UNIVERSITY OF GOTHENBURG

The Importance of Quality Attributes in Enterprise Resource Planning Selection for Small Companies - A Case Study

Bachelor of Science Thesis Software Engineering and Management

DAVID GREGORY

The Importance of Quality Attributes in Enterprise Resource Planning Selection for Small Companies - A Case Study

DAVID GREGORY

© DAVID GREGORY , June 2014.

The Importance of Quality Attributes in Enterprise Resource Planning Selection for Small Companies - A Case Study

David Gregory
Software Engineering & Management
University of Gothenburg
Gothenburg, Sweden
David_gregory60@hotmail.com

Abstract

During the last ten years, Enterprise Resource Planning (ERP) systems have become one of the most important pieces of technology for companies, assisting in streamlining a company's information infrastructure. As vendor technology has improved, this has led to the possibility of small companies being offered ERP solutions to implement and integrate into their existing systems, or to buy an ERP system 'off the shelf'. All too often companies select an ERP without looking into what the needs of the company are, and particularly the Quality Attributes (QA) of a system are ignored. Identifying these attributes could assist small companies and vendors in assessing, choosing, and implementing the correct systems in the future. This study examines the QA associated with ERP systems, paying particular attention to the QA associated with ERP systems for small companies. This paper will use interviews, related work, and a thematic analysis to identify Quality Attributes, and identify which are the perceived Quality Attributes for staff at a small company, and discuss if the attributes found are useful to small companies when choosing an ERP system.

1. Introduction

Today, many small companies face the challenge of increased competition, increased customer expectations, and an expanding company. Customers are becoming more demanding, and looking for the most up to date products. Small companies must seek out the most up to date technology to keep existing customers and attract new customers. As a result, technology must be updated, quality improved, and processes streamlined, so that a company can offer customers the best possible service and solutions, and also be as competitive as possible in their particular market. Willis et al [45] present the fact that many small companies are considering the possibility of implementing an ERP, but realise that this is a complex process.

An Enterprise Resource Planning system, or ERP, is business management software, which can assist a company in storing and managing data. Brady et al [11] highlight that ERPs help a company in operating business processes, by integrating areas such as sales, marketing, staffing administration and issues, and accounting. ERP systems also assist in managing information company wide, via a shared database, and shared management tools. Watson & Schneider [43] describe ERPs as a term for an integrated enterprise computing system, whilst Gable [25] amongst others describes an ERP as a number of integrated applications usually consisting of areas such as marketing, logistics, finance, and human resources. There are now many suppliers of ERP systems in the market, all offering different products and packages. As technology advances and small companies realise the importance of implementing more advanced systems, vendors are now turning their attention to smaller companies offering cheaper solutions. The process of choosing a new ERP involves considering many internal and external factors, which can affect selection, as well as considering the quality attributes of a new system.

When choosing and implementing a new ERP, there are various papers and studies that support how important QAs are in the process.
As more small businesses realise the importance of investing in an ERP, Umble et al [41] discuss the point that small companies are generally inexperienced with ERPs, there are many vendors available on the market, and there are many factors to consider, which makes it very difficult for a small company to make an informed decision. As a result, an ERP system may be purchased that does not

address a small company's QA requirements, and could result in a costly implementation failure, or the company ends up with a system that does not fit the company's needs. A study in this area will help companies of every size, but particularly small companies, look at factors to consider, in this case QAs of an ERP, so that companies can investigate more thoroughly which ERP they should choose. This could save a small company time and costs for research and consultants. It is important to research this area of QA, because many researchers focus on using the ISO standard 9126 model for evaluating software. Fahmy et al [23] have mentioned that the ISO Standard 9126 model can be used to assess any software tool, but can sometimes be too general, so it is important to research if 9126 is a suitable model for assessing QAs for ERP. Patchara & Yang [37] have created a QA model for selecting an ERP, however their research focused on 2 companies in China, and the research included medium sized companies as well. This paper will focus on a small company in Gothenburg (validity threats are covered in section 3.5) , Sweden, benefitting small companies based in Sweden and Europe, using the Patchara & Yang model as an evaluation tool.

In this paper we conducted a case study at a company with 15 employees, with the aim of investigating which QAs are perceived as important by employees at a small company. This research will assist small companies as a whole, to make more informed and accurate decisions when choosing new systems. The research was carried out and data collected by interviewing employees. The 15 members of staff were divided into the following departments: IT Management, the CEO and Business Product Manager, Sales and Marketing, The Program Coordinators, the Business Area Managers, and lastly the finance department. After the interviews, the data was analysed and extracted using thematic analysis detailed by Braun & Clarke [13] to answer the research question.

This paper consists of a related work section, research methodology section including a case company description, results section, discussion, and a conclusion.

2. Related Work

This section will present the main software models which will be used in our thesis to assess QAs, as well as presenting other software models. The concepts within the main software models will be presented and discussed to see how they relate to each other and how they will be used in this study. Also, relevant work which has been carried out in other studies in similar areas will be briefly presented and discussed.

A QA according to Chung et al [18] is a quality aspect of a software system that can also be called a non-functional requirement. There are several QA models that are used for assessing the quality of software. Listed below are some of the more commonly used models, with an explanation of what they are.

ISO standard 9126 [28] consists of 6 characteristics and 27 sub-characteristics. ISO standard 9126 defines the 6 characteristics of the quality model as follows:

- Functionality is the capability of the software to provide functions which meet the stated and implied needs of users under specified conditions of usage.
- Reliability is the capability of software to maintain a certain level of performance for a certain level of time.
- Usability is the capability of the software to be the effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments.
- Efficiency is the relationship between the level of performance of the software and the amount of resources used, under stated conditions
- Maintainability is defined as the ease and ability to identify and fix a fault within the system.
- Portability is defined as the ability to transfer software from one environment to another.

Other quality models exist for assessing the quality of software. Alrawashdeh et al [2] discussed the following four models during their research, and we will give a brief overview of the models and why they were not used in this study.

McCall's quality model [34] assesses the quality of software through three levels. The first level consists of 11 factors which represent the external or customers view. The second level consists of 23 quality criteria for the quality factors. This represents the internal or developers view. The third level provides a set of matrices to measure the quality criteria. Behkamal et al [5] argue disadvantages with the McCall model are that not all the matrices are objectives and many are subjective, and the functionality of the software is not present.

Boehm's quality model [10] is closely based on McCall's model with a similar hierarchical structure. Panovski [36] argues that a disadvantage of Boehm's model is that it does not present an approach to assess the characteristics it presents.

The FURPS model [26] looks at Functionality, Usability, Reliability, Performance, and Supportability. Al-Qutaish [1] discusses the fact that FURPS does not cover the characteristic of portability, so is not a complete model, in comparison with the ISO Standard 9126 model.

Dromey's model [21] builds on the ISO 9126 model by adding two further characteristics, which are then divided into three categories. These are requirement quality, design quality, and implementation quality. Fahmy et al [23] highlight the disadvantage that the reliability and maintainability characteristics of Dromey's model cannot be assessed before the software is actually implemented.

Fahmy et al [23] argue that the ISO standard 9126 model can be used to evaluate the quality of any software product, however Fahmy et al [23] believe the standard can be too general.
Carvallo and Franch [16] find the ISO standard 9126 can be a little too flexible in some circumstances.

Jacobs [29] argues that the handling and balance of QA are important in the requirements engineering process, whilst Chung et al [18] highlight the fact that QA play a critical role in software development. Chung et al [18] also argue that QA are often misunderstood in comparison to other less critical aspects of software development. Cysneiros & Leite [19] discuss the fact that ineffective handling of QA can lead to more expensive software and a longer time-to-market. Berntsson Svensson et al [7] discuss the fact that decisions about what QA to state on a product have an effect on the choice of architecture and development project. This helps establish which dependencies there are between QA. Berntsson Svensson et al [7] also argue that creating a product which meets customers' requirements will substantially increase the chance of success in the market. Mukti et al [35] maintain that internal and external QAs must be addressed when choosing and implementing a new ERP system if it is to be a success. Mukti et al [35] also discuss that vendors tend to offer the same product regardless of size, ignoring the QAs small business have or need to address.

Patchara & Yang [37] in their study identify 6 characteristics and 10 sub-characteristics (detailed in figure 1.1 opposite), which are slightly different to ISO standard 9126. What is important about this particular model is that it is specifically tailored for QAs for ERPs.

Patchara & Yang [37] believe that small companies should enquire about the three sub - characteristics of vendor credentials, as those particular sub-characteristics can give an impression of how good a vendor is. The sub-characteristics are vendor reputation, market share, and demonstrations of previous implementations.

Patchara & Yang [37] also argue that the financing option and its sub-characteristics, particularly implementation costs, come very high up in the decision making process for small companies, when selecting a new ERP. Patchara & Yang [37] use the Analytic Hierarchy Process (AHP) to analyse their results.

Figure 1.1 Patchara and Yang's software model

Characteristic	Sub-Characteristic
Vendor Credentials	Vendor Reputation Market Share Demonstrations of previous implementations
Financing Option	Software Cost Consulting & Maintenance Upgrade Cost How to pay for the Investment (Time and Way)
Maintenance	After Sale Service and Training Updating and Inquiries
Functionality	
Flexibility	Customisation
Implementation	Ease of Integration

There are several studies which have been carried out, researching how quality attributes affect the selection of ERPs.

Sarkis and Sundarraj [40] argue that existing ERP packages cannot provide a ' one size fits all' for every process of every industry, which leads Wei et al [44] to emphasise this point by stating that a company must choose a vendor and an ERP system that is flexible and responds to customer needs. Markus [33] and Brandyberry et al [12] highlight the fact that if a company adopts too many integrated technologies, it becomes less flexible and harder to 'disconnect' itself. Uwizeyemungu & Raymond [42] counter these views by arguing that integrated processes allow for quicker sharing of new information, which means a company can respond quicker to change, and increase the company's flexibility. Barki and Pinsonneault [4] argue that integration is the most important characteristic. Caldas and Wood [15] believe that integration distinguishes ERP systems from Information systems (IS) because ISs often fragment information creating a set of subsystems that

cannot communicate with each other, or communicate with each other with great difficulty.

Ram et al [38] argue that QAs such as flexibility, reliability, ease of access, and integration have a significant bearing on the quality of information produced by using the ERP. Furthermore, Ram et al [38] maintain that a company cannot influence QAs in an ERP, so need to work closely together with developers to ensure the best product is produced.

Fan & Chen [24] believe using the vendor consultants as much as possible, for a smooth transition and customisation is important. Fan & Chen [24] also discuss choosing the correct vendor, and warn against attempting to build an ERP within the company, especially if the company has limited financial and human resources.

Langenwalter [31] asserts that price, time, and vendor support are the most important factors when choosing an ERP. Butler [14] continues the price theme by adding that on top of the initial investment cost, maintenance costs, and human resources costs can be very expensive for companies when adopting an ERP. Everdingen et al. [22] researched that the supplier and the software system are the major attributes when looking at a new ERP. This research however was more geared towards medium sized businesses. Holland and Light [27] found that a company can experience difficulties when trying to integrate existing systems with the new ERP system.

There have been a few studies carried out, researching how a small company carries out selection of an ERP.

Bernroider & Koch [6] in their study, claim the attributes of operating system independency, process improvement, market vendor position, customer and supplier needs, internationality of software, increased organisational flexibility, guidelines from a controlling company, improved innovation capabilities, and good support should be the criteria that small and medium sized companies base their selection decisions on.

As a difference from other studies, we will look at the QAs from Patchara & Yang's model, as well as the ISO standard 9126 model, regarding ERP selection, and apply it solely to a small company. The majority of other studies focus on large companies, or medium and small companies.

3. Research Methodology

The chosen method to carry out this research was the case study. Cresswell [19] describes the case study as a qualitative approach where the author or researcher often makes claims based on the findings of constructivist perspectives. The researcher also can collect primary data,

and analyse the data to create patterns. Cresswell [19] also emphasises that qualitative procedures rely on data and images, and have unique steps in the data analysis. The case study also involves a certain level of interaction between the researcher and the company, and quite often, the researcher spending a large amount of time at the case study company, being able to ask follow up questions, and look deeper into research areas if required.

The case study method explained above, can be combined with Yin's [47] explanations that a case study can form the basis of research for a typical, critical or deviant case, and the case study can assist in testing a formulated theory. Yin [47] also believes the case study method will allow existing research to be confirmed or disputed, and allow new hypothesis to be brought forwards. With the case study method and theories, we believe the following research question can be answered.

RQ: What are the perceived quality attributes in an ERP for employees at a small company?

3.1 Case Company Description

Chalmers Professional Education (CPE) was suitable for this case study as CPE was looking into to upgrading to an ERP system and wanted research carried out in this area. As CPE is a small company, it was possible to gain as much empirical data as possible by interviewing the different departments in groups, because the different groups all use the current system and have views they would like to share. The author also chose this particular company as he believes that Chalmers Professional Education was be able to provide him with the information he was looking for to carry out the research.

CPE was founded in June 2010 when 2 the different units of Chalmers Advanced Management Programs (CHAMPS) and the Maritime Waypoint merged. CHAMPS was founded in 1989 and has given education in such areas as strategy, and project management, and Maritime Waypoint was founded in 2000, and has given various educations in subjects such as shipping, and cargo handling.

CPE is a part of Chalmers University of Technology's organisation and offers tailored education of professionals in industry. CPE offers open and in-company educational programs and seminars for directors and co-workers in the main fields of Executive, Industrial engineering, Shipping,

Energy and Built Environment. The programs are designed with the specific industry's needs and requirements in mind.

CPE has a long term strategy to offer educational programs in all of Chalmers areas of expertise. CPE has an aim to provide industry with world-leading knowledge in technology-related knowledge areas.

The long term strategy is to make educational programs available in all of Chalmers' areas of advance, which are: Energy, Information and Communication Technology, Life Sciences, Material Science, Nanoscience and Nanotechnology, Production, Built Environment, and Transport.

The philosophy of the company has 4 key points as well as wanting to offer the latest and most relevant high-quality education:

- **Generating business utility**
  Individual competence is developed and programmes are offered that directly increase positive business influence.

- **Contributing to long-term and sustainable growth**
  The programmes offered convey knowledge and develop abilities that add to the customers' capacities for conducting economically, socially and ecologically sustainable business activity.

- **Access to the best knowledge**
  CPE is committed to customers' need for development, and has access to a global network of subject experts in both academia and companies. The situation determines what the best knowledge is and who the right expert is for each occasion. Sometimes a local consultant is needed, sometimes an international authority on a particular subject.

- **Accessing knowledge through the best pedagogy**
  CPE offers a broad spectrum of pedagogical arrangements for conveying and exploiting knowledge in the best way for each particular customer. CPE excels in understanding the customer's needs and designing educational activities with high effectiveness.

CPE is based at Lindholmen, Gothenburg and currently employs 15 permanent staff. There is a sales team of approximately 8 students who work part time. The staff are divided up into the following departments:

-Management

-IT
-Program Coordinators
-Sales and Marketing
-Business Area Managers
-Finance

The current system at CPE is approximately 10 years old. This system interacts with a number of other systems and tools, which are not integrated, so sometimes information must be manually input across all the various systems and tools. To be able to expand and compete in the future whilst offering the best services to customers, CPE realises that it must invest in a new system, and has chosen to investigate the possibility of an ERP.

3.2 Planning/Selection

To gain as much varied data as possible, the interviews were divided into five groups. The groups correspond to the departments that exist within the company, namely (1) IT Management, the CEO, and Business Product Manager, (2) Sales and Marketing, (3) the Program Coordinators, (4) the Business Area Managers, and lastly (5) the finance department. Each group contained exactly three people. The intention with the group size was also cut out the chance of bias, taking such a wide cross section of the company. Kitzinger & Barbour [30] add that groups of this size can discuss issues with each other, with the researcher facilitating discussions, and the groups can discuss a specific set of issues, and the group interaction will generate data. If the groups were any bigger, some people may have remained silent during the interview and not contributed, whilst others may have talked for too long. This would not be a good representation of the groups' thoughts and ideas. The groups were also formed into specific departments, so that the employees could share and discuss ideas and problems specifically related to their section.

The interviews have been designed this way to encourage the employees to speak openly and honestly about what they think about the old system, the possible new ERP, and any other issues they may have. As employees in the same field are sitting together being interviewed, they will brainstorm and bounce ideas off each other, which will lead to very productive interviews. With the guarantee of anonymity being interviewed in groups, employees will feel comfortable talking about these issues alongside their colleagues who may share similar thoughts. The interview questions were influenced and inspired by reading the research and case study paper of Andersson & Stekovic [3]. This paper focused on CRM systems, but asked pertinent questions, which could be modified for the purpose of our case study.

3.3 Data Collection

The interviews were semi-structured [39], which means the interviewees were asked a series of set questions and allowed to talk as freely as they like. Robson [39] believes the semi-structured interview for this type of qualitative research helps understand phenomena in their real life context. Berntsson Svensson et al [8] add to this that semi-structured interviews allow common information on pre-determined areas to be collected, as well as allowing the researcher to probe deeper if required. The questions were designed so that the author could ask the interviewees the questions listed in Appendix A, and then ask follow up questions to subtly move the interviewees into the areas of QA. Here data was recorded about technical issues, usability, training, thoughts about management, and any thoughts the employees had. The questions asked can be found in the appendix.

The interviews lasted between 40 and 60 minutes. Staff were asked to explain what their job entails, and then asked to walk through a typical usage of the current system in order to carry out their job. Staff were also be asked what they find to be important with an ERP system, the difficulties they have with the current system, and what they like and dislike about the current system. Staff were also asked what they would like to see in the new system. These questions were designed so that the employees would focus on the areas in which QAs are important, and would also assist in answering the research question.

The interviews took place in the spacious meeting room, which allows a projector to be used if necessary, and a white board for drawings and notes. The interviews were recorded and transcribed, and from this detailed notes were taken from the staff interviews to enable analysis and cross reference with all data collected from the related work section. After the interviews were transcribed, and notes taken, the employees were shown the notes, so that they could validate that the notes were an accurate representation of what they said.

3.4. Data Analysis

A qualitative six step thematic analysis [13] was carried out so that the QAs could be identified, and statements grouped for contrasting and comparison. Thematic analysis emphasizes pinpointing, examining, and recording patterns within the data received. The patterns and themes noticed in the data can become good starting points for categories for the thesis. Here we will be able to determine if there are any comparisons in Quality Attributes at Chalmers Professional Education, and the Quality Attributes found in the related work. The six steps are as follows:

Read and become familiar with the data. This was carried out by reviewing the research discovered in the related work section, and listening to the interviews again. Once the interviews had been listened to a first time, we listened a second time and transcribed the interviews. The transcriptions were read and re-read to so that initial notes and ideas could be made.
Generate codes or look for developing themes. At this stage we produced initial codes for the data. The transcriptions of the interviews were read and potential codes and themes were underlined. Once all the data had been read and coded, the data with the same code was collated together.
Combine codes into themes for further analysis. At this point a long list of codes had been generated. The codes then had to be sorted into themes. This was achieved by using mind-maps drawn on paper to sort the codes. Some codes formed themes and sub-themes, and other codes were discarded or kept as outliers.
Analyse how the themes support the data collected and tie in with the research questions. This stage of the method contained two parts. Firstly we re-read all the data extracts that fitted into each theme to ensure they formed a coherent pattern. The second stage involved considering each theme in relation to all the data collected as a whole. We looked if there were links between the themes and if the themes related to the research questions.
How the themes contribute to understanding the data. At this stage the themes were given names and defined, analysed, and explanations of why the themes were of relevance and interest were written. The themes were compared with the data collected from the related work section, to see if there were any differences or correlations, and we discussed why there were be differences and correlations.
Produce a comprehensive report. After all the data was gathered and analysed in the above five steps, a comprehensive thesis was written, detailing all findings, and explaining how the research was carried out.

3.5 Validity Threats

Cresswell [19] identifies four categories of validity threat.

Internal Validity - Cresswell [19] describes internal validity threats as treatments or experiences of the participants that could affect the relationship between treatment and outcome. Typical internal validity threats in a case study can be maturation, selection bias, and instrumentality. Maturation can happen when participants become more knowledgeable about a subject during the research and interviewing, and change their views. To counteract this, we kept interviews to a maximum of 60 minutes, by gathering as much related work information, and information about the present system as we could. To counteract selection bias, all 15 employees were

interviewed, so a complete overview of the company could be taken. Instrumentality was dealt with by basing the interview questions on a previously used case study in a similar area [3].

External Validity - External validity threats are defined by Cresswell [19] as when the researcher generalises the results, and applies the results to groups, situations or individuals outside of the study. Berntsson Svensson et al [8] add to this by emphasising that this does not happen very often, because the researcher is more concerned with proving a point with the study at hand. Berntsson Svensson et al [8] also include the fact that generalisation and theory development can assist in understanding other cases and situations. Chalmers Professional Education was selected because it fitted the criteria of the study (small company looking to choose an ERP system).

Conclusion Validity - Conclusion validity threats are the degree to which conclusions about the relationship among variables based on the data are correct or reasonable. Cresswell [19] describes conclusion threat validity as when researchers draw incorrect conclusions from the data i.e. finding a correlation between sets of data when there is none, or finding no correlation between sets of data when there is correlation. This was counteracted by using adequate interviewing, [39] questions [3] and analysis techniques [13].

Construct Validity - Cresswell [19] defines construct validity threats as when researchers inadequately define and measure variables. In our research the variables we chose were measured by interviewing employees at Chalmers Professional Education, with the use of semi-structured interviews. The validity threat was counteracted by using the theory of Wohlin et al [46], and gathering information from different areas on the subject of QAs and ERPs, this in turn stopped any mono-operation bias.

4. Results

In this section we present the results from the interviews carried out at Chalmers Professional Education.

4.1 Perceived Quality Attributes (RQ 1)

Usability - All groups mentioned usability as a key quality attribute for the new system. Features that were mentioned were having all information in one place under one system, to reduce having to have 4 or 5 interfaces active at the same time, and having one uniform method of inputting data to

reduce redundancy in the database. The groups were in agreement that there was too much manual inputting in too many systems, which led to data being lost.

All groups mentioned that information was scattered and not easy to find, and it is desirable for the new system to have clear icons and labels where information can be found easily. Continuing this theme, group 1 and group 4 thought it would be useful if all documents, correspondence, and information for projects could be generated and saved within the project. Group 5 highlighted the fact that there is no help section on the interface with the current system. If an employee becomes stuck, they have to ask the IT department for help. Group 2 discussed the possibility of keeping the various categories of employees and companies when the new system is used, because a lot of work had been carried out creating these categories. The categories could then be refined, so it is easy to find project leaders within target industries.

Group 1 mentioned that usability should extend to the customer as well, so the customer can also have a smooth experience when navigating the site or making a booking.

Functionality - Functionality and particularly traceability was viewed as important a factor as usability for the employees. Each group expressed a wish to have a dashboard or overview for each individual project, so that everybody can see what stage a project is at, what needs to be done, and what has been done by whom. This way, employees can take responsibility for their individual tasks, and update the dashboard accordingly when tasks are completed. Group 2 and group 4 suggested that the dashboard can be colour coded to correspond with the status of the various parts of the project. Group 2 also felt this would give more of a 'team feel' to projects, as well as inspiring ownership, and a teamwork mentality in general. Group 4 added that reminders and alerts could also be sent to improve traceability, although this could be counted under usability.

To tie in with usability, groups 1, 3, and 4 discussed that if correspondence for individuals and companies can be saved within a project, it is easier for employees to bring up the history if they talk to an individual or company they have never spoken to before. Employees can gain an overview of the situation straight away, as well as trace what colleagues have been working on.

Group 1 added that one password and username for the entire system would increase traceability, because employees could see what colleagues have done within all systems, because they only have one username.

Maintenance - Another quality attribute and key concern amongst employees was having a robust system. The present system is currently maintained and updated by one member of staff. The fear amongst all groups was, if that member of staff were away and the system crashed, no one would be able to fix the problem. The main point inside this

critical factor was covered by group 1, where the system should be able to cope with a single application failure, and should be quick and easy to fix if there are problems. Where necessary, the vendor should be able to assist at very short notice. Group 5 also felt it desirable to have a vendor who is local, and can offer the sub-characteristic of After Sale Service and Training.

Group 1 and group 2 also highlighted the importance of a robust system being able to streamline and improve data collection, with the possible assistance of the vendor (group 1). Group 2 and 3 believe this would help in targeting prospects. Group 2 also believes a robust system can give good statistics about which strategies work or not.

Portability - A critical quality attribute for the company itself and the nature of its work would be information sharing. This key factor has two parts. Firstly, there is the information sharing within Chalmers Professional Education itself, which all groups highlighted, and secondly there could be information sharing between Chalmers Professional Education and sister companies. Group 1 and group 3 highlighted the fact that there is a large amount of data that Chalmers Professional Education and the sister companies possess, which could be of great benefit to each other.

Ease of Integration - All groups are affected by this quality attribute in many different ways and have different solutions. Group 1, speaking from an IT and management perspective, think that data migration from the old to the new system should not be a problem. Also, from a management perspective, that the transition should be modular if possible, focusing on the real problem areas, which are the CRM, document servers and project portal. When other software is integrated, it can then be done gradually and smoothly.

Group 2 believes if there are multiple applications in the new system, they should be linked, and update automatically when another section is updated.

Group 3 was particularly interested in the possibility of data transfer between sister companies, to assist with targeting prospects on the sales and marketing side. To build on this, it is important to export data between applications and the new system, without losing any data. Groups 3, 4, and 5 also highlighted the fact that applications should be able to interact with the new system and update when the system updates, if the new system has to interact with applications.

Vendor Credentials - Group 5 expressed the wish to have a superuser present at the office, and to have a system customised from a company, not a system built 'in house'. Group 5 added that it was important to use the vendor's skills as much as possible, to ensure the system is as usable as possible for the staff. Group 1 also commented that the

vendor must be utilised properly, so that the systems can be integrated properly, and function as the staff want them to. Group 5 and group 1 discussed the point that having a vendor that is local or provides immediate support is also important if any problems occur.

5. Discussion

It can be argued that the findings from the study highlight the most important quality attributes in an ERP for employees at Chalmers Professional Education. The attributes are usability, functionality, maintenance, portability, ease of integration, and vendor credentials.

Furthermore, it can be argued, given the volume of information gathered from the interviews with employees at Chalmers Professional Education, that usability, functionality, and ease of integration are viewed as the three most important quality attributes from the six quality attributes discussed in the interviews. It is interesting to note that the research from the related work section, does not point to usability as being as important as the other QAs. Bevan [9] explains that usability is often only considered as ease of use in the user interface, and as such usability is viewed as an independent contribution to software quality. Chattopadhyay & Natrajan [17] also argue that usable software products are more popular with users.

Patchara & Yang recommend a two level process of assessment. Firstly, the characteristics of Vendor Credentials, Finance Option, maintenance, functionality, flexibility, and implementation should be looked at. After the characteristics have been assessed, then the sub-characteristics should then be assessed.

Usability affects every employee in a company who uses the system. If information is scattered and very difficult to find or extract and collate, this could lead to vital details being missed or lost. Equally, having systems and tools that are unconnected, leads to frustration amongst employees. It becomes a very time consuming task to manually update five or six different systems, instead of the systems updating automatically. If an ERP is user friendly and helpful, it can lead to increased productivity and reduce stress amongst employees. The ISO standard 1926 [28] contains usability as a characteristic, as does the FURPS model [26]. It can be argued here that Patchara & Yang's model characteristic of functionality can be compared to the ISO standard 9126 characteristic of usability.

Ease of integration can be linked to usability, as a fast and easy customisation and integration is of particular importance, so that a company can begin education and use

of the new system as quickly as possible. Loh and Koh [32] emphasise this point by stating that the ERP should be integrated and provide seamless data flow between all modules, thus increasing operational transparency. Companies have to be wary that too much customisation of an ERP can lead to difficulties updating the system in the future. This is in agreement with Markus [33] and Brandyberry et al [12], who stated that too much integration means a company becomes less flexible, and Barki and Pinsonneault [4] who believe integration is the most important feature of an ERP. Uwizeyemungu & Raymond [42] countered these views however, saying that increasing integration actually increases a company's flexibility and ability to respond to change.

Functionality can also be linked to usability, in that employees can see what has been done and what needs to be done in a certain project, as well as being able to trace particular details of a project, and being able to see who has done what. It can be argued that traceability can also increase productivity, as less time is spent searching for details, documents, and history of a project or correspondence when everything can be found in one place. Another important point from this quality attribute was mentioned in one of the interviews. Traceability promotes a team feeling, ownership, and responsibility. Caldas & Wood [15] support this by linking integration of systems with functionality, arguing that integrated ERP systems reduce fragmentation allowing better communication between subsystems.

Vendor credentials supports the views offered by Ram et al [38] that a company cannot influence QAs in an ERP and needs to work closely with the vendor. Fan & Chen [24] and Langenwalter [31] also name vendor credentials and support as the most important attribute, but Langenwalter also names price as an important attribute. It was noteworthy that the finance option did not appear in interviews. Small companies usually do not have the budget available that large companies do, but in this particular case, perhaps budget is not an issue.

The author's findings are similar to the model presented by Patchara & Yang, in the fact that the characteristics of implementation, flexibility, functionality, and maintenance are discussed in the interviews. These compliment the findings from the interviews of usability, maintenance, information sharing, system integration, and vendor credentials.

The author's research also has similarities with the ISO 9126 standard. The findings from the interviews of usability, robustness, information sharing, system integration, and vendor cooperation, compliment the characteristics of usability, reliability, portability and maintainability from the ISO 9126 standard.

6. Conclusion

The purpose of this study was to identify which QA are important when selecting a new ERP system, and which QA are perceived as important by staff at a small company. Based on our related work and empirical findings, the following points can be concluded.

To have the greatest chance of choosing the correct system, a company must look at which ERP closely matches the specific needs of the employees and the company as a whole. It does not matter how small or large a company is, for the company to choose the correct system, the research from our study suggests following the models presented by Patchara & Yang [37] and the ISO 9126 model [28], will give a company a very good indication of whether the ERP is suitable for them or not.

The author believes from the interviews and research carried out, that for small companies, it would be far better to follow the Patchara & Yang model, than the ISO model, at least when initially assessing an ERPs suitability. It can be argued here that although the ISO model contains more sub-characteristics, so can complete a more detailed assessment, it seems more geared towards medium and large companies.

We also conclude from this case study that we found all of the characteristics from Patchara & Yang's model present at Chalmers Professional Education, so it may suggest that small companies, medium companies, and even large companies should focus on the same QAs when choosing a new ERP system. It could be a case of looking into the same QAs but scaling up or down, depending on the size of the company, when it comes to a QA such as the Financing Option.

Certainly regarding Chalmers Professional Education, the focus seemed very much on usability, functionality, integration, and to a certain extent customisation, in comparison to the other characteristics and sub-characteristics discussed and discovered during the research carried out. These details assisted in answering the research question 'What are the perceived quality attributes for employees at a small sized company'.

6.1 Future Research

The study was carried out in this particular area, because we felt that there was a lack of studies which could assist small companies in choosing an ERP. As business and technology are developing in a way where streamlined processes are crucial for offering the best product, small companies may become lost in the ERP market.

We believe further research on QAs for small companies when choosing an ERP would benefit the industry as a whole, because more information can be gathered and compared, and a deeper insight offered within this area. Small companies can make better informed decisions, and vendors can offer a more specific product to small companies.

Further studies could also be carried out on the 2 models used to research quality attributes for small companies. The ISO 9126 model and the model presented by Patchara & Yang offer interesting characteristics that companies should consider. Research could also look at whether one model is more suitable for larger companies, and the other more suitable for smaller companies.

The last area of further research could be a study into ERP systems vs Customer Relationship Management (CRM) systems for small companies. A study into which system a small company actually requires, and the QAs associated with each system would be very beneficial.

7. Acknowledgements

8. References

[1] Al-Qutaish, R. E. (2010). Quality Models in Software Engineering Literature: An Analytical and Comparative Study. *Journal of American Science Volume 6*, Number 3.

[2] Alrawashdeh, A., Muhairat, M.,and Althunibat,A. International Journal of Ambient Systems and Applications (IJASA) Vol.1, No.1, March 2013.

[3] Andersson, L., Stekovic, K. (2011). Factors associated with success and failure in CRM system use. A case study of the sales department in a B2B. Linnaeus University.

[4] Barki, H. and Pinsonneault, A. Explaining ERP implementation effort and benefits with organizational integration. *Cahiers du GreSI*, No. 02-01, 2002, 27 pages.

[5] Behkamal, B., Kahani. M., and Akbari, M. K. (2009). "Customizing ISO 9126 Quality Model For Evaluation Of B2B Applications", *Journal Information and Software Technology, vol. 51*, Issue 3.

[6] Bernroider, E. & Koch, S. (2001) ERP selection process in midsize and large organizations. *Business Process Management Journal.* Vol 7, Issue 3, pp 251-257.

[7] Berntsson Svensson,R. Höst, M., Regnell, R. Managing Quality Requirements: A Systematic Review. 2010 36th EUROMICRO Conference on Software Engineering and Advanced Applications.

[8] Berntsson Svensson, R., Gorschek, T., Regnell, B., Torkar, R., Shahrokni,A., and Robert Feldt, R. Quality Requirements in industrial Practice—An Extended Interview Study at Eleven Companies. IEEE Transactions on Software Engineering, VOL. 38, NO. 4, July/August 2012.

[9] Bevan, N. (1995). Measuring Usability as Quality of Use. Software Quality Journal, 4, 115-150.

[10] Boehm, B. W., Brown, J. R., Kaspar, H., Lipow, M., McLeod G. and Merritt, M. (1978). Characteristics Of Software Quality, *North Holland Publishing, Amsterdam*, The Netherlands.

[11] Brady, A Joseph, Monk, F. Ellen And Wagner J. Bret, (2001). *"Concepts in Enterprise Resource Planning",* Course Technology, a division of Thomson Learning, Inc.

[12] Brandyberry, A., Rai, A. and White, G.P. Intermediate performance impacts of advanced manufacturing technology systems: An empirical investigation. *Decision Sciences,* Vol. 30, No. 4, 1999, pp. 993-1020.

[13] Braun, Virginia & Victoria Clarke (2006). "Using thematic analysis in psychology". *Qualitative Research in Psychology* **3** (2): 93.

[14] Butler, J. (1999). Risk management skills needed in a packaged software environment. Information System Management 16(3), 15-20.

[15] Caldas, M.P. Wood Jr. T. How consultants can help organizations survive the ERP frenzy. *Academy of Management's Annual Meeting*, Chicago, august, 6th-11th, 1999.

[16] Carvallo, J.P., & Franch, Z. Extending the ISO/IEC 9126-1 Quality Model with Non-Technical Factors for COTS Components Selection.

[17] Chattopadhyay,T., & Natrajan,N. The Role of Functional Requirements, Operational Quality and Usability in the Success Story of Software Projects. *International Journal of Engineering Science Invention,ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726, www.ijesi.org Volume 2 Issue 6, June. 2013, PP.36-41.*

[18] Chung,L., Nixon, B. E. Yu,E., and Mylopoulos, J. Non-Functional Requirements in Software Engineering. Kluwer Academic Publishers, Norwell, MA, USA, 2000.

[19] Cresswell,J. Research Design - Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications, ISBN 9781452226101, 2013.

[20] Cysneiros L.M. & Leite, J.C.S.P. "Nonfunctional Requirements: From Elicitation to Conceptual Models," IEEE Transactions on Software Engineering, vol. 30, May. 2004, pp. 328-349, doi: 10.1109/TSE.2004.10.

[21] Dromey, R. G. (1996). Concerning The Chimera [Software Quality]. *IEEE Software, vol. 13*, pp. 33-43.

[22] Everdingen, Y.V., Hillegersberg, J.V. & Waarts, E. (2000). ERP adoption by European midsize companies. Association for Computing Machinery. Communications of the CAM 43(4), 27-31.

[23] Fahmy, S. Haslinda, N. Roslina, W and Fariha, Z. (2012). Evaluating the Quality of Software in e-Book Using the ISO 9126 Model. *International Journal of Control and Automation Vol. 5*, No`. 2.

[24] Fan, L. & Chen, J. (2010). Influencing Factors on ERP System Selection. *IEEE International Conference on Software Engineering and Service Sciences.* pp 671-673.

[25] Gable G. (1998). *"Large Package Software: a Neglected technology*?", Journal of Global Information Management, Vol. 6, no 3.

[26] Grady,R.B., "Practical Software Metrics for Project Management and Process Improvement", Prentice Hall, Englewood Cliffs, NJ, USA, (1992).

[27] Holland, C.P. & Light, B. (1999). A critical success factors model for ERP implementation. IEEE Software 16(3), 30-36.

[28] ISO (2001) ISO/IEC 9126-1: Software Engineering—Product Quality—Part 1: Quality Model. International Organisation for Standardization, Geneva.

[29] Jacobs,S. "Introducing Measurable Quality Requirements: A Case Study," Proc. Fourth IEEE International Symposium on Requirements Engineering (ISRE 99), IEEE Comput. Soc, Jun. 1999, pp. 172-179, doi:10.1109/ISRE.1999.777997.

[30] Kitzinger,J, & Barbour, R. (1999) Developing Focus Group Research: Politics, Theory and Practice. 1999. Sage Publications.

[31] Langenwalter, G.A. (2000). Enterprise Resources Planning and Beyond Integrating Your Entire Organization. CRC Press LLC, Florida.

[32] Loh, T. and Koh, S. (2004). Critical elements for a successful Enterprise Resource Planning implementation in small and medium sized enterprises. *International Journal of Production Research.* 42 (17). pp3433-3455.

[33] Markus, M.L. Paradigm shifts - E-business and business/systems integration. *Communications of the AIS,* Vol. 4, (article 10), 2000.

[34] McCall, J. A., Richards P. K. and Walters, G. F. (1977). Factors In Software Quality, US Rome Air Development Center Reports, US Department of Commerce, USA.

[35] Mukti, S.K., Tripathi, P.,and Rawani,A.M. A Framework for Investigating the ERP System Quality from Users Point of View in Indian Industries. *Journal of Economics, Business and Management, Vol. 1, No. 4, November 2013.*

[36] Panovski, G. (2008) Product Software Quality. Department of Mathematics and Computing Science, Technishe Uni- versity Eindhoven, Eindhoven.

[37] Patchara, B. & Yang, S. (2010). How SMEs make their decision for choosing an optimal ERP provider by using AHP method.

[38] Ram, J., & Corkindale,D., Wu, M. (2013). Industrial Management & Data Systems Vol. 113 No. 3, 2013 ,pp. 350-366.

[39] Robson,C., *Real World Research.* Blackwell, 2002.

[40] Sarkis,J.,& Sundarraj, R.P., 2000. Factors for strategic evaluation of enterprise information technologies. International Journal of Physical Distribution & Logistics Management 30 (3/4), 196–220.

[41] Umble,E., Haft, R., Umble, M., Enterprise Resource Planning: Implementation Procedures and Critical Success Factors. *European Journal of Operational Research.* Vol 146, No.2 PP 241-257.

[42] Uwizeyemungu, S. & Raymond, L. (2004) Essential characteristics of an ERP system : Conceptualization and Operationalization. The *Sixth International Conference on Enterprise Information Systems*, Porto,Portugal.

[43] Watson, E. & Schneider, H. (1999) "Using ERP Systems in Education," *Communications of the Association for Information Systems*: Vol. 1, Article 9

[44] Wei, C., Chien, C., Wang, M. 2003. An AHP-based approach to ERP system selection. Int. J. Production Economics 96 (2005) 47-62.

[45] Willis, T. H., Willis-Brown, A.H. and McMillan, A. Cost containment strategies for ERP system implementations. *Production and Inventory Management Journal*, Vol. 42, No. 2, 2001, pp. 36-42.

[46] Wohlin,C., Runeson, P., Höst, M., Ohlson, C., Regnell, B., and Wesslen, A. (2000) *Experimentation in Software Engineering: An Introduction.* Kluwer Academic.

[47] Yin, R. K. (1994). Case study research: Design and methods. SAGE Publications, Thousand Oaks.

Appendix A

Interview Questions

1. Do you know what an ERP is?

2. How important is the present system for your job?

3. How do you use the present system?

4. How many interfaces do you need to access simultaneously to do your job?

5. Do you know what the goals and strategy of the current system are? i.e. do you know the functionality of the system?

6. Have you encountered problems with the present system?

7. Are you encouraged to, and have you participated in giving feedback for improving the present system?

8. Is there anything you like about the present system?

9. Is there anything holding you back from using the system more?

10. What would you like to see in the new system, and what recommendations would you make?