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A risk based model for quantifying the impact of information quality

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ABSTRACT

Information quality is one of the key determinants of information system success. When information quality is poor, it can cause a variety of risks in an organization. To manage resources for information quality improvement effectively, it is necessary to understand where, how, and how much information quality impacts an organization's ability to successfully deliver its objectives. So far, existing approaches have mostly focused on the measurement of information quality but not adequately on the impact that information quality causes. This paper presents a model to quantify the business impact that arises through poor information quality in an organization by using a risk based approach. It hence addresses the inherent uncertainty in the relationship between information quality and organizational impact. The model can help information managers to obtain quantitative figures which can be used to build reliable and convincing business cases for information quality improvement.

1. Introduction

Information quality has been identified and confirmed as a key determinant for information system (IS) success [1,2]. Information quality is the fitness for use of information and is a multi-dimensional concept [3–5] with dimensions such as, for example, accuracy, consistency, interpretability, timeliness and completeness. In this paper, the terms "data quality" and "information quality" are used interchangeably, as is often done in academic literature. Information of poor quality can endanger the competitiveness and success of organizations. It can lead to poor decision making [6–12] and can in many ways create risks that hinder organizational performance [13–16].

Effective methods for assessing how poor information quality impacts the business are therefore crucial to enable an organization to focus information quality improvement where information quality affects the business goals most severely. They are also needed to build a convincing business case for information quality improvement initiatives. However, current methods to assess the business impact of information quality are inadequate when it comes to thoroughly quantifying the business impact of information quality. Some methods have been proposed by management consultants without a solid mathematical underpinning ([5,17,18,37]). Models proposed in academic literature either focus on information quality processes and technical metrics without characterizing the impact of information quality, e.g. [4,19–21], or use utility theory to characterize the impact of information quality [22,23], which is difficult to apply in practice, as little guidance is provided in those papers to link utilities to key business performance indicators. In particular, these models do not consider the uncertainty that is inherent in the relationship between information quality and business outcomes.

Understanding and assessing the risks arising from information quality will allow organizations to focus on information quality improvement where it matters most and also help to justify the costs incurred in information quality improvement. The technical challenge is that an adequate model has to be as easy to use as possible to be applicable by practitioners in an industrial context and it has to be feasible to collect the input data required by the model. At the same time, it needs to provide the necessary rigor to build a believable business case for information quality improvement. Furthermore, the business impact of information quality must relate to business metrics that are accepted and meaningful in the given industrial organization.

This paper presents a risk based approach to quantify the business impact of information quality that achieves the balance between usability and rigor. It has been extensively applied and refined in six industrial case studies and successfully tested for feasibility, usability and utility. The model enables managers to quantify how information quality affects their organizational performance and use the results to build solid business cases for information quality improvement.

The novelty of this research is to apply risk management concepts and methods to information quality management in order to quantitatively assess the business impact of information quality in a comprehensive manner. It adds a probabilistic

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dimension to the current state of the art of information quality business impact assessment methods. The model therefore provides an improved solution for industrialists to understand and assess the risks arising from information quality on an organization-wide scale. The results of these assessments can be useful to guide information quality management strategy based on a solid factual basis of the actual impact of information quality in the organization. The research shows a further way to utilize risk management effectively in the information systems discipline, in addition to current applications in the areas of information security and IT failure management.

2. Research methodology

A design science approach as defined by [24,25], following a pragmatic philosophical paradigm is taken as the philosophical underpinning and methodological approach in this research. Design research follows a cycle of develop/build and justify/evaluate of the research artifact. The artifact in form of the model was therefore designed and tested in four consecutive research phases, as shown in Fig. 1. The model presented in this paper is an instance of a cause-to-effect operational risk quantification model, which can "preserve the cause-to-effect relationship that shows how operational risk can be reduced, managed, and controlled" [26, p. 16]. In phase 1, a review of relevant literature in information quality and risk management and 15 semi-structured interviews with management professionals were conducted to understand the current needs and practices in the industry. This helped to prepare the six in-depth case studies (summarized in Table 1), which had a focus on the manufacturing and utility sectors and aimed to develop, refine and test the model. Every case study involved a 1–2 weeks visit on the company's site to facilitate at least six data collection workshops with managers and employees, which took half a day each. In phase 2, information risks (defined as risks arising due to poor information quality) were identified and analyzed in three industrial case studies in a number of core business processes. The data collected in these case studies was used to develop the initial model. Case company A was a large semiconductor manufacturer, case company B a family owned medium-sized steel manufacturer, and case company C was a medium-sized energy company. The initial studies were not aimed at fully understanding the investigated phenomena, but to assist in the development of the model. The model was then further applied in two industrial case studies D and E (manufacturing companies) by a final year M.Sc. student for testing and refinement. Using an independent facilitator showed that the model can be applied without the presence of the researcher. After each workshop, a feedback discussion took place to evaluate how the model and methodology can be improved and refined. The final version of the model was then applied in a last case study F, this time with the researcher as study facilitator.

A questionnaire was given at the end of each of case studies D, E and F to all workshop participants to judge the utility of the model. Five criteria were used to evaluate the model output: feasibility, usability, relevance, usefulness and confidence. Relevance, usefulness and confidence are three different aspects and measures of overall utility of the approach. The criteria ensure that the model strikes the right balance between industrial applicability and rigor. Each criterion was evaluated on a five step scale from 1 (very high), 2 (high), 3 (neutral), 4 (low) to 5 (very low). The results from the questionnaires are shown in Table 2. The five criteria were evaluated consistently high or very high in all three case studies. The refined version of the model used in case study F received a slightly better evaluation in terms of usefulness and confidence.

2.1. Model assumptions

The purpose of the model is to be feasible, usable and useful in an industrial environment. This requires a number of limiting assumptions. Although risk changes over time, the model is static, as otherwise the data input would be far too complex for the intended purpose. An information resource (this could be a piece of information or the source of an information) can have one or more information quality problems. For practical reasons, the model assumes that the information quality problems/consequences are independent of each other. A metric for each business objective has to be defined, which can be financial or non-financial, but this has to be an interval scale in order to allow the statistical calculations needed, such as, for example, calculating the mean and standard deviation. A ratio scale is an affine line of ordered points without a true zero point, which can be used to calculate the size of the

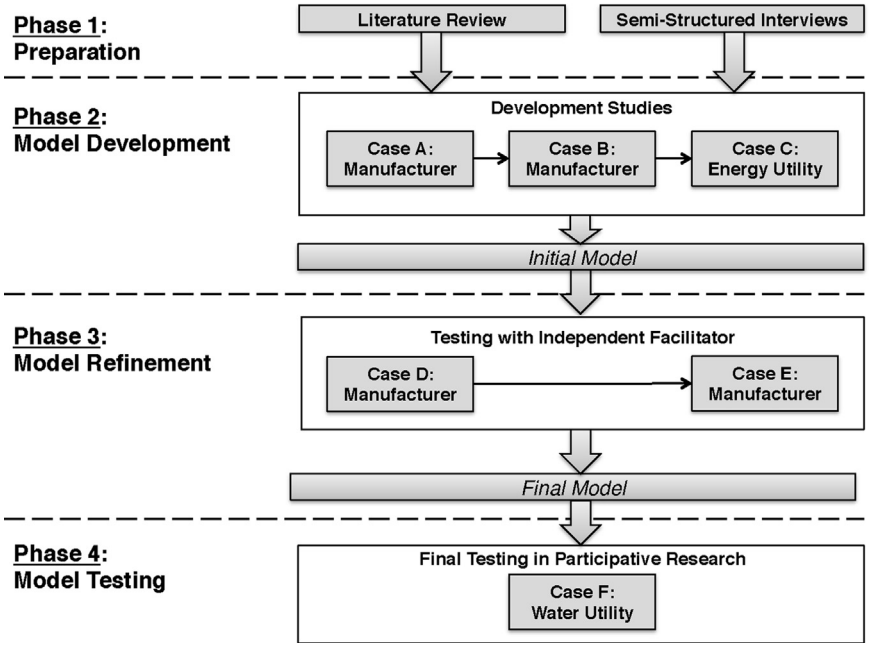

Fig. 1. Research methodology.