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Improving the quality of process reference models: A quality function deployment-based approach

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A B S T R A C T

Little academic work exists on managing reference model development and measuring reference model quality, yet there is a clear need for higher quality reference models. We address this gap by developing a quality management and measurement instrument. The foundation for the instrument is the well-known Quality Function Deployment (QFD) approach. The QFD-based approach incorporates prior research on reference model requirements and development approaches. Initial evaluation of the instrument is carried out with a case study of a logistic reference process. The case study reveals that the instrument is a valuable tool for the management and estimation of reference model quality.

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1. Introduction

Today's hyper-competitive and increasingly regulated markets see organizations place significant focus, and thus resources, on managing and improving their business processes [42]. Such improvements and innovations are considered to be an important factor in creating organizational wealth [49]. Indeed, recent Gartner studies show that CIOs now consider Business Process Management (BPM) to be the top priority in the coming years [41–43]. The high prioritization of process management in the recent years is also due to today's regulatory climate, which is forcing organizations to document processes and ensure their compliance. Many recent regulations (e.g. Anti Money Laundering Act [4]), however, are principle-based, as opposed to being prescriptive in nature, and require significant interpretation on account of the regulatee [36]. Anecdotal evidence from the Australian finance sector suggests that organizations are seeking reference models (RM) to help ease their compliance management pain and reduce the significant spending brought on by compliance requirements.

RM are blueprints of recommended practice and, thus, are sources of reusable and efficient business processes on which organizations can model their own [58]. Their main purpose is to streamline the design of enterprise models and enable organizations to apply 'best practice' knowledge. The use of high quality RM can result in cost and risk reductions, as well as an improvement of the organization's business processes [58]. It is estimated that the use of RM in projects can reduce the project duration and required financial resources by 30% [60]. Clearly, while there is much potential for savings with the use of RM, using a low quality RM can be damaging to the performance of the organization and to the quality of its decision making. Business processes, and therefore also RM, contain decision making components, such as policies or business rules for example [54], hence a high quality specification of the RM is important to ensure compliance with various requirements. In other words, an organization should ensure that the considered RM is complete, accurate, and easily configurable (i.e. flexible) for their purpose. To date, however, little work has been carried out that might provide guidance for the selection of high quality RM, let alone guidance for the development process that leads to high quality RM [45]. Only a few studies have focused on the quality of RM, despite reference modeling being an established field in Information Systems research. This situation is despite the fact that prior research has explicitly identified the need to close this gap [70]. For example, according to Fettke and Loos [20], the selection of models is increasingly complicated while being 'a crucial task for the project'. Frank [24] concludes that "… the evaluation of reference models is a challenging, yet important task". Accordingly, the organizations that develop RM (e.g. standardization or regulation bodies), and also those that are potential RM users, would value an instrument that aims to increase the quality of RM, through guiding its development, and also provides an easy measure of model quality that can be used in communication between the RM provider and RM user organizations. Indeed, the research presented in this paper was incepted by a request from a German standardization body that required such an instrument despite already having a quality control process in place. The organization was interested in obtaining an RM quality management and measurement instrument that would incorporate a best practice RM development process while also taking into consideration RM user requirements.

In response to the clear gap in RM quality research, and in response to the request of the aforementioned standardization organization, we

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present an interrelationship matrix-based artifact for increasing and measuring the quality of RM. The measurement evaluates the steps that are taken to develop an RM with respect to a set of required model characteristics and also considers the 'voice of the customer'. We adapt the first phase of the Quality Function Deployment (QFD) approach (also referred to as 'narrow QFD') for this purpose and derive an artifact that not only helps organizations develop high quality RM but also measures the achieved quality level. QFD, which originates from Japan, is an approach aimed at satisfying the users through the provision of high quality products that fit the users' requirements. The approach involves collecting user demands and converting them into design targets and major quality assurance points to be used throughout the development phases [3]. We see a QFD-based approach as most suitable here due to QFD's user-centric nature that captures the mapping of user requirements into product design [26].

The paper is structured as follows. Section 2 discusses related work — its main contribution is the extensive literature analysis and synthesis of academic literature related to RM quality and RM development, much of which is published in various German publication outlets and, hence, not easy accessible by international researchers. Research methodology is presented in Section 3. Section 4 describes the proposed instrument and Section 5 presents its application in a case study. Section 6 discusses findings related to the development process and RM characteristics. Last, Section 7 summarizes contributions, limitations and outlines future research.

2. Reference model development and characteristics

The general aspect of model re-use dates back to the 1930s [70] but was revitalized in the early 90s by Scheer [59–61], Österle et al. [50–52], and Hammel [28] for the process modeling domain. At the time, as Business Process Reengineering (BPR) was gaining popularity, organizations began to realize the cost advantages of RM on their process redesign projects. Since then, BPR has given way to BPM, with organizations taking an increasing interest in continually and holistically managing and improving their processes. Today, organizations spend significant amounts of money on BPM initiatives [75]. Recent BPM market analysis indicates that improvement of processes for productivity gains will be the main driver of the market in the coming years [74].

The redesign of processes for the purpose of increasing productivity is one example of a potentially fruitful opportunity for the application of RM. It is not the only opportunity however — RM have been used for a wide variety of purposes [20]. For example, they have been applied throughout the Enterprise Resource Planning Lifecycle [56], used for standardization of organizational software [73], curriculum design ([38,44]), knowledge and supply chain management [23], and decision support (e.g. selection of ERP packages or validating enterprise-specific models) [22]. Fettke et al.'s [23] survey and classification of RM indeed shows a very broad application of RM and classifies the models into specific orientation categories (*viz.* business function, Information Systems function, industry).

Regardless of the field or categorization, there is no doubt that "there is currently a remarkable renaissance in using reference models" [34]. Despite the increased popularity, there is a lack of understanding of the characteristics required of RM and also of their development process. In the next two sections, we consolidate various works on RM characteristics and development strategies in order to present a consistent and cohesive body of knowledge in this domain.

2.1. Process reference model development

While literature emphasizes the advantages of having access to high quality RM, this emphasis is not balanced with much published academic work that guides quality RM development [71]. Prior studies have shown, however, that a defined and structured development process contributes positively to the validity and quality of a RM [73]. In the development of a quality management and measurement instrument for the RM domain, we were also motivated to consolidate existing (and often only published in German) contributions towards RM development. There is a clear need for such consolidation in this domain [22]. This need is strengthened by the fact that RM research is predominantly conducted in Germany [22] and sometimes also only locally published.

A literature analysis of RM publications shows a strong German influence (e.g. [2,24,73]) with many of the publications available only in German language (e.g. [7,21,28,29]). Some of these publications contain guidance for RM development and, hence, are included in our consolidation so that their contributions can be available to the larger research community. In the remainder of this section we present an overview of both English and German published research on RM development and then present the seven phase RM development process.

RM development models have a sequential and sometimes cyclic structure of their overall construction processes in analogy with systems engineering [2]. The majority of the mentioned development stages have commonalities with software development approaches. Our aim in this section is to consolidate these works to arrive at a synthesized model that builds on the systems development life cycle (SDLC) ([1,15,25,40]). Orienting the RM development process on the SDLC provides the benefit of manageable, well separated phases that clearly define required inputs and outputs [5]. The RM development process embraces seven phases, which emerge out of the synthesis of prior RM development research outlined below, which are based on prior research and practical experiences.

Schütte [63] proposes a process model for the development of industry-specific RM. The model allows configuration and consists of five phases that emphasize the importance of model based planning. Building on Schütte's work [63], Schlagheck [62] considers RM development as an iterative process that focuses not only on the development aspect but also on the application aspect of the RM. The RM development phases are those of problem definition, analysis of the problem domain, construction, evaluation, and evolution [62]. Becker et al. [7] use in their RM development process different perspectives for considering various RM user groups. While their suggested RM development process is similar to that proposed by [62], it consists of an additional phase dedicated explicitly to marketing of the RM.

The process presented by Ahlemann and Gastl [2] emphasizes the use of empirical evidence in the RM development. The development phases are adopted from prior research (specifically, that of Schütte [63] and Schlagheck [62]) but the work presents specific instructions and hence, offers guidance on documentation and user involvement in the development process.

Thomas and Scheer [71] describe the development process as a chain of activities, which involves the planning, information search, documentation of user organizational knowledge and model construction. Fettke and Loos [20], on the other hand, describe the development process at the high level as a cycle that consists of problem definition, construction, assessment, and maintenance. Even the well recognized work of Schütte and Rotthowe [64], which introduced the Guidelines of Modeling (GoM), only at the high level describes that the principles of construction adequacy, language adequacy, economic efficiency, systematic design, comparability and clarity need to be observed in RM development initiatives.

In addition to the academic contributions, there is also a number of RM design philosophies known in practice. However, these philosophies are very high level approaches that do not provide any guidance for RM development [68] and, hence, are not incorporated in our consolidated RM development process below.

The first phase of the RM development process is *problem definition*. Relevant activities in this early stage include outlining the

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