

## ASSESSING THE QUALITY OF SERVICE OF POWEL'S NETBAS AT A NORDIC UTILITY

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### ABSTRACT

*The power industry's overall need to become more efficient affects all parts of their business. With respect to asset management and workforce management business processes this is becoming increasingly apparent. One of the critical success factors of high process quality are high quality Information and Communication Technology (ICT) solutions. This paper proposes a method to assess the quality of ICT solutions for asset and workforce management applications within the power industry. The method has validated the method through an empirical case study at a Nordic utility.*

### 1. INTRODUCTION

With an increasingly competitive business environment, utilities are forced to optimize their business processes in all areas. The workforce management process is no exception to this rule. Any major process improvement is contingent on high-quality Information and Communication Technology (ICT). Few methods are available to assess ICT quality in an objective and comparable way. This lack of ICT quality assessment methods means that it is difficult to determine whether or not an ICT solution adequately supports the business processes or not.

Meanwhile, the ICT industry has evolved its products into the Service Oriented paradigm, where focus has been shifted from technical solutions onto the actual services offered to the business processes. A service is a function with a number of nonfunctional constraints encapsulated in a manner as to hide the underlying technical implementation from the user. Using so called Service Oriented Architectures (SOA) [1], utilities may be able to easily and flexibly compose services from a number of ICT systems and solutions to support their business processes.

This paper proposes a method for assessing ICT solutions within the asset management domain at electrical distribution companies. The output of the method is a quantitative assessment of the quality of the services offered by the ICT solution under investigation. "Quality of Service" is here defined as the accuracy, usability, performance and maintainability offered by ICT solutions. The method has been applied in a case study [2] at a Nordic utility Powel's NetBas' modules Project Management and GIS were assessed.

The remainder of the paper unfolds as follows. Section 2 describes Bayesian networks which can be employed for system quality analysis. Section 3 briefly summarizes the frameworks for evaluating the Quality of Service properties mentioned above. Section 4 describes the details of the case study. Section 5 deals with results and their validity followed by the conclusions in Section 6.

### 2. BAYESIAN NETWORKS

Friedman et al. [3] describes a Bayesian network,  $B = (G, P)$ , as a representation of a joint probability distribution, where  $G = (V, E)$  is a directed acyclic graph consisting of vertices,  $V$ , and edges,  $E$ . The vertices denote a domain of random variables  $X_1 \dots X_n$ , also called chance nodes. Each chance node,  $X_i$ , may assume a value  $x_i$  from the finite domain  $\text{Val}(X_i)$ . The edges denote causal dependencies between the nodes, i.e. the causal relations between the nodes. The second component,  $P$ , of the network  $B$ , describes a conditional probability distribution for each chance node,  $P(X_i)$ , given its parents  $\text{Pa}(X_i)$  in  $G$ . It is possible to write the joint probability distribution of the domain  $X_1 \dots X_n$  using the chain rule of probability, in the product form

$$P(X_1, \dots, X_n) = \prod_{i=1}^n P(X_i | \text{Pa}(X_i))$$

In order to specify the joint distribution, the respective conditional probabilities that appear in the product form must be defined. The second component  $P$  describes distributions for each possible value  $x_i$  of  $X_i$ , and  $\text{pa}(X_i)$  of  $\text{Pa}(X_i)$ , where  $\text{pa}(X_i)$  is the set of values of  $\text{Pa}(X_i)$ . These conditional probabilities are represented in matrices, here forth called Conditional Probability Matrices (CPMs). Using a Bayesian network, it is possible to answer questions such as what is the probability of variable  $X$  being in state  $x_1$  given that  $Y = y_2$  and  $Z = z_1$ .

In the general case, the relations between variables described by the conditional probability matrices can be arbitrarily complicated conditional probabilities. The model presented in this paper uses only a few relatively simple relations, such as AND, OR, and leaky versions thereof. A simple example illustrating the AND relation in an availability context is given in *Figure 1*.

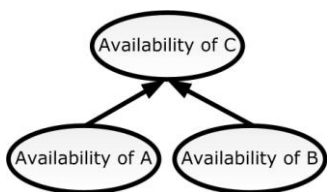


Figure 1: A very simple Bayesian network for availability analysis.

The AND relation, relating the availability of *C* to those of *A* and *B* is given in Table 1. More comprehensive treatments on Bayesian networks can be found in e.g. Neapolitan [4], Jensen [5], Shachter [6] and Pearl [7]. In this case study, the Bayesian networks were instantiated in the tool GeNIe [8], which automates the Bayesian analysis once the numbers have been collected.

Table 1: A conditional probability matrix showing the AND relation used in Figure 1.

Availability of A		Up		Down	
		Up	Down	Up	Down
Availability of B	Up	1	0	0	0
	Down	0	1	1	1

### 3. A FRAMEWORK FOR QUALITY OF SERVICE ASSESSMENT

One of the most commonly cited frameworks for software and system quality assessment is the ISO 9126-1 standard for software quality measurements [9]. For the purpose of the system quality analysis framework presented herein, we have used an adapted version of the ISO 9126-1 framework. The resulting framework was a reduced version of the ISO breakdown taking into account the requirements of Powell and the Nordic utility. In the end it was decided that the qualities of interest were *accuracy*, *performance*, *maintainability* and *usability*.

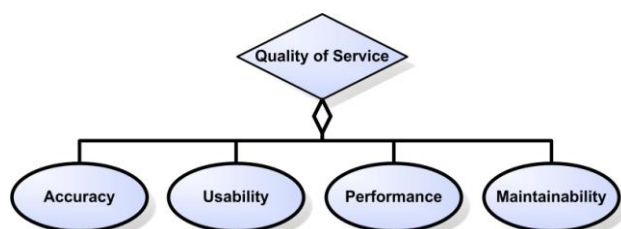


Figure 2: The system properties that constitute Quality of Service in this case.

This study chose two modules in Powel NetBas and investigated the quality of these implementations along the four dimensions listed above. The metrics for system quality analysis presented below were found in literature from

fields such as ICT maintenance, performance engineering, data quality analysis, etc.

### Maintainability

System maintainability is defined as the ease with which a software system or component can be modified to correct faults, improve various non-functional properties, or adapt to a changed environment [10]. There are several frameworks for analysis of software maintainability, such as [11][12] or [13]. The framework used for this study breaks down maintainability into the concepts of reusability, integrability and flexibility. Flexibility is the system’s inherent ability to accommodate change, which depends on the quality of the system architecture, which encompasses factors such as the size or complexity of the system. Integrability is the system’s ability to integrate with other systems. This is influenced by for instance the platform used and the existence of proper system documentation. Finally, reusability is determined by whether or not it is possible to reuse components of the system for other applications. An excerpt of the maintainability framework is found below.

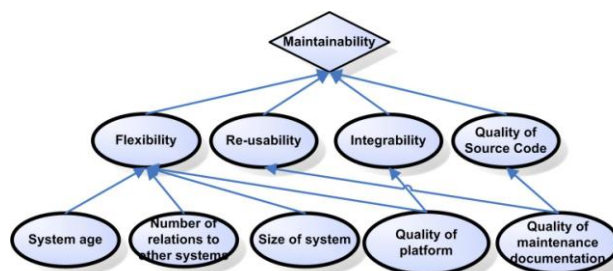


Figure 3: An excerpt Bayesian network for maintainability assessments.

### Performance

Adopting the view of Smith & Williams [14] performance can be defined as the degree to which a software system can meet its objective in terms of scalability and responsiveness. Scalability is the system’s ability to accommodate an increase in the number of requests whilst preserving its responsiveness. Responsiveness can be further broken down into response time and throughput. Some system properties having a causal effect on performance are the hardware and software used, the number of users compared to the number of users the system were designed for etc.

### Accuracy

The accuracy of an information system is measured by the degree to which it, given correct input data, produces output data that is accurate. This is determined by how close the output value is to the expected or “real” value. Some factors

having an impact on accuracy are the suitability of the formats of data attributes, and the existence of consistency checks in databases [15]

**Usability**

The usability of a system reflects how easy it is for a user to interact with and perform his or her tasks in the system. The definition employed here is based on Nielsen [16] and ISO/IEC 9126-1 [9] and comprises the factors learnability, efficiency, error recoverability and user satisfaction. Learnability refers to the ease of learning to use the system for a new user. Efficiency is the degree to which system users are able to work effectively once they have learnt the basics of the system. Error recoverability is how well users are able to correct errors occurring during system usage. Finally, user satisfaction is a measure of whether users find the system appealing or not. The usability heuristics found in Nielsen are the basis for the usability Bayesian network. Important factors among these are for instance the quality of the graphical user interface (GUI) design, or the quality of user documentation.

**4. THE CASE STUDY**

In order to test the proposed method and validate it in a real setting, a case study was conducted on Powel’s NetBas at the Nordic Utility’s Distribution business unit. NetBas is a system developed to provide asset documentation and support for work and decision processes. The system provides a number of different functions, such as load calculations, maintenance, project management etc. In this case study, we limited our attention to two modules relevant to workforce management, viz. (i) the GIS module and (ii) the project management module.

**Data Collection**

The evaluation was performed using the Bayesian network for quality of service assessment outlined in section 3, i.e. each of the two modules were evaluated in the dimensions of usability, maintainability, performance and accuracy.

In order to observe the quality of service, data was collected from several different sources throughout the study: (i) reading existing documentation, (ii) conducting interviews, (iii) making observations, and (iv) a questionnaire. Out of these methods, interviews were most abundantly used. In all, nine people were interviewed.

The aggregated data collected by methods (i) through (iv) are visualized in Figure 3. The results thus collected were

converted into probability distributions suitable for analysis in the Bayesian networks described in section 2.

Finally, using a simple mean of the scores for the GIS, and project initiation modules, an overall estimation of the technical quality of service was performed.

**5. RESULTS**

The overall scores, on a measurement scale from 1 to 5, were 3.70 for the GIS function and 2.92 for the project management function. This corresponds to an unweighted average of the four properties investigated, as illustrated in Figure 3.

The performance of the GIS function is generally considered low by the users. This, however, should not primarily be blamed on NetBas, but rather on the set-up of the LAN at the local utility office. The precision of the GIS function is generally deemed high. To some extent, this might be due to a small sample, and a disproportionate effect of a few collected data points.

The project management module is comparably large and complex. Furthermore, it is not very extensively used by the utility. In general, users seem to be less than fully satisfied with the data stored in the system. In particular, the accuracy seems to be poor, as users claim a need to double check existing data. Another issue is the help functions, which are considered insufficient.

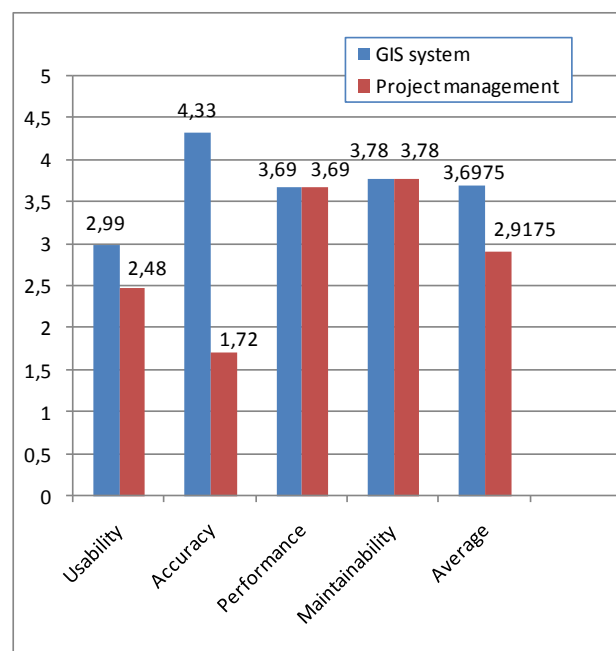


Figure 4: Illustration of the results.

Based on the present study, a number of recommendations for improvement has been made. These are categorized into

actions to be taken by the utility and Powel, respectively. The usability of NetBas could be improved by information and education about the system within the Nordic utility. Many users demand functionality that is in fact already provided within the system. Similarly, internal educational measures might bring about an improved attitude towards the system as such. The performance of the GIS could be improved by improvements to the office LAN.

The most critical property for the project initiation function is the precision and the gap in the database. Work to decrease the gap is continuously performed by the utility.

The measures on the part of Powel are, of course, less specific than those at of the utility. Increased focus on training and demonstration at the time of delivery might substantially improve usability. Another area which will affect usability is improvement and tailoring of the help functions according to the perceived needs of the users.

## 6. CONCLUSIONS

This study has applied a framework for quality of service assessment on Powel's NetBas system, specifically the modules relevant to the workforce management business process at a Nordic utility. The kind of quantitative evaluation that a framework such as this offers, allow for comparisons between ICT solutions than what is presently the case. Easier comparisons improve the quality of ICT related decision-making, and thereby the quality of the implemented ICT solutions and the business processes that are supported. The framework evaluates non-functional properties through underlying causally connected factors. A more in-depth analysis of the final result of an evaluation therefore also provides answers to questions concerning an ICT solution's strengths and weaknesses, thus generating suggestions of how to improve the solution.

## 7. ACKNOWLEDGEMENTS

The authors wish to thank master students Tobias Gustafsson, Stefan Jonsson, and Fredrik Löf, for the work they have spent on the present case study. Furthermore, thanks are due to Göran Wikström at Powel Energy Management AB, as well as the respondents at the utility.

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