Towards Implementing IT Service Management in an ERP for the IT Service Industry

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Abstract. ERP systems were fundamental in achieving efficiency gains in traditional manufacturing companies. In order to make the benefits of ERP utilizable by IT service providers, their processes need to be operationalized in ERP. IT service management (ITSM) frameworks describe these processes. They are however described using natural language. To be able to operationalize ITSM, the current state of the art of ITSM framework formalizations is analyzed. Also, it is determined which ITSM frameworks should be chosen for operationalizing IT service providers' processes. Finally, research gaps are identified.

Keywords: IT service management, ITIL, COBIT, ISO/IEC 20000, Meta-model, Ontology, Enterprise Resource Planning, Structured Literature Review

1 Introduction

Information Systems researchers have intensively discussed the industrialization of IT [1]. Standardization is one of industrializations core concepts achieving efficiency gains in value creation.

Enterprise Resource Planning (ERP) systems have been fundamental in traditional industries in order to support standardization. They are packaged application systems, support all processes and functions of an enterprise on a common database, and provide managers with a comprehensive view of the company's state [2, 3, 4]. ERP systems such as SAP's ERP usually ship with predefined processes that are proclaimed to be best practice and serve the standardization concept.

An IT service is "a service provided by an IT service provider. [It] is made up of a combination of information technology, people and processes."[5] The IT service industry consists of providers offering such services.

This paper argues that ERP systems, as they have supported companies of traditional industries in their value creation, are also suitable to support certain members of the IT service industry. In particular they can further standardization with a common process model. IT service management is "the implementation and management of quality IT services that meet the needs of the

[customer's] business. ITSM is performed by IT service providers through an appropriate mix of people, process and information technology."[5]. IT service management represents the core of IT service providers' business which therefore should also be the core business concept of a provider's ERP.

The ERP envisioned will address the needs of members of the IT service industry that exhibit, in their service production, a high degree of standardization and automation with resulting economies of scale. These providers will often serve external customers offering large quantities of the same service. IT providers offering very individualized services, e.g. some specialized software developing, are not seen as users of such an ERP system.

An IT service management framework implemented in an ERP will serve the goal of standardizing processes within IT service providers. However, no academically researched reference model of an ERP system for the IT service industry taking an IT service management framework as a basis exists [6].

There are a number of IT service management frameworks that define the processes of IT service provider's core business. They provide process descriptions which could serve as a basis for creating the predefined processes that are part of ERP software.

The ITSM frameworks' processes are mostly defined using natural language, but, if they shall be operationalized by implementing them within an ERP system they need to be formalized. This paper defines formalizations as models and meta-models, but also as taxonomies and ontologies as they can formalize natural language definitions [7]. Thus, the first research question of the paper is the following. **RQ1:** What is the current state of the art of formalizations of IT service management frameworks?

Many authors describe the IT Infrastructure Library (ITIL) as the worldwide de facto standard for IT service management (e.g. [8]), which was also confirmed by the framework's documentation itself [9]. Often ITIL is called best practice and some authors even go as far as awarding it generic reference model status [10]. However, ITIL is a framework of common practices [11] which lacks scientific foundation [11, 12]. Thus, because more than twenty other frameworks exist [6] that are related to or intended for ITSM, the second research question is: **RQ2:** Which ITSM framework should be chosen as a basis for describing ITSM processes in an ERP for the IT service industry?

The identified works will provide starting points for the conceptualization of an ERP system. However, only some points are addressed. Thus, the task of the third research question is the following. **RQ3:** In what areas is further research necessary to build an ERP for the IT service industry?

The following section presents the literature review that was conducted to answer the research questions. These answers are developed in section 3. The paper ends with a conclusion section.

2 Literature review

Seuring and Müller describe how a literature review can be conducted in four steps [13]: collection, descriptive analysis, category selection and material evaluation.

2.1 Material collection

In material collection the scope of the search has to be set: finding publications that contain formalizations of ITSM frameworks. Thus, articles' abstracts should contain the abbreviation or full spelled word IT service management as well as the different defined types of formalization. ITSM is strongly related to IT Governance, therefore, the term was included as well.

To gain up-to-dateness publications not older than five years were searched, setting the timeframe to 2007–2013. Databases were selected that have a good coverage of information systems and computer science topics. Not all potentially relevant journals and conferences are covered this way. However, the references in identified relevant papers were also analyzed. Thus, the limitation of ignoring outlets is alleviated. Checking the references also limits the constrainedness of scope set by the timeframe. The parameters of the material collection are summarized in table 1.

Keywords: ((ITSM OR "IT service management" OR "IT Governance" OR "IT-Governance") AND (model OR "meta-model" OR meta-model OR meta-modelling OR "meta-modelling" OR taxonomy OR ontology)
Timeframe: 2007 – 2013
Databases: ACM Digital Library (ACM), AIS Electronic Library (AIS), Directory of Open Access Journals (DOAJ), EBSCOhost (EBSCO), IEEE Xplore - Digital Library (IEEE), SciVerse ScienceDirect (SVSD), and SpringerLink (SL)

Table 1. Material collection: keywords, timeframe, and databases

Papers had to be published in a journal or conference proceeding and be written in English. When all the articles were retrieved their abstracts were read, and irrelevant papers were sorted out. After the remaining papers were read in depth irrelevant papers were sorted out again. Papers were excluded whose topic was curriculum related, or which were introductory articles such as prefaces or editorials. Some authors formalize relevant content, Ebert et al. [14] for example present an IT service model, but do not base their work on an IT service management framework. These papers are also considered irrelevant.

Table 2 shows the number of papers that were analyzed in the different stages.

The high rate of irrelevant publications may be explained by the very general word model. Also some IT Governance publications were not relevant. Searching the references of the identified publications from table 2 identified six relevant papers [22, 23, 24, 25, 26, 27]. The structured literature review was extended

Source	Collect	Abstract	Full text	Papers
ACM	7	1	1	[10]
AIS	35	7	2	[15, 16]
EBSCO	13	1	0	-
DOAJ	3	0	-	-
IEEE	106	36	4	[17, 18, 19, 20]
SVSD	4	2	1	[21]
SL	135	2	0	-
SUM	303	49	10	

Table 2. Relevant papers in each stage: Collecting the papers, reading the abstracts and reading the papers' full texts.

by an unstructured search which found two additional papers on Google Scholar (GS) [12, 28]. Furthermore, several different management frameworks exist which include or are primarily designed for ITSM. A comprehensive collection of these frameworks was identified in [6]. These were analyzed for containing ITSM formalizations. IBM Tivoli Unified Process [29] was selected from amongst the 24 frameworks because it formalizes ITSM processes with workflow diagrams.

The descriptive analysis of a structured literature review will often feature a trend analysis of the number of papers identified per year in the search frame. However, due to the small number of found papers such an analysis is not performed here. The next section will describe the category selection and subsequent material evaluation.

2.2 Category selection and evaluation

In total, twelve works were identified that report on a formalization of an ITSM framework. The difference between sixteen identified papers and twelve works exists because Valiente et al. and Goeken and Looso report in different papers on the same model in different stages. A first result, as demonstrated by table 3 which categorizes the works by ITSM framework, is that considerable academic effort has been invested into the modelling of ITIL. Alongside ITIL, COBIT and ISO/IEC 20000 have also been researched.

The results also show that different versions of the framework were used, but only Huang et al. appear to have used a version of ITIL that was outdated at the time of publishing their paper. As none of the works are based on the newest versions of the frameworks, they need to be updated if applicable. The update from ITIL v3 to ITIL 2011 only comprises error corrections that are not substantial [30]. However, changes made in the update from COBIT 4.1 to COBIT 5 include newly added processes and the improvements are described as considerable [31]. The revisions made to ISO/IEC 20000 include alignment to other standards, change of terminology, and clarification of concepts [32].

Consequently, different versions of the ITSM frameworks have to be considered when updating the process model of an ERP system in order to align it

Authors	Framework	Framework version	Articles
Goeken and Looso	COBIT	COBIT 4.1	[23, 24, 15]
Spies	COBIT	COBIT 4.1	[19]
Braun and Winter	ITIL	ITIL v2	[10]
Jäntti and Eerola	ITIL	ITIL v2	[25]
Huang et al.	ITIL	ITIL v2	[18]
Valiente et al.	ITIL	ITIL v3	[27, 28, 20, 21]
Strahonja	ITIL	ITIL v3	[26]
Goeken et al.	ITIL	ITIL v3	[12]
Baiôco et al.	ITIL	ITIL v3	[22]
Rohloff	ITIL	ITIL v3	[16]
IBM	primarily ITIL	ITIL v3	[29]
Brenner et al.	ITIL, ISO/IEC 20000	ITIL v3, ISO/IEC 20000:2005	[17]

Table 3. Papers categorized by author and by ITSM frameworks

with the perhaps revised practices. This will come with challenges when processes were customized.

2.3 Limitation

This study is limited because it searches in a limited timeframe and a limited number of publication outlets. However, the analysis of the references of the relevant works somewhat alleviates this. In addition, the search was restricted to abstracts. This was done because databases have different search fields, but with all databases abstract based search was possible and therefore it seemed to be more consistent not to look in different parts of the paper in different databases. However, more relevant papers might be found if title and keywords fields would also be included. Last, the keywords represent a set of formalization terms which might not be exhaustive. This was tried to be addressed with the very general term model.

Now, considering the previous section ITIL, COBIT and ISO/IEC 20000 are only three frameworks of over 20 frameworks. Thus, the results section starts with answering the second research question.

3 Results

3.1 Choosing an ITSM framework

Considering the results depicted in table 3 it seems clear which ITSM framework the authors whould choose: "ITIL, of course, maybe COBIT and maybe ISO/IEC 20000". Why would they be right, considering that there are alternatives and ITIL, COBIT and ISO/IEC 20000 have not been scientifically conclusively evaluated? The three frameworks are based on extensive industry experience and have all undergone a rather extensive review and maturement process. They can

be seen as proven practice solutions to manage the IT services of a firm. There might be other good or better frameworks. But these are the most widely approved and most widely adopted frameworks which exist to date. Thus, when conceiving an ERP for the IT service industry, which is supposed to be adopted by a lot of firms, a framework should be chosen that is close to what companies are already doing. Alternative approaches should however be analyzed in order to improve ITIL, COBIT and ISO/IEC 20000 if applicable.

Ensuing RQ2 comes the question of why COBIT and ISO/IEC 20000 should be used when ITIL is used. To answer this it is helpful to first look at the frameworks themselves. According to the first book of ITIL's documentation [5], ITIL shall provide guidance to IT service providers for their ITSM practices. It underlines the wide pervasion but also makes clear that organizations need to adopt ITIL according to their needs because it is not a standard. The authors of COBIT [33] underline the governance and management character of the framework. In contrast to ITIL it calls itself a holistic framework for enterprise IT, not specifically for ITSM. With the standard ISO/IEC 20000 [32] organizations can get certified that they manage their IT services according to the requirements outlined by the standard. The three frameworks are not mutually exclusive. COBIT is in parts based on and aligned with ITIL and ISO/IEC 20000 [33]. Whereas COBIT describes more what to do, ITIL describes how to do it [33]. ISO/IEC 20000 can be seen as a smallest common denominator of what is necessary to manage IT services. These assessments are also substantiated by looking at the randomly selected process of capacity management. Its description covers 22 pages of prose text in ITIL [34], four structured pages featuring bullet-lists and tables in COBIT [35], and a half of a page in ISO/IEC 20000 with requirements list and limited prose text. According to Sahibudin et al. [36] ITIL and COBIT cover the same processes except incident management.

Thus, as the frameworks are not mutually exclusive they can all serve different aspects of building an ERP for the IT service industry. This will be elaborated on in the next sections.

The following section answers the first research question.

3.2 Current state of the art of ITSM formalizations

Table 4 shows the different works with their type of formalization, the scope, and the type of disclosure. The scope column describes if an individual process or multiple processes are formalized. In order to conceptualize an information system it is necessary to have full access to the formalization. Thus, the fourth column describes to what extent the formalization is disclosed.

Goeken and Looso, Goeken et al. and Strahonja build meta-models of COBIT and ITIL. Amongst the three, Goeken and Looso's work is the one that is most broadly covered which is why it is presented here. They justify their choice because COBIT is structured and attempts to provide a holistic view on IT management. Goeken and Looso develop their meta-model in order to improve the scientific basis for ITSM frameworks. The model, which is presented in extended entity relationship notation, describes the structure of COBIT processes. This,

Authors	Formalization	Scope	Disclosure
Goeken and Looso	meta-model	cross-process	full
Spies	ontology	cross-process	partial
Braun and Winter	meta-model	IT service	full
Jäntti and Eerola	conceptual model	problem management	full
Huang et al.	meta-model	incident management	full
Valiente et al.	ontology	cross-process	full
Strahonja	meta-model	cross-process	partial
Goeken et al.	ontology	cross-process	partial
Baiôco et al.	ontology	configuration management	partial
Rohloff	process model	cross-process	partial
IBM	process model	cross-process	full
Brenner et al.	information model	cross-process	partial

Table 4. Papers categorized by type of formalization, by scope, and by type of disclosure.

for example, enables the addition of compliant new processes. The meta-model is built by adhering to a set of established modelling principles which Goeken and Looso extend by three principles of their own, particularly developed for meta-models. Among the found literature, theirs is the most extensive description of methodology used for creating a formalization.

Both Valiente et al. and Spies use ontologies. While the former authors formalize ITIL, Spies formalizes COBIT. They further define constraints and are consequently able to add semantics to their ontology. The work by Valiente et al. is more extensive which is why it is discussed in detail.

Valiente et al. develop their ontology of ITIL because the framework lacks semantics needed for automated processing. They integrate their ontology with the general purpose ontology OpenCyc. The full ontology is disclosed in [28]. By additionally defining constraints they can achieve semantic model consistency. Using the Semantic Web Rule Language, they define, for instance, that if an incident management activity is coordinated by a specific process, then that activity must be coordinated by an incident management process:

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itil:Activity(itil:ICTD_IM_Activity) ∧ itil:Process(?p) ∧
itil:coordinatedByProcess(itil:ICTD_IM_Activity,?p)
→ itil:IncidentManagement(?p)
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This enables them to define or test processes according to ITIL compliance. Valiente et al. validate their approach at a Spanish IT service provider who implemented the IT incident management process.

Jäntti and Eerola, Huang et al., and Baiôco et al. build conceptual models, a meta-model and an ontology for problem management, incident management, and configuration management. Rohloff builds process models for all ITIL v3 processes, but only discloses the model of one process as an example. IBM Tivoli Unified Process (ITUP) however, provides process models for all IT service man-

agement processes of ITIL and fully discloses them. According to the authors, ITUP is also closely aligned with several other ITSM frameworks, but the main source is ITIL. ITUP has no scientific foundation, but its authors claim that it is based on extensive industry experience. Thus, when using ITUP in a scientific context, it should be scientifically evaluated.

Braun et al. developed a meta-model of an IT service in order to integrate IT service management with enterprise architecture. The meta-model could be used as a data model, but, Brenner et al. provide a more convincing approach although they do not fully disclose their work. They adapt and extend the Shared Information/Data Model which is related to the enhanced Telecom Operations Map (eTOM). Their information model is developed to be compliant with ITIL and ISO/IEC 20000. It is intended to be used by companies that share processes and therefore need to exchange information in a standardized way.

Some work has been conducted in order to formalize ITSM. One difficulty is that the ITSM frameworks comprehensively cover their domain. The identified formalizations often only cover certain processes or aspects of the frameworks. Also, complete and soundly scientific evaluated formalizations are rare. Amongst the identified work the one by Valiente et al. stands out in these regards.

In the next section the third research question is answered: What future work needs to be done in order to build an ERP for the IT service industry?

3.3 Future work in conceptualizing an ERP for the IT service industry

Scheer describes five views that need to be considered when developing information systems [37]: organization, data, control, function, and output. When conceptualizing an ERP system these views offer a structure for determining what needs to be conceptualized. The identified literature partially fits to three of these views.

An information system is designed to support an organization. Different users have different duties, needs, or may have different authority levels. Therefore, access rights and functional roles need to reflect the organizational structure. COBIT provides structured and extensive information on process responsibilities and could consequently serve as a basis for this part of the ERP.

In the data view an information model for all relevant data must be developed. Here, the proposal from Brenner et al. [17] provides a promising foundation. Brenner et al. chose ISO/IEC 20000 for their data model. This was a good choice because a standard compliant data model will serve cross organizational collaboration and a common understanding of ITSM concepts.

The control view connects the organizational, the data, the functional and the output view into a sequential and logical series of process steps. Considering the analyzed literature, two alternatives exist for integrating ITSM processes as "best" practices into an ERP system.

The first is utilizing complete formalizations of ITIL such as done by IBM [29]. This has the advantage that the processes can be used as is. It has, however,

been stated that ITIL should not be implemented by dogmatically following the guidelines [5, 38] but also considering the individual firm's requirements.

An alternative is presented by Valiente et al. [21] who formalize the knowledge of ITIL in an ontology and define constraints by which they can add further semantics. For an ERP system this approach could be used in order to allow customers to define their own processes that would be compliant with ITIL. Of course this means that when taking the system into operation an initial investment has to be put into implementing the processes.

As mentioned in the previous section the identified works lack the comprehensiveness of the formalized ITSM frameworks. Thus, the first open research gap is to evaluate and consequently extend the proposals for completeness.

The function view is described in ITIL: How are the services composed? What functions are required to provision a certain service? These questions need to be answered for firms individually, but a general formalization is still required. A potentially fitting concept might be the universal service description language (USDL) [39] which holds ready appropriate concepts.

Furthermore, the output view has not been addressed yet. Two aspects are how to publish and bill services. Again the possibilities of the USDL should be investigated here. It also needs to be considered how far the value creation (in this case the service provision) should be integrated into the ERP system. Different tools exist to support provisioning and it needs to be determined how much of their functionality the ERP system shall provide. This question is closely linked with potentially missing competitive advantage when an IT service provider uses standard software, because the more standardized the more difficult it is to have a competitive edge.

The mentioned starting points for the individual views all represent mere conceptual work. Also, their compatibility has not been evaluated. Thus, these concepts should be implemented and their combination tested. Also it needs to be decided how everything should be fit together. Will the control view for example be implemented by a monolithic system or could it be distributed on different systems via a service oriented architecture?

The last section concludes the paper.

4 Conclusion

In order to conceptualize an ERP for the IT service industry, this paper argues that ITSM frameworks must be formalized in order to operationalize them within ERP. A literature review was conducted in order to capture the respective current state of the art. Meta-models, ontologies, conceptual models, and process models were used for formalizations. Interesting approaches towards formalization include the work by Valiente et al. and Brenner et al.. Valiente et al. provide means, via an ontology and a rule set, to determine if an ITSM process is ITIL compliant. Brenner et al. use an information model which was closely aligned with the eTOM framework to adapt it to ITIL and ISO/IEC 20000.

Their model can serve as a data model for an information system supporting ITSM.

The paper also comes to the conclusion that ITIL, COBIT and ISO/IEC 20000 are the frameworks that should be focused on when developing an ERP system for the IT service industry.

This study identified the following points which need future work. The identified work needs to be evaluated for completeness. Furthermore, for the output view foundation the following needs to be determined: How can an IT service provider describe its services and functions adequately? How can the output of an IT service provider be supported? How comprehensive shall an ERP solution be in order to enable IT providers to maintain their competitive edge through individual IT solutions? Additionally, how can the different views be fitted together in an architectural framework?

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