphs.

FTE per function			Variable data		
ProjectID	Function	FTE	ProjectID	Variable	Data
1	MM	3	1	RatioConC/Named user	100%
1	Support	4	1	HA	25%
1	ARAP	6	1	Wfunc	52,00%
1	FD	4	1	NrTotalSys	3
1	CM	6			

Figure 17 – Data input form for rDB, to the right are FTE usage for each function in the first assignment and to the left data are saved about each variable.

Variable	Average	Max	Min	Function	Average	Max	Min	FTE
CompanyCodes	6,17	8	4	MM	4	8	2	39
HA	0,43	0,73	0,25	Support	5	8	3	46
NrClients	8,17	22	3	ABAP	4	6	2	33
NrCustomiz	5,67	8	3	FD	6	9	4	51
NrERP	4,00	6	2	CM	5	8	3	49
NrIndprogs	5,67	9	3	Security	5	7	3	45
NrInstance	4,50	7	3	Admin	4	8	2	39
NrTotalSys	3,50	6	2	OM	5	9	2	44
OrgChange	0,28	0,66	0,1	AC	4	8	1	38
PeakDialogue	1401,67	3533	500	Clerical	4	7	2	34
PlatformStdrd	0,51	0,7	0,24	PCRM	4	6	3	38
RatioConC/Named user	0,58	1	0,25	PCRS	3	6	1	25
RatioProdTotSys	0,43	0,55	0,35	Total	481	481	481	481
SDP	0,48	0,75	0,25					
Seniority	18,17	62	5					
Wfunc	0,45	0,65	0,24					

Table 9 – reference database with average values for each variable and each function

5.6 Validation of the model

To evaluate the model, data need to be collected to compare prognosticated FTE with real FTE per function and in total. This will show the correlation between each functions M&S workload affected by the complexity index and the real workload. We have tried to do this with the information gathered by our questionnaire but more information is needed. In the examples below we show what information we have gathered but the

prognosticated cost are not accurate since data about all variables have not been collected and also neither FTE average (fig. 18 and 19).



Figure 18 – Actual FTE vs Prognosticated FTE. (Index elimination has not been conducted due to lack of information so normalization is not possible)

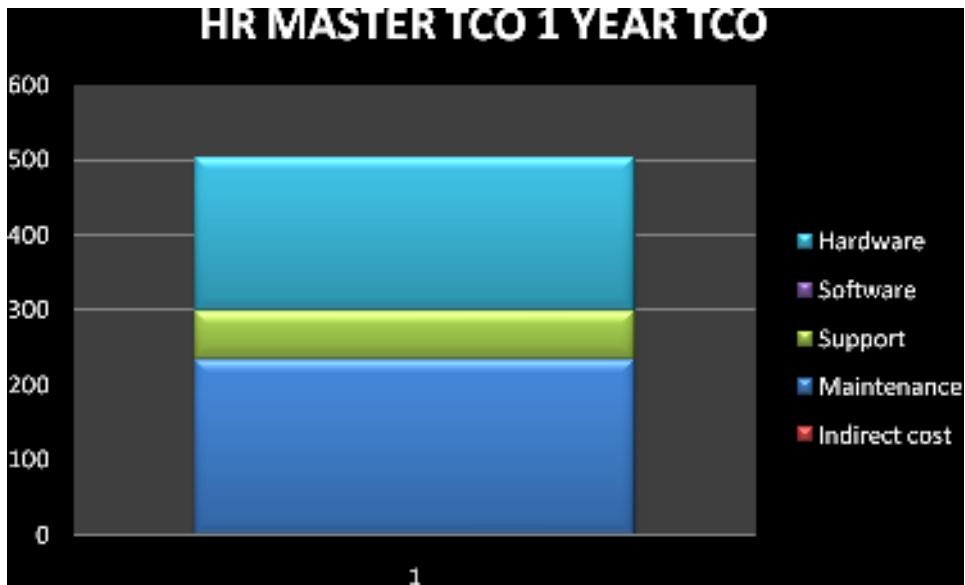


Figure 19 – actual FTE compared to prognosticated FTE.

Another approach to evaluate the correlation between complexity index and M&S workload is by a regression analysis ($x = \text{Complexity index}$, $y = \text{Hours}$). As we can see in the scatter plot below (fig. 20), the higher index the more effort is needed. Once again, this is an example based on fictional data and should be viewed as a way to validate our model after a substantial data collection.

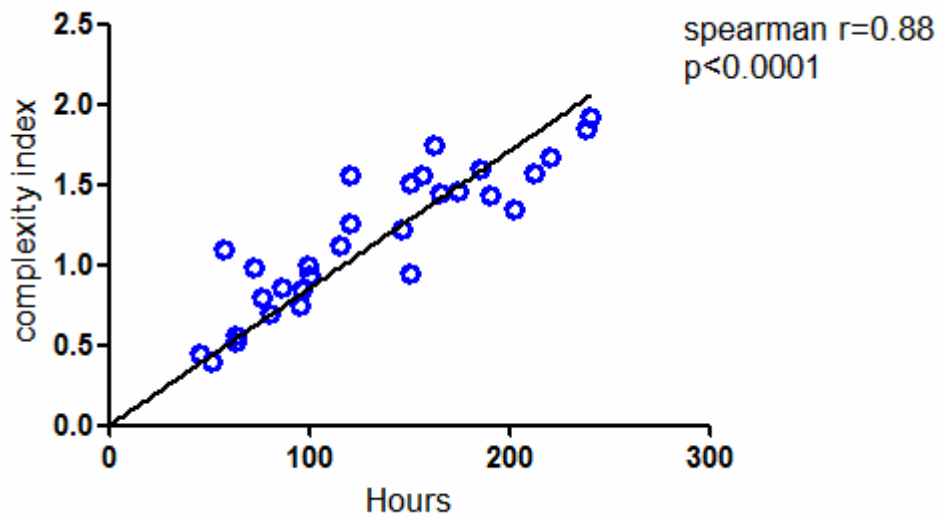


Figure 20 – Regression analysis on complexity index versus hours

6. Discussion

In this section we discuss our findings and previous research related to our three identified tasks used throughout this report to resolve our research question which are factors that drive M&S cost and effort, financial and non-financial measurement and metrics, cost and benefit evaluation and comparison using KPI's. Each section will include key findings, recommendations and academic contributions.

6.1 Eliminate differences between assignments supporting dissimilar ERP environments

After only four years, the ERP using organizations have invested more in the maintenance cost than in total implementation cost (Ng, et al. (2002). It is therefore imperative to recognize, both for end-users and for the IT department/organization what drives these M&S costs. What causes the variations and to what degree do these disparities affect the complexity profile and the M&S workload?

6.1.1 Key findings

There are many interconnected factors influencing the workload for the supporting IT organization, for instance organizational structure, corporate strategies, business processes and infrastructure. Factors like these can all have a bearing on M&S effort and on each other. An enterprise with complex business processes needs a complex ERP system with a multifaceted infrastructure which adds to the M&S workload. If the organization has a need for a high service level the infrastructure needs to be state of the art, which also creates more effort for the supporting M&S organization/department. On top of all these factors, IS systems are social systems having an impact and are being influenced by environmental, organizational, behavioral and cultural issues (Stefanou, 2001) (See figure 33).

How much M&S work load is required?

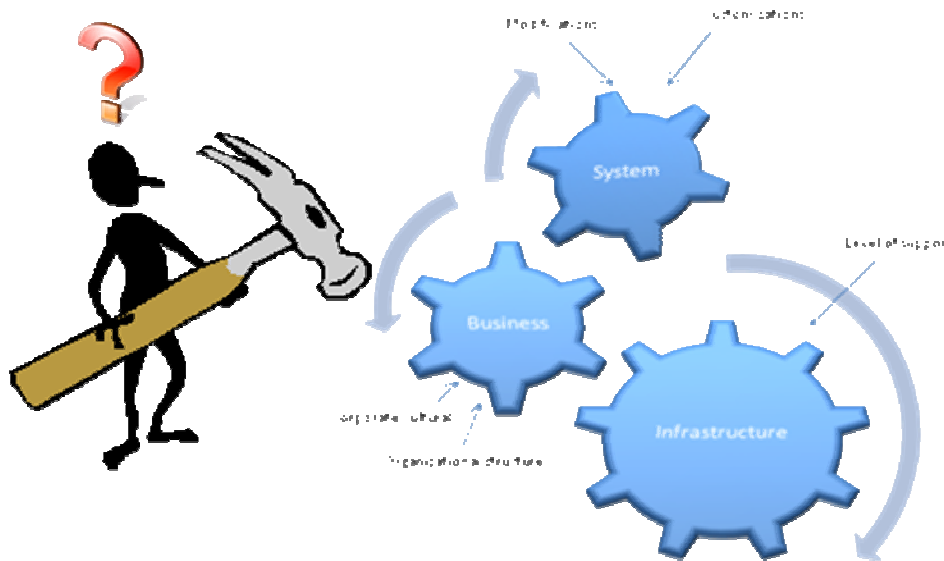


Figure 21 – ERP environment complexity. Everything affects everything.

Key differences in our opinion are; ‘Stage in the software life cycle’, ‘amount of named SAP users’, ‘Annual revenue’, ‘type of industry’, ‘size and complexity of solution supported’, ‘level of support’ and ‘degree of customizations and modifications’.

6.1.2 Recommendations

To further validate the model there is a need to do a quantitative data collection over a long period of time with perhaps regression analysis on all variables. We recommend the use of our questionnaire as a basis for the data collecting, though it needs to be fine tuned. Our proposition is that a dialog is started with SAP experts together with M&S managers about the questions in the questionnaire and the complexity variables. We believe that some of the variables need to be removed and some other factors may be added, but further work needs to be accomplished to decide which ones. When the questionnaire has been completed, it could be used for data gathering for building the reference database as well as a procedure for future benchmarking projects. In addition there needs to be a consensus on the definitions of the different functions within VOLVO IT so that FTE usage on each of these functions can be collected and measured.

6.1.3 Academic contribution

We try to complete the tough mission to remove dissimilarities between assignments in different organizations with our own created complexity calculator. The decision not to consider social and cultural aspects was determined not to be relevant for us since we were only assessing VOLVO IT and hence there was no need for us to consider these factors. What we failed to realize at that time was the fact that VOLVO IT supports many different types of organizations where, we believe, these aspects definitely have an impact on M&S effort. The complexity tool calculates an index of total complexity based

on the above factors (with the exception of social aspects) which is then used as a normalizing value to enable comparisons and also to prognosticate M&S effort. We choose effort and the unit FTE instead of cost to further eliminate differences such as differing salary levels. In the initial phase of our research the idea with a calculator for complexity seemed to be a good methodology to solve the dissimilarity dilemma but now, we consider this to be a utopia. Instead of seeing our complexity index as an exact and precise calculation, it should be viewed as a tendency or trend. If the complexity index is high the M&S effort will probably be too. The complexity variables could be seen as indicators more than exact numbers.

6.2 Evaluation and measurement of the assignments cost and benefits

ERP has been available since the early 90ths and still there are no consensus on how and what to measure with ERP M&S (Stefanou, 2001; Goyal., A, SEN., P.M, 2005). A lot of costs are centered in M&S (Ng, C.S.P., G.G. Gable et al, 2002) but still, no one seems to know how to measure it. Bauer pointed out that things that are measured also gets managed which demonstrates the significance of identifying relevant metrics. Previous studies have shown that M&S cannot be seen as cost centers (West, Daigle, 2004). Indirect costs are often a result of misdirected funding in direct costs. If cost savings are done on user training too much the cost can move to the business unit because of informal training which lowers the available resources to perform business tasks (Gartner Group, 2007). Indirect costs have a huge impact on the total cost (Daigle & West, 2004) and end-user organizations seem oblivious of this huge impact by these unbudgeted costs.

6.2.1 Key findings

Considering M&S as cost centers could result in an attempt to cut these costs no matter the consequences which could increase the TCO in the long run. As previously shown, savings can actually be made by investing in M&S, for instance investing in training can reduce the indirect costs of end-user training (Gartner, 2007). We believe M&S activities can improve operational performance and increase organizational value. Formal end-user training adds human capital value and lowers the cost of informal training and keeps these resources available to the business tasks (Gartner Group 2007). Roughly 90% of all computer resources are represented by indefinable assets for example investments in software, training and organizational change due to IT activities (Brynjolfsson and Yang, 1997; Stefanou, 2001). This pinpoints the substantial amount of worth that maintenance activities produce and this is what we want to measure. There are a lot more benefits than just cost reductions with IT applications (Farbey et al, 1993) and we believe this is related to maintenance and support processes as well. As suggested, an evaluation of ERP should include an examination of benefits coming from changed business processes (Stafyla & Stefanou, 2000). User satisfaction is also essential to measure (Stefanou, 2001) and relatively easy to measure. We believe that the intangible nature of ERP (Donovan 2000; Remenyi, 2000)) is the reason to why there are a lack of specific metrics to evaluate costs and especially benefits. Another approach to measurement is to analyze and decide what the goals with the measurement are, then choose questions that will answer if these goals are being fulfilled and then decide on measures (Dekkers et al, 2005) which are in line with what we believe. Careful consideration are of the essence when choosing metrics

and especially key performance indicators because previous studies has shown that the some measurement can have an effect on people's behavior which can result in lower productivity and even reduced quality (Hoffman, 2000). This is because the metrics used are based on models and guesses about system and organizational behavior that is most often incorrect (Hoffman, 2000). Benefits do not come from the ERP system itself, but from the organizational change caused by the ERP usage and also from enhanced functionality implemented (Donovan, 2000). We consider this is also valid on M&S because maintenance activities, at least perfective maintenance add value through enhanced functionality. Not much is known about measuring benefits in operation, maintenance and evaluation in ERP-systems, but perceived customer satisfaction and benefits from improved decision making is important to calculate, though also challenging. Furthermore resistance to change can be a big contributor to operations costs (Stefanou, 2001) which are applicable on M&S activities involving implementation of new functionality. Perceived costs and benefits that come from changed business processes need to be assessed (Stafyla & Stefanou, 2000).

Another way of measuring M&S are to measure business performance before and after the M&S assignment and reflect on the added value that was directly related to M&S. More research has to be conducted on how to calculate how much value was directly related to M&S.

6.2.2 Recommendations

We do not want to decide on specific metrics for VOLVO IT since we do not know the purpose with the benchmarking mission and therefore cannot decide on the measurement goals. VOLVO GROUP does not seem to measure indirect costs or benefits as of today (2008). To be able to conduct relevant assessments on M&S we advocate VOLVO GROUP to start measuring indirect costs as well as reflecting on how to evaluate created value with M&S activities and identifying specific metrics depending on the goals with the assignment. When evaluating M&S we think it is important to define the type of maintenance or support activity that is to be measured. One approach for VOLVO IT could be to classify their M&S in accordance to the M&S categorization (section 2.8); corrective, adaptive, perfective, user support, preventive and external parties (Lientz & Swanson, 1993; Burch & Kung, 1997; Fui-Hoon Nah et al 2001) and start measuring effort in used in each category and also in what stage of the software life cycle model (see section 2.8). After a while trends should appear that may or may not be in line with previous findings as shown in table 2 in section 2.8. We believe that Corrective, adaptive and perfective maintenance to total maintenance as well as user satisfaction are interesting performance indicators in combination with the financial measures supported mentioned throughout this master-thesis. To measure the M&S staff performance Service request response time and service request resolution time sorted after complexity³³ of service request are two other metrics that might be of interest (Informant A, 2008) and thus agreeable measurements between organizations to use as basis for comparison.

³³ Defined as severity level: severe, major, minor or minimal at VOLVO IT (questionnaire response from respondent C)

It is crucial to know the aim with the maintenance activity, and measure its value. This is important for two reasons, first a decision if the activity should be carried out or not and second, to be able to measure the M&S performance.

For instance, if new functionality is added in a perfective maintenance activity, the goal of the implementation should be evaluated and identified. Then an estimate is done to see what future value this new functionality will create for the organization. We believe NPV are an appropriate technique to be used as a decision basis. If NPV is positive, the new functionality adds more value than it costs and hence should be implemented.

Let us say we have the following scenario. An initial cost for developing and implementing the new functionality is 75.000 SEK. Prognosticated Cash Flows (CF) are added value induced by the new functionality due to improved business processes.

CF year 1: 25.000 SEK - CF year 2: 35.000 SEK - CF year 3: 40.000. The Net Present Value is calculated with a cost of capital of 4%³⁴.

$$NPV = -75.000 + \frac{35.000}{(1+0.04)^1} + \frac{25.000}{(1+0.04)^2} + \frac{40.000}{(1+0.04)^3} = 17\,327,60583$$

Hence, the new functionality should be implemented since the NPV has a positive result of ≈ 17328

6.2.3 Academic contribution

We believe that all the maintenance activities add value for the organization but in different ways and in various degrees. Corrective maintenance do not add direct value, but opportunity costs exist of not doing the corrections which are adoptable for adaptive maintenance as well. By performing preventive maintenance should lower the amount of corrective maintenance and as a result these freed up resources can be spent on perfective maintenance tasks will add customer value. User support involves user training and help desk which adds value by increasing human capital value as well as decreasing indirect costs such as informal training. Preventive maintenance involves problem identification before they get too complicated to resolve, which also creates value depending on the system quality and amount of testing. Our proposal is that research is focused on what value M&S creates in each of the maintenance categories as reflected and discussed in table 10.

³⁴ Risk factor has not been considered in the discount rate.

Maintenance category	Added value
Corrective	Decreased opportunity cost
Adaptive	Decreased opportunity cost
Perfective	Improved performance and processing efficiency
User support	Increased human capital and lowered indirect cost such as informal training
Preventive	Less corrective maintenance
External parties	N/A

Table 10 – Summary on what value the different maintenance categories contribute to organizations according to us

6.3 Comparison of the assignments

The purpose of assessing the assignments are to be able to compare them with other assignments supporting and maintaining various systems and business processes with their unique system installation and varying level of service agreements. ERP systems constantly evolve and this cause numerous modifications and customizations to the system (Stefanou, 2001). This creates a situation where almost no system is the other alike. This diversification is a problem because it is tricky task to find other similar systems to benchmark against.

6.3.1 Key findings

The average cost per user is higher for larger companies because the ERP solutions are more comprehensive. At the same time larger companies are given volume discounts as well as bargaining powers. (Aberdeen, 2007) These are just a few identified examples on differences between different sized companies. It is still possible in theory to compare all assignments if all the differences are eliminated. This is in our opinion not possible in practice. In a recent report, an additional benchmarking category was added, peer group benchmarks. It can be applied within an organization to compare sites or divisions (ISBSG³⁵, 2008). This new classification fits our use of peer Groups; consequently VOVLO IT is intending to conduct a Peer-Group benchmark.

To compare one assignment and come to the conclusion that it is not performing as expected on the basis of a higher maintenance cost compared with the average without removing assignment discrepancies are useless. The values would not mean anything unless they are normalized with the use of the complexity index and the peer-group approach. The reasons for the higher cost could be because the assignment was only for one month, or the system had only 500 users compared to 10.000 in the average assignment or all these factors combined. When all things are alike, then comparisons of the assignments can be performed. The aim with the benchmarking is to use the average measures as an indicator on how things should be going and thereafter compare that with other assignments to make assumptions about the cost, FTE usage and benefits.

³⁵ International Software Benchmarking Standards Group

We are concerned with the fact that so many differences exist, so many that we suggest that an elimination of them all is not feasible, however with the use of a peer-Group benchmark approach, we believe we would come one step closer to perfection. More research is needed about peer-groups. We believe that even when using comparisons in the same peer-Groups there can still exist many differences between two assignments, for instance if VOLVO IT compares two assignments supporting large companies. The SAP solution may still be in different life cycles, the first are in the introduction phase and the second solution is the maturity phase. In the maturity phase perfective maintenance is normally the largest (Fui-Hoon Nah et al, 2001). If a peer Group benchmark are performed with the metric ‘amount of perfective maintenance / total maintenance cost’ and result in 40% for both the assignments, it indicates that that the first assignment is doing really good (or the second really bad) since the first assignment was expected to have less amount of perfective maintenance in relation to the second due to its life cycle stage, consequently the first should have the most corrective maintenance since most of that type of maintenance is performed in the initial phase.

6.3.2 Recommendations

We recommend VOLVO IT to use so a peer-group benchmark in combination with the complexity index. Examples of peer-groups is Named SAP users, (ASUG, 2006) same solutions, organizations of same size (size can be measured for instance with annual revenue or number of employees). A combination of peer-Groups may also be an option to further eliminate differences. Furthermore, we advise VOLVO IT to list all their maintenance activities and then divide them after the categorization: corrective, adaptive, perfective, preventive, user support and external parties and store the data sorted after the different peer-groups.

6.3.3 Academic contribution

Today, there are still a lack of research and awareness about maintenance and support especially in the field of benchmarking and given that a big part of all costs occurs after go-live (Ng, C.S.P., G.G. Gable et al, 2002) we think is remarkable. Our contribution to science is our Benchmarking model, how to eliminate differences, analyze, measure and compare different assignments with each other. We hope this master-thesis will encourage more research to further increase the awareness of the exciting and highly relevant field of ERP M&S benchmarking.

6.4 Benchmark model validation

Our complexity calculator contains parameters that are assumed to have an effect on M&S effort. Further testing of our model is needed since we have not been able to collect sufficient amount of data to validate our model. As for now we have made a generalization that the relationship between FTE and complexity are linear. This could prove, and probably will, not be the case, but further testing and data gathering are needed. Another aspect is that each variable might influence the index in different extent. For example, amount of customizations could prove to have substantial effect on future M&S effort, while amount of modules have no effect. We believe that the variables are

relevant but their individual influence on complexity has to be examined. Furthermore the variables may have different effect depending on the peer-groups. For instance the variable ‘amount of ERP systems’ may have a lower impact on complexity for SME’s³⁶ than for larger enterprises and the index might be influenced differently depending on the maintenance function. The purpose of the questioner was to collect data on different M&S assignments and on each complexity variable to be able to validate our model. The answers were somewhat diverse which indicates that the questions needs to better defined to ensure it fulfills its purpose and separate questionnaires might have to be formed to take in consideration each peer-group. The answers from the questioner came from very dissimilar systems which made comparison hard for instance number of named SAP users in the organizations ranged from 540 to 45.000. Some of the answer were not in line what we expected which led to elimination of some variables but more reflection and analysis is needed. Considerable data gathering needs to be carried out to confirm the parameters relevance. To confirm their relevance and individual impact on M&S we suggest that substantial amount of data³⁷ is collected on each parameter and its total maintenance cost. A regression analysis is then performed on each variable and used in the complexity calculation if the parameter is found to be influencing total M&S cost. An example are amount of modules in relation to total M&S cost in companies with an amount of Named SAP users between 1001 and 2000 (See fig. 22).

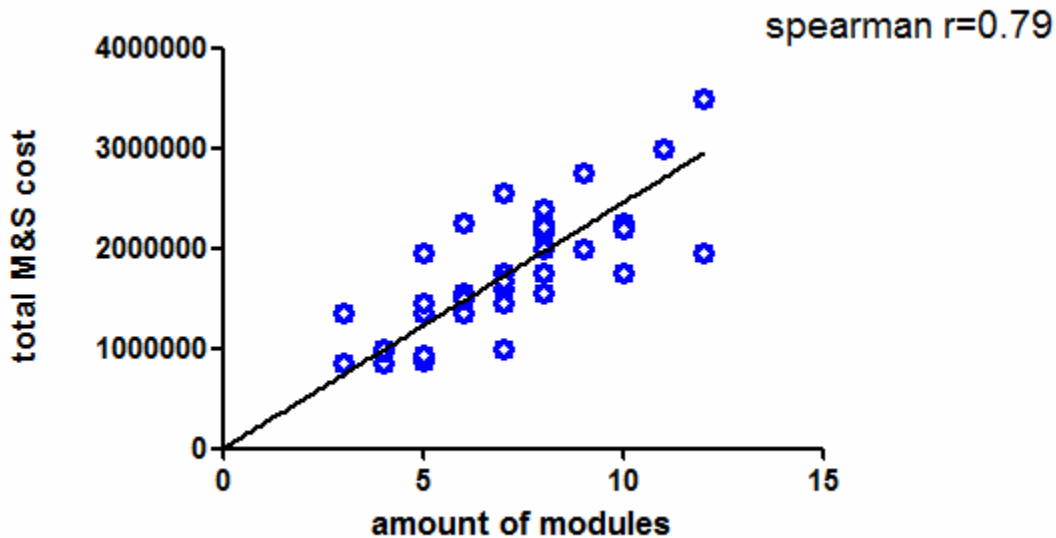


Figure 22 – Regression analysis amount of modules versus Total M&S cost for companies with 1001-2000 Named SAP users (fictional example).

³⁶ Small and Medium Enterprises

³⁷ (not less than 30 different assignments according to statistical techniques)

7. Conclusion

We found that there was no standard method for measuring performance of maintenance and support assignments in an ERP environment.

With the use of our complexity index, many discrepancies can be removed by using the index as normalizing value. However, it is impossible to detect all differences, and even if they are recognized it is not feasible to eliminate them all. By combining the index with the peer-group benchmarking concept, it enables the comparison of dissimilar assignments. VOLVO IT are now, with our model, able to compare many of their M&S assignments on similar conditions.

The decision of what metrics to use when performing a benchmark is a project by itself. Both financial and non-financial measures are needed to evaluate the performance of the M&S assignment. Other benefits than cost reductions exists, still it is not known which these benefits are, and consequently it remains unknown how measure them. User satisfaction is an important metric to measure as well as benefits from the maintenance assignments. What benefits to measure is a weakness in the current literature in the field of M&S. Procedures on how to measure the value of maintenance activities such as investments in software, end-user training and organizational change should be put into practice.

We believe that the aim should be to keep the amount of corrective maintenance down to free up M&S resources and use them on perfective maintenance tasks instead, which we assume, will add customer value, since perfective maintenance should improve the organization or the ERP system. To be able to conduct relevant assessments on M&S we advocate VOLVO GROUP to start measuring indirect costs and to reflect upon how to evaluate benefits in M&S activities, as well as identifying specific metrics, depending on the aims with the assignment.

Today, there are still a lack of research and awareness about M&S, especially in the field of benchmarking. We contribute to this field by presenting a Benchmarking model that compare different assignments, with emphasis on the recognition of factors that drive M&S costs. In addition we provide functionality in our model for KPI utilization to make comparisons. We consider 'percentage of corrective and perfective maintenance to total amount of maintenance' are interesting indicators, which may improve performance both locally and in an enterprise perspective by shifting M&S resources from corrective maintenance to preventive maintenance and, thus, freeing up resources for perfective maintenance activities. Finally, we hope that our findings will create an interest in M&S assignments, and that this will lead to a deeper knowledge and awareness in the M&S field.

8. Future research

This master-thesis proposes a benchmarking model for comparison of different assignments within and between companies. It should be viewed as a pre-study, with a model that needs to be tested and further developed. However, one should consider that a more complex application type might increase the work load for M&S. The same will be true in the case of easiness of reading the code and its structure, as well as for the maintenance of both the code and the structure complexity. The lack of previous research shows that more research has to be conducted in measurement and evaluation of M&S assignments in the field of SAP/ERP. Research on which KPI's to apply and when to apply them, that is, which KPI's depending on purpose. Additional evaluation is desired about what KPIs to use when measuring of M&S. It may also be of interest to consider the dimension of risk when assessing ERP M&S.

Finally, we suggest that more reflection and research needs to be performed about the driving factors in M&S costs, especially in the area of social organizational factors. Research about how social, cultural and environmental issues affects the M&S processes may be of interest, since ERP systems are used in social environments. Possibly, mental models and cognitive mapping could be used to evaluate ERP M&S assignments, given that it is applicable to M&S.

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Appendix A

- Application productivity (Total Size of code supported / Full time equivalents i.e., KLOC / FTE or FP/FTE).
- Minor Enhancements Productivity (Number of Minor Enhancements / PM)
- Maintenance Productivity (Number of SRs resolved / PM)
- Component Productivity (Number of components supported / PM)
- Base code change rate (Size of code added/deleted/modified / Total size of application)
- SLA Adherence (Number of SR's resolved with in turn around time / Total number of SR's resolved) *100
- % Bad Fixes (Number of Bad fixes / Total number of SR's resolved) *100
- Problem turnaround time (MTTR, Mean time to resolve the SR)
- Application SR density (Number of incoming SRs/Size of the code supported)
- Cost per error (Effort spent per SR)
- Database proportion (Database Size /Size of the code)
- Proportion of maintenance
- Proportion of minor enhancements
- Team Volatility (Number of in or out movements of team / total team size)
- Effort per location
- Effort per user
- Effort per concurrent user
- Effort per installation
- Effort per available hour
- Effort per change
- Effort per hour of availability
- Effort per staff volatility

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Appendix B

Interview with Oracle senior implementation project leader

1. *What support does the user-organization receive from the vendor?*

Answer: Help desk support, new versions and patches several times every year and the cost for this is a fixed price. The price depends on what type of support the organization chooses. Can have multilingual support and 24/7

2. *In what way does the implementation affect M&S?*

Answer: Keep with the standard system as much as possible and User-training also affects M&S. Degree of testing does also effect the amount of bugs.

3. *Which costs and problems may occur after post go-live for the company?*

Answer: Initially the support cost is higher, and more errors occur. After a while the users get more used to the system and fewer bugs are found. When new functionality is installed, the life cycle restarts. What is done last is more prone to have more faults since it has not been thoroughly tested, new parameterization. Every change of the system leads to risk of faults and a need for user-training. Manuals and documentation is very important.

4. *How do you think M&S performance is best measured?*

Answer: The response time to service requests and the time used for problem resolution. The complexity of the request is also of importance.

5. *Are there any differences between the modules in an M&S perspective?*

Answer: The more clients using a module the less problems with it. For example, if everyone uses financial modules. The more standardized solution the better

6. *Which are key stakeholders in the end-user organization?*

Answer: Superusers – Level 1 support and the person responsible for maintenance

7. *In what way does the vendors support responsibility change from before to after go-live?*

Answer: It does not

8. *What factors influence the cost for the end-user organization when implementing enhancements and patches?*

Answer: The end-user competency, customizations and the size and complexity of the patch

9. *What can be done to minimize the cost of the ongoing M&S?*

Answer: A clear architecture. No unnecessary dependencies in the system which can create ripple effects.

10. *What do you [the vendor] do to lower the support cost?*

Answer: We do not lower the costs for support but we do work for added value for the customer.

11. *Do you think there are differences between industries in an M&S effort perspective?*

Answer: Yes, I think there are differences between different industries, but it is hard to exactly pinpoint the differences. For example, in the medical industry, they are more used to tests so maybe that could affect M&S.

Appendix C

TCO costs in an ERP environment. All costs should be calculated as annual costs, hardware and software are depreciated over 3 years. If hardware is not owned, annual leasing fees should be used instead.

Direct (budgeted Costs)

Hardware

- SAP server
- DB server
- Other servers
- Storage (space used)
- HA system & components supporting HA and occupancy cost
- Redundant server
- Networks
- Disk drivers
- Occupancy (electricity, maintenance, office space, property taxes, security)
- Disaster recovery (including contingency site)
- Hardware upgrade cost related to ERP

Software

- SAP ERP
- Software license fees
- System management tools (Tivoli, EMC patrol)
- O/S license (related to ERP)
- Utilities (i.e. security, disaster recovery, automated operations, print, performance analysis)
- Modules (logistics, project management)
- Tools (Data query, OLAP, DW, DBMS)
- Clustering (Shared processing)
- Software investments related to ERP

Operations (technical support and infrastructure operations)

- managing backup & storage
- OS maintenance
- ERP maintenance
- Network management
- DB support and maintenance
- Server maintenance
- help desk (technical support)
- Other services
- Outsourcing (services from third party, not VOLVO IT + staff at VOLVO IT handling outsourcing, contract fulfillment etc)
- Performance tuning

Administration

- End-user training

- Disaster recovery training and testing
- Change Management
- Administration (Applications area as budgeting and chargeback)
- Audit and control (ERP application audit, master data review)
- ABAP development
- Functional development
- Security

Indirect costs

- End-user operations - Misdirected funding of services in direct costs like training, technical support and helpdesk lead to indirect cost. Peer and self-support, end-user formal training, non-formal training, self-development of applications and local file maintenance are examples of this. For example, if employees ask each other for help instead of using formal support such as a help desk, end-user productivity can be negatively affected by this.
- Downtime - Productivity lost because of planned or unplanned downtime. Scheduled downtime due to maintenance and unplanned downtime can be a result of some failure the ERP system or its supporting infrastructure making it unavailable.

Appendix D

Assignment 1

SOLUTION: CATS/PS/SD/FI/CO/HR

Application specification questions

1. Which application was the assignment for?

Answer: CATS/PS/SD/FICO/HR (3 different solutions)

2. Which company is the assignment for?

Answer: Volvo Technology, Volvo Business Services and VCE

3. What was the assignments duration and scope?

Answer: VBS; since August 2006

VTEC; since 2005

VCE; since 2005

Cost related questions

1. How much was the maintenance and ongoing costs for the M&S assignments?

Answer: Time and material for all solutions, support 5000SEK/month per solution.
Maintenance (maintenance and minor enhancements) cost 2007 (invoiced to customer);

VCE 695KSEK

VTEC 1125KSEK

VBS 859KSEK

2. How much was the annual total software costs related to the SAP system?

Answer: n/a since invoiced through Master Finance

3. How much was the annual total hardware costs related to the SAP system

Answer: n/a since invoiced through Master Finance. For VCE the estimate was 72KSEK/year. For VTEC the estimate was 480KSEK/year. n/a for VBS.

4. How much was the annual total implementation costs related to the SAP system

Answer: The proposed set up cost for VTEC was 2260KSEK. For VCE it was 1799KSEK. VBS n/a

5. How much was the annual training costs related to the SAP system

Answer: VTEC estimate 200hrs, VCE 40hrs (user-guides), VBS n/a

6. How much is the vendor support cost? 20% of license cost?

Answer: n/a

7. Does the company measure indirect costs, such as user operation and downtime, if so how much are they (See definition of end-user operation at bottom of page 6)?

Answer: not for this solution but maybe for the entire masterfinance landscape.

8. How much was planned and unplanned downtime?

Answer: In accordance with MasterFinance agreement

9. How many FTE's were used in the assignment, and if it's possible sorted after staff functionality, i.e. Maintenance management, support, ABAP etc

Answer: Currently the staffing looks like this;

VCE; MM approx 0,2, CATS/PS/HR 0,2,
VBS; MM approx 0,15, CATS/PS/HR 0,1, SD 0,1
VTEC MM approx 0,15 ,CATS/PS/HR 0,1, SD 0,1,

Since Time/Material contract, there is no fixed percentage for the roles, hence the estimations. ABAP and FI/CO are just a few hours/month in total. In total the roles CATS/PS/HR, SD, FI/CO and ABAP account for approx 0,6 FTE for all three solutions. Maintenance Mgr approx 0,5 for all three solutions.

Business related questions

1. How many named SAP users does the company have (licenses)?

Answer: VTEC approx n/a

VCE approx 540

VBS n/a

2. How would you rate the company's level of organizational change related to average?

Answer: Average

3. How complex is the business processes?

Answer: Not so complex

4. Production code complexity (plants / production codes)

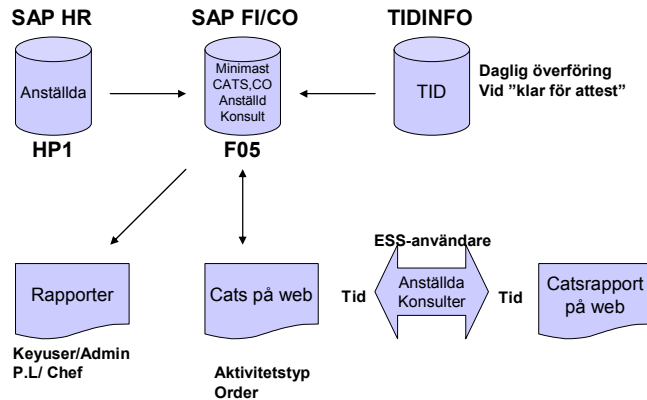
Answer: Not complex

System related questions

1. How does the system architecture look like? Is it central/de-central, linked or consolidated system landscape?

Answer: Links between local time reporting system, HP1 (HR master data), see picture;

Systemsamband



2. How much functionality is utilized and how many modules does the company have implemented and which are they?

Answer: The solutions contains the following modules;
 VTEC; FI/CO, PS, SD, HR (mini-master) and CATS
 VCE; HR (mini-master), PS, CATS
 VBS; SD, CATS, FI/CO, HR (mini-master), PS

3. How many total systems does the company have in use?

Answer: n/a

4. How many company codes do they have?

Answer: VTEC; SE04
 VCE; SE51, SE52, SEAA, SEAC, SEAD
 VBS; SEAM

5. How many enhancement projects have been carried out during the assignment mission?

Answer: VBS; 1 during 2007 (EDI)
 VTEC n/a – no major ones
 VCE n/a – no major ones

6. How old is the system?

Answer: VCE solution has been existing for approx 3 yrs
 VBS solution approx 18 months.
 VTEC approx 3 yrs

The system itself has been existing much longer, in use by MasterFinance.

7. How many instances does the company have?

Answer: FT5-001 + FT5-003
 FA5-001 + FA5-003
 F05-001 + F05-003
 FX5-003 chain only valid for VCE solution, company code SEAD

8. How many customizations have been done, if it's not measurable more or less than average?

Answer: Average for solutions of this size

9. How much effort has been invested in knowledge transfer activities due to lack of system documentation?

Answer: At the end of the projects for VCE and VTEC documentation has been created, system documentation and end user guides.

For VBS (set-up not done by Volvo IT), hardly no documentation existed at hand-over to maintenance – a specific project was set up in order to have documentation in place, approx 65 hrs were spent on this.

Infrastructure related questions

1. Does the company have a high availability system?

Answer: normal

2. Do they have a back-up and/or a disaster recovery system?

Answer: n/a

3. Do the company use Windows, UNIX, others or mixed system landscape?

Answer: n/a

4. How many percent of the landscape is aligned to standard.

Answer: n/a

Service level related questions

2. What level of support was agreed on in the SLA for the M&S assignment? (24/7 help desk, multilingual, system performance such as response time and % uptime)

Answer: See part of the assignment below, same conditions for all three solutions.

Schedule A: Availability and Service Levels

A1 Availability of application support

Support	
Availability	08.00-23.00 CET Performed by Gothenburg 08.00-17.00CET. Official local holidays not included. Extended support has to be requested 5 days in advance and will be handled as change requests.

1.2 Severity levels Support

The standard severity levels are defined in Appendix 2. Respons/ resolve times are based on 8 hours working days. Respons/ resolution times are allocated to the VOLVO IT site owning the case.

1.3 Response Time Support cases

Response time is calculated as the time from which the issue is logged in VINST until the issue is assigned to an action owner.

Response time/ Priority	
Response Time / Rate, Major	30 minutes/ 90%
Response Time / Rate, High	2 hours/ 90%
Response Time / Rate, Medium	8 hours/ 80%
Response Time / Rate, Low	16 hours/ 80%

1.4 Resolve Time Incidents

Resolve time per case type incident is calculated as the time from which the issue is assigned until the case is closed (excl. time for test and approval from issuer).

Business Requirements are handled as local Enhancement requests. Questions are also excluded.

Resolution time “Major” is not applicable for test and development environments.

Resolve time Incidents/ Priority	
Resolution Time / Rate, Major	24 hours/ 90%
Resolution Time / Rate, High	72 hours/ 90%
Resolution Time / Rate, Medium	10 working days / 80%
Resolution Time / Rate, Low	Best effort

A2 Service levels Operation

The below service levels for operations are set in the SAP R3 Master Finance agreement, AA no 2120504171, and applicable for PAUS Solution being a part of the Master Finance landscape.

Operation	
2.1 Availability of application operation	Supervision 24-hours a day, seven days a week
2.2 Performance Levels	Technical support basic, 0800-1700 CET Technical support premium, 0000-2400 CET

Operations area	Custom Package
2.2 Performance Levels	50 GB/hr

R/3 Response time for online processes (Monthly average excl. Network)	<1,5s
--	-------

2.3 Back up

Data source	Incremental backup	Retention period	Full backup	Retention period	Other (options, limitations etc)
Production Server	Four Weekdays	4 week	Once a week	4 weeks	Offsite storage of all tapes
Test Server			n/a		
Develop. Server			Once a week	4 weeks	Offsite storage of all tapes

There is no back-up of the Test systems.

2.4 Planned Operational Maintenance

The productive CATS/SD/PS Systems are available 7*24 with the exception of normal maintenance windows on Sundays. Once a year, usually during Easter, there is a longer maintenance window, between 6 am and 9 pm

Enlarged maintenance windows may be needed. Point in time and length of the down time will be announced at the minimum 2 weeks in advance. Maintenance that affects availability of the systems at the end of the month or at the end of the year will be avoided.

Schedule B: Support helpdesk

The Service Desk is the primary point of contact for all calls. Its goal is to facilitate the restoration of normal operational services with minimal impact on the customer within the scope of the agreed service levels and business priorities. The Service Desk receives records and classifies incidents from Users and Key Users (Super Users). The recording of Incidents is performed using the agreed Case Tool. The Service Desk gives initial support. If there is a known solution or work-around to the incident, it is provided to the User.

B1 Support case tool

All CATS/PS/SD/COPA related issues will be logged in the VOLVO IT case management system VINST by the issuer or by VOLVO IT. The issuer receives a response that the case has been received together with a reference number and information about what severity level the case has been classified to. VOLVO IT confirms to issuer and commits to have assigned a resource and a severity level according to the definitions and agreed time frames.

B2 Contact information

2.1 2nd level support

Support cases must be reported to the VOLVO IT SAP Support via VINST.

Gothenburg:
E-mail: sapr3@Volvo.com
Phone: +46 31 66 51 60

2.2 3rd Level Support

SAP is providing the 3rd level support. VOLVO IT is the link to SAP for questions related to Support, Maintenance and Enhancement services.

Schedule C: Performance tracking and reporting

C1 Key performance indicators

The following Key Performance Indicators will be used for the SAP PAUS solution if requested by VTEC:

Incoming cases per type (incident, request, question):

Reporting number of incoming cases per type/severity level.

Resolved cases per type:

Number of resolved cases per type/severity level.

Response time:

Per severity level.

Resolution time for incidents:

Per severity level

Support
Response time
-Severity 1 (Major)
-Severity 2 (High)
-Severity 3 (Medium)
-Severity 4 (Low)
Resolution time
-Severity 1 (Major)
-Severity 2 (High)
-Severity 3 (Medium)
-Severity 4 (Low)

Reporting

VOLVO IT is responsible for reporting and follow-up to the CUSTOMER of all work commissioned through VOLVO IT, independent on whether the work has been carried out by own or by VOLVO IT contracted personnel. Below activities is not connected to the KPI reports.

Overall

- Financial follow-up
- Quality disturbances
- New development

Maintenance

- Transport Packages
 - OSS notes implemented
 - Proactive activities
 - Cleaning activities
-

Assignment 2

Solution: HR MASTER

Application specification questions

5. Which application was the assignment for?

Answer: HR MASTER (HRT)

6. Which company is the assignment for?

Answer: VOLVO GROUP HQ

7. What was the assignments duration and scope?

Answer: Assignment is yearly based and reconducted every year

Cost related questions

10. How much was the maintenance and ongoing costs for the M&S assignments?

Answer: Support : 2,9MSeK / Maintenance : 10,5 MSeK / Total = 13, 4 MSeK

11. How much was the annual total software costs related to the SAP system?

Answer: if you mean licence : I have no clue that's handle centrally by IT Gov.

12. How much was the annual total hardware costs related to the SAP system

Answer: 9,26 MSeK

13. How much was the annual total implementation costs related to the SAP system

Answer: I have no idea of the HRT project costs . Should be asked to the Program Manager

14. How much was the annual training costs related to the SAP system

Answer: No training on the IT side. No clue for the business side.

15. How much is the vendor support cost? 20% of license cost?

Answer: no clue.

16. Does the company measure indirect costs, such as user operation and downtime, if so how much are they (See definition of end-user operation at bottom of page 6)?

Answer: no

17. How much was planned and unplanned downtime?

Answer: 90% planned / 10%

18. How many FTE's were used in the assignment, and if it's possible sorted after staff functionality, i.e. Maintenance management, support, ABAP etc

Answer:

Maintenance management = ~ 2FTE
Support : 3 FTE
Maintenance : 8 FTE

Business related questions

4. How many named SAP users does the company have (licenses)?

Answer: on HRT soon 45 000

5. How would you rate the company's level of organizational change related to average?

Answer: no so good ☺

6. How complex is the business processes?

Answer: **Medium. Sometimes the process does not exist and then it is complex.**

8. Production code complexity (plants / production codes)

Answer: Low.

System related questions

10. How does the system architecture look like? Is it central/de-central, linked or consolidated system landscape?

Answer: Core system with a lot of interfaces (up to 100 interfaces)

11. How much functionality is utilized and how many modules does the company have implemented and which are they?

Answer:

HR PA OM for all

Time for US and FR and KR

Payroll for Korea and partially for FR (rest is outsourced)

Benefits for US and KR

Training for KR

Portal for all

BW for SE

Websphere broker for SE

Mailforms for SE

12. How many total systems does the company have in use?

Answer: with are using 18 servers for HRT (dev, qual, prod. Etc...)

13. How many company codes do they have?

Answer: too many : the target is all the company codes of the Volvo Group.

14. How many enhancement projects have been carried out during the assignment mission?

Answer: Up to 100

15. How old is the system?

Answer: 5-6 years

16. How many instances does the company have?

Answer: one productive instance.

17. How many customizations have been done, if it's not measurable more or less than average?

Answer: Thousands...

18. How much effort has been invested in knowledge transfer activities due to lack of system documentation?

Answer: a lot and it is not finished...

Infrastructure related questions

5. Does the company have a high availability system?

Answer: Yes

6. Do they have a back-up and/or a disaster recovery system?

Answer: Yes

7. Do the company use Windows, UNIX, others or mixed system landscape?

Answer: yes

8. How many percent of the landscape is aligned to standard.

Answer: 95 %

Service level related questions

3. What level of support was agreed on in the SLA for the M&S assignment? (24/7 help desk, multilingual, system performance such as response time and % uptime)

Answer: all of this.

Assignment 3

Solution: SCORE (STEP1)

Application specification questions

9. Which application was the assignment for?

Answer: SCORE (Step 1)

10. Which company is the assignment for?

Answer: VOLVO 3P

11. What was the assignments duration and scope?

Answer: Score Step 1A = Time Reporting and hours follow up is in production since May 2005. Score step 1B = Follow up of actual and committed costs is in production since July 2006. Score Step 1C = Budget and planning process is in production since October 2006.

Score Step 2 project = Resource management & Project scheduling, Comparison between capacity & forecast to manage resources is on-going. The go-live is schedule for July 2008 and the hand over to the maintenance is planned from September until December 2008.

The Score Step 3 = Resource management & Project scheduling, Organization setup planner will follow the step 2 project.

Cost related questions

19. How much was the maintenance and ongoing costs for the M&S assignments?

Answer: Cost for the Maintenance and support of the Score application = 7150 Ksek.

20. How much was the annual total software costs related to the SAP system?

Answer: The Operation service as per this Assignment Specification is 3000 Ksek.

This includes the software, hardware and operations costs for a year.

21. How much was the annual total hardware costs related to the SAP system

Answer: see Question 2 of this chapter

22. How much was the annual total implementation costs related to the SAP system

Answer: In my opinion the costs related to the implementation of the SAP system was included in the project costs once. The yearly support and maintenance of this are included in the Total I&O costs for a year (see Question 2 of this chapter).

23. How much was the annual training costs related to the SAP system

Answer: The Training costs related to SAP system were also in my opinion part of the project costs.

24. How much is the vendor support cost? 20% of license cost?

Answer: Unknown at the application level. These costs are centralized at the GSAP level and certainly spitted between each customer (to be confirmed by Erwan Durand).

The Licenses costs are invoiced directly the 3P.

25. Does the company measure indirect costs, such as user operation and downtime, if so how much are they (See definition of end-user operation at bottom of page 6)?

Answer: I don't know if Volvo 3P measures these types of costs. In nearly three years the System has never been down (unplanned downtime). Each planned downtime have been done during the Maintenance Window specified in the SLA.

26. How much was planned and unplanned downtime?

Answer:

The cpu resources (db included) shall be available without fault **99,9%** during opening hours measured over a period of rolling 13 weeks. The availability is measured at the server, not end user. The servers have scheduled maintenance hours on Sundays **17:00 until 21:00** (CET). A warning is sent to customer when there is time for scheduled maintenance at latest 24h in advance to "application owner". NOTE! that infrastructure is not included in the availability measure.

SCORE processes shall be available without fault **99.6%** during the opening hours measured over a period of rolling 13 weeks. If the server/database etc is up 100%, **SCORE** process should be **99,7%**. The availability is measured at the server, not at the end users position. The availability will be measured manually by Volvo IT through **SCORE** log files. Downtime caused by the servers, database is included in the availability for **SCORE**

Total (servers and SCORE)

As **SCORE** processes wont work without the base installation of **SCORE**, server, database etc, the total availability will be **99.5% (99,9% of 99,6%)**. All together the system downtime should be max 28 min/ week, measured over a period of rolling 13 weeks during opening hours.

Measurement: Data provided by monitoring tools.

Goal value: > 99,5 %

How many FTE's were used in the assignment, and if it's possible sorted after staff functionality, i.e. Maintenance management, support, ABAP etc

Answer: Maintenance management 1 FTE, Support 1 FTE, Maintenance (support Level 3, bug fixing, Abap): 3 FTE

Business related questions

7. How many named SAP users does the company have (licenses)?

Answer: 3700

8. How would you rate the company's level of organizational change related to average?

Answer: Volvo 3P is a Global Business Unit. I think that this company's level of organizational change is medium (on a scale of 5 I would rate 3).

9. How complex is the business processes?

Answer: The Business processes are very complex with 3P.

12. Production code complexity (plants / production codes)

Answer: The Production code is therefore quite complex too.

I mean in this that the specifics developed for Volvo 3P in Score are Complex.

System related questions

19. How does the system architecture look like? Is it central/de-central, linked or consolidated system landscape?

Answer: The Score system architecture is quite complex. There is one core system called PSP 500 (Score) which is linked to several other SAP applications (HRT, MF) or non SAP system(VCD, BOSS, JENA, EDB, GPS ...) by several interfaces (in-going or out-going) and ALE Link. There is a web interface and a Global BW system linked to Score also.

PSP 500 (Score) is the referential system for the project, HRT is the referential system for the Human Resources data and MF for the financial costs. All these data are "consolidated" in Score.

20. How much functionality is utilized and how many modules does the company have implemented and which are they?

Answer: Modules implemented: FI, CO, PS, MM, HR (PA/OM) and CATS. BW

Functionalities: Time Tracking, Project Structure/Definition, Actual posting, Transfer CATS to CO, Payment plan, Budget definition/follow up, Copy Actual to plan...

21. How many total systems does the company have in use?

Answer: There is a development (PSD), a Qualification (PSA), maintenance (PSM) and a production system (PSP). For R3 system.

A Dev (AVD), Qualification (AVA) and production (AVP) system for BW.

22. How many company codes do they have?

Answer: Seven (FR46, US10, US45, SE26, BR03, AU04, IN01)

23. How many enhancement projects have been carried out during the assignment mission?

Answer: 36 Enhancements + 5 Score project Roll out.

24. How old is the system?

Answer: May 2005

25. How many instances does the company have?

Answer: PSD 700 Sand Box, 120 Unit tests clients

PSA 200 Integration reference IMG, Data 210 Integration Tests, 400 User acceptance

PSM 500 Non regression test Emergency request

PSP 500 production

26. How many customizations have been done, if it's not measurable more or less than average?

Answer: more than average

27. How much effort has been invested in knowledge transfer activities due to lack of system documentation?

Answer: In the project phase the Knowledge transfer has been done to the 3P Key Users.

The Key Users were in charge of producing the documentation towards the end users. Some documents have been issued from the maintenance to the Key Users to clarify the use of some programs or processes.

The system documentation came from the project to the maintenance. This documentation was rather of good quality and the documentation which has been produced on the maintenance side since the handover was associated to Bug fixing or enhancements.

Infrastructure related questions

9. Does the company have a high availability system?

Answer: *Availability of Operation - Define the application AND/OR I/O availability.*

99.50 - combined CPU & application (see definition Schedule E)

Opening hours will be: 5*18.5 (Mo-Fri 06:30AM to 01:00 AM. However, outside these hours, system will remain on duty except 1 hour daily stop for night batches, but operational excellence can not be guaranteed).

Availability support – Operation 2nd level support – UNIX.

Technical support hours – 24 hours 7 days/week

(GOT VTC UNIX BO)

10. Do they have a back-up and/or a disaster recovery system?

Answer: yes

11. Do the company use Windows, UNIX, others or mixed system landscape?

Answer: Internet Explorer v6.0 or more (ITS Web interface for CATS), MyPlace, SAP GUI versions 620 patch 55, UNIX, Windows.

12. How many percent of the landscape is aligned to standard.

Answer: In Score there is 70 % of Standard and 30% of specific development.

Service level related questions

4. What level of support was agreed on in the SLA for the M&S assignment? (24/7 help desk, multilingual, system performance such as response time and % uptime)

Answer:

1st Level Support – (Back Office only)

Back Office

Working in conjunction with the central Help Desk and user support operation, back office support will resolve user problems and undertake planned activities that cannot be solved by the Help Desk. Volvo IT back office support takes care of all desktop hardware, peripherals, operating systems, mail and messaging applications and office productivity tools. Volvo IT engineers operate to a defined, measurable and enforceable SLA.

2nd Level Support

2nd Level Support is a support service that deals with incidents routed from Back Office or Key users. Service can be extended. The 2nd Level Support Service includes incident resolution. (*Incident: Any event that is not part of the standard operation of a service and that causes, or may cause, an interruption to, or a reduction in, the quality of that service).*

Availability support - Application

Application	Definition
Back office support <i>(GLB SCORE BO)</i>	Level 1 – Front Desk Back Office : 8am to 5pm local time - French for LYN - Swedish, for GOT - English for USA <u>- Brazil:</u> 08.00 – 17.00 local Time handled from France from 08:00 to 11:00 and from the US from 11:00 to 17:00 - Language: English <u>- India:</u> 08.00 – 17.00 local time : handled from China from 08:00 to 14:30 and from France 14:30 to 17:00 - Language: English <u>- Australia:</u> 10.00 – 17.00 local Time handled from China - Language: English

2nd level support <i>(LYN SAP SCORE 2nd)</i>	<p>Level 2 – Volvo IT Experts: Office hours during working days</p> <ul style="list-style-type: none"> - Europe : 08.00 – 17.00 CET - US : 08.00 – 17.00 EST <p>Except for month-end closing (2nd working day of the month) :</p> <ul style="list-style-type: none"> - Europe : 08.00 – 19.00 CET - USA : 08.00 – 17.00 EST <p>Should the closing date be changed, Volvo IT has to be informed at least 10 days before, in order to be able to provide this extended support at the new closing date.</p>

Service level - As related to 2nd level support organization

Service level	Application	Comments
<i>Resolution time and rate – Severity level according to VINST</i>		
Resolution Time / Rate, Severe	24 h / 80%	In certain cases, workarounds could be provided until complete resolution of the problem.
Resolution Time / Rate, Major	48 h / 80%	In certain cases, workarounds could be provided until complete resolution of the problem.
Resolution Time / Rate, Minor	120 h / 90%	In certain cases, workarounds could be provided until complete resolution of the problem.
Resolution Time / Rate, Minimal	Best effort	