Classifying ITIL Processes

A Taxonomy under Tool Support Aspects

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Abstract— **Providing IT services to customers with better, guaranteed quality has been the aim of many diverse efforts, undertaken under the common denominator "IT Service Management". Lately, more organizational approaches to this issue have been gaining popularity, especially the guidelines of the IT Infrastructure Library (ITIL) for IT Service Management business processes.**

But just like with most other business processes, implementing ITIL processes in an efficient way involves building or procuring IT tools that can support them. On this aspect, ITIL itself offers only minimal guidance.

This paper addresses basic issues of supporting ITIL with process-oriented tools such as workflow management systems. It discusses the need for workflow management support of service management processes to achieve service level compliance, and presents criteria for determining which IT Service Management processes can and should be supported by workflow management systems. The IT Service Management processes defined by ITIL are evaluated and divided into four basic process classes according to their suitability for workflow management, thereby laying a foundation to future top-down approaches for comprehensive ITIL tool support.

I. Introduction

IT Service Management (ITSM) is the discipline that strives to better the alignment of IT efforts to business needs and to manage the efficient providing of IT services with guaranteed quality. A technical approach to these issues, namely infrastructure-oriented, *technological IT Service Management*, or *Quality of Service* (QoS) management, has been the focus of many research efforts in the area of network and systems management. But like in the early days of the *Software Engineering* discipline, when dissatisfaction of customers with the often unsuccessful outcome of large software development projects drove the focus from providing the individual programmer with ever better tools to an inclusion and adaption of engineering and project management methods, now there is a fundamental shift happening in the ITSM field. Here it is mostly companies' discontent with a perceived lack of transparency in IT provisioning that drives the rising interest in organizational aspects of IT Service Management.

In this trend towards embracing principles of *organizational IT Service Management*, the *IT Infrastructure Library* (ITIL) has, of all approaches, gained the biggest popularity and can - at least in Europe - now indeed be called a de-facto standard. The release of ISO 20000 [1], which is based on the ITIL-aligned BS15000 by the *British Standards Institution* (BSI) [2], will probably bring even wider adoption of ITIL in the industry.

Even though it has only recently gained wider popularity, ITIL is not new. So called *best practices* for various aspects of IT operations have been published in Great Britain by the *Central Computer and Telecommunications Agency* (CCTA) under the IT Infrastructure Library label since the late 1980's. The CCTA has now become a part of the *Office of Government Commerce* (OGC), which took over ownership of ITIL. For the further development of ITIL, the OGC is cooperating with the BSI, the itSMF (*IT Service Management Forum*), an increasingly influential association of ITIL users, and also with the two IT Service Management examination institutes, the Dutch EXIN (*Exameninstitut voor Informatica*) and the British ISEB (*Information Systems Examination Board*). The OGC is still coordinating official developments though, and retains the ownership of ITIL.

The first ten published books, the "core titles" of the first ITIL version, were combined in a *Service Support* and a *Service Delivery* set that contained the guidelines for IT Service Management. These, with some minor restructuring and renaming, have been complemented, updated and then combined into the two titles Service Support [3] and Service Delivery [4] for the current ITIL Version 2. ITIL guidance however covers many more topics. Along with *Planning to Implement Service Management*, the current ITIL version also includes volumes on *ICT Infrastructure Management*, *Application Management*, *Software Asset Management* and *Security Management*. (The first version covered an even bigger, albeit different scope of application domains - see [5] and [6].)

Service Support and Service Delivery remain nevertheless the core of ITIL. Their scope, which is also that of the official ITIL Service Management certifications [7], is in the context of ITIL literature usually referred to as "IT Service Management"[1]. Accordingly, the remainder of this paper will be limited to this scope, and the terms "ITIL processes" and "ITSM processes" will be used synonymously and refer to the processes described in ITIL Service Support and ITIL Service Delivery.

Service Support and Service Delivery each define five processes, as depicted in figure 1 (as in later figures, the official process name *Financial Management for IT Services* is abbreviated to *Financial Management* and *IT Service Continuity Management* to *Continuity Management*). Service Support also

[1]Recently, also *Security Management* is sometimes seen as one of the Service Delivery processes and hence part of IT Service Management.

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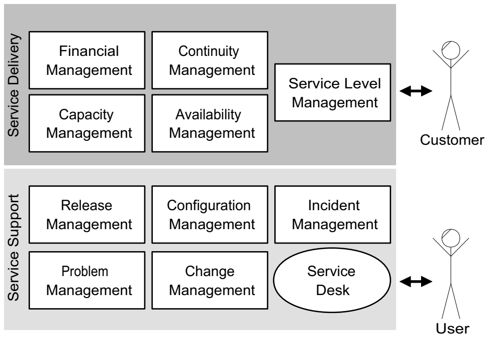

Fig. 1. Scope of ITIL IT Service Management

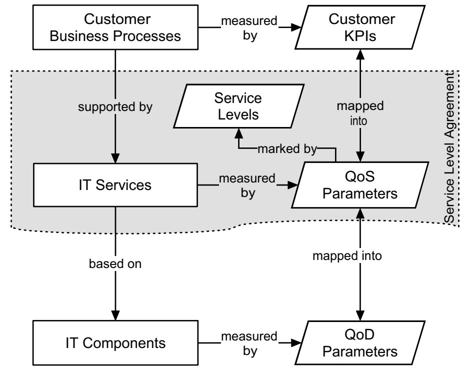

Fig. 2. Service Level Management concepts (based on [9])

has a chapter for *Service Desk* guidance. The Service Desk is however a business function (or unit) and not a process. It generally fulfills the role of first line support in *Incident Management*, but serves as a *single point of contact* (SPOC) for the user in all other concerns as well. ITIL differentiates between the roles of *user*, i.e. somebody using the IT service, and *customer*, i.e. the contractual partner concluding a *Service Level Agreement* (SLA) with the IT organization. The point of contact to the IT organization for the customer is the *Service Level Manager*. A more detailed description of the individual processes is beyond the scope of this paper, but a brief, freely available of ITIL's contents can be found in [8].

ITIL devotes only little space to guidance on IT management tools though. Relatively detailed, albeit in parts not wholly consistent guidelines are only provided for the *Configuration Management Database* (CMDB), which is supposed to serve as a repository and information retrieval tool for a services and IT infrastructure model - and also as a platform for information integration between the other ITSM processes. On workflow support for the processes, the guidance is minimal though. The general information on tools in chapter 9 of Service Delivery [4] stays rather superficial. For some processes there are short sections about tool support, but these are either concerned with tools related to only particular process activities, or stay very brief (e.g. seven bullet points on the requirements for Incident Management tools - see [3], section 5.9).

The next section will discuss why - at least for some ITIL processes - workflow management is all but indispensable for service level compliance and thereby for effective IT Service Management. Section III presents criteria for determining the necessity, potential benefits and applicability of workflow management support for specific ITSM processes. These criteria are the basis for the evaluation and taxonomy of ITIL processes in section IV. Section V discusses related work and section VI concludes the article.

II. The Impact of IT Service Management Processes on Service Levels

The key to better alignment between business needs and IT efforts is effective *Service Level Management* (SLM). The following paragraphs will define important SLM terms and discuss why service level compliance necessitates workflow management of at least some ITSM processes. Since ITIL's guidance on SLM lacks concise definitions of some important concepts (e.g. there is no definition of the term "Service Level" in ITIL), the first step will be to amend ITIL's concepts and definitions based on work done by Lewis [9].

SLM tries to achieve more customer-orientated IT service providing through negotiating, concluding, then continuously monitoring and adapting a Service Level Agreement between the IT organization and its customer [5] [4] [9].

A SLA specifies the conditions of how an IT service is to be provided. In corporate scenarios, this IT service is usually requested by the customer organization to support one or more of its business processes (see figure 2). The customer organization is primarily interested in the performance these processes, which is measured by *Key Performance Indicators* (KPI). KPI is a term used to describe key figures and ratios relevant to a business process - e.g. lead time (or cycle time), i.e. the average time needed to complete a process instance (or "case"), from its triggering event to conclusion. The IT organization's focus is however usually not on the performance of the its customer's business process, but on managing its own infrastructure through controlling the quality-relevant parameters of its infrastructure components, i.e. the *Quality of Device* (QoD) parameters [10].

It should be noted, that for every quality aspect there are usually two fundamental types of performance parameters, serving different purposes: real-time status parameters and parameters encapsulating longer-term characteristics. For example for the aspect *availability*, a parameter can refer to the current status of a component (*up* or *down*), or to the likelihood of it being available over a prolonged time interval, i.e. to its reliability (e.g. measured in *mean time between failures*). In the context of Service Level Management we refer to the latter *time-integrated* parameters (unless otherwise noted).

A SLA contains a description of the service and a definition of its functionality. Especially in corporate scenarios where the applications and IT systems, on which the services are based, have already existed before the first conclusion of a SLA - or where the services to be provided are standardized - this is commonly relatively easily agreed upon. At the core of a SLA however, and usually posing the harder problems, is the definition of non-functional quality goals or *service levels*. But before agreeing on a quality goal for an IT service, it is first necessary to agree on how the quality of the service can be measured. This is the problem of defining and measuring QoS parameters: QoS parameters should be meaningful for the performance of the customer's business process, i.e. every QoS parameter should have influence on at least one KPI, otherwise its usefulness is questionable. If on the other hand poor IT performance influences customer KPIs detrimentally, then this should be traceable by a QoS parameter.

Specifying QoS parameters requires effort and willingness to compromise of both parties involved in the conclusion of a SLA: Neither the mapping of customer KPIs to QoS parameters, mainly the responsibility of the customer, nor the mapping QoS parameters to component parameters, a task required by the IT provider, is trivial. When parameter definitions are agreed upon, service levels can be defined by marked ranges of QoS parameters (see again figure 2). For instance, a service level "gold" might define the acceptable range of the QoS parameter "availability" as "greater than or equal 99.9%".

While defining and controlling QoS parameters for measuring performance might play an increasingly important role for some types of services (e.g. those involving audio and video transmission) – of all QoS parameters, *availability* is in practice [11] and principle the most most fundamental and important one (an unavailable service cannot be attributed any other quality) and shall be the focus of the following discussion. For an IT organization to guarantee service levels, especially if the SLA specifies penalties for noncompliance, it must be able to predict what service levels are achievable at what cost with reasonable precision. Traditionally, IT organizations have focused on improving availability through adapting their technical infrastructure, e.g. by using more reliable components or building more fault-tolerant systems e.g. using automatic failover mechanisms. Consequently, predicting achievable service levels means mapping QoD parameters to QoS parameters, a task for which e.g. automation through the use of a *quality management application* integrated into a *service management platform* has been proposed [10].

Dealing with availability issues solely by technical measures is not sufficient tough. Relying on improvements in the infrastructure is often not the most efficient way [12], and very high availability is hard to achieve at any cost without proper organizational measures.

The common definition of availability is based on the two fundamental parameters *mean time between failures* (MTBF) and *mean time to repair* (MTTR). Assuming continuous service time (i.e. no scheduled downtime) and MTBF being large compared to MTTR one comes to the familiar formula of $\frac{MTBF-MTTR}{MTBF}$ for availability (see e.g. [13]). For underlining the fact that MTBF and MTTR contribute to availability in equal measure, this can also be expressed as $1 - \frac{MTTR}{MTBF}$, so for instance halving MTTR will improve overall availability to the same extent as doubling MTBF. A prediction of achievable availability targets and the costs involved in achieving them, necessary for negotiating SLAs, must therefore take both parameters into account. Even though organizational aspects can have a significant impact on MTBF [12], the biggest influence on it is usually the quality of the infrastructure. MTTR on the other hand is primarily dependent on non-technical factors – i.e. in the context of ITIL: the performance of the IT Service Management processes.

Figure 3 illustrates the parameters that *time to repair* or *downtime* is composed of: The *detection time*, i.e. the time until an incident[2] is registered, can be shortened by technical measures like the use of monitoring tools (although in practice many incidents are still first reported by users to the service desk). The activities for the incident resolution however, mostly involve human intervention and their durations have a direct relation to typical KPIs of Incident Management (*response time*, *repair time*) and Change Management (*recovery time*).

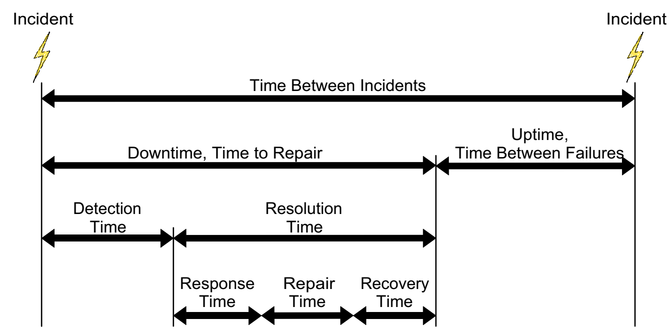

Fig. 3. Parameters influencing downtime (based on [4])

This means that tracking response, repair and recovery times is essential to achieving service level compliance. This is not only important under real-time aspects for specific process instances, e.g. for escalating incidents and reallocating resources when agreements on service levels are about to be breached. Also for the calculation of achievable availability-related service levels, knowledge of *ITSM KPIs*, based on sound statistical data from tracking Incident Management instances, is crucial (see figure 4). So while maybe for pure performance aspects infrastructure-oriented, technological IT Service Management might suffice - efficient achievement of higher availability-related service levels cannot be done without organizational IT Service Management. IT Service Management must hence be based upon two pillars of equal importance: a technological approach - and an organizational approach, based on principles of *Business Process Management* (BPM).

While this distinction is not made quite so explicitly in ITIL, it it nonetheless reflected in the guidance on Service Level Management: How a service is technologically realized is to be documented for each service in a *Service Specification Sheet*.

[2]ITIL's usage of the term "Incident" is not completely consistent. In the following *Incident* will be used in the narrower sense, referring to service failures

The mapping of Service Level objectives to KPI targets is described in a separate document, the *Service Quality Plan* [14].

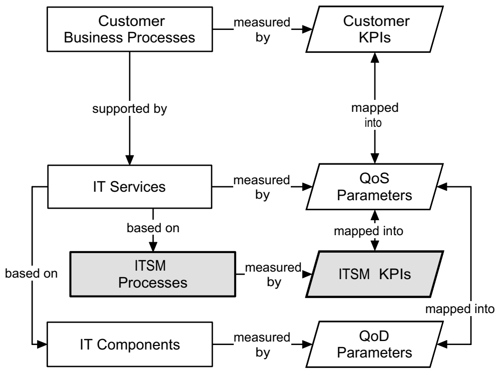

Fig. 4. IT Service Management and IT processes

In large scale environments, monitoring all variables contributing to ITSM KPIs precisely is practically impossible without the use of suitable tools. Such a tool might not only track the variables of the ITSM business process, it might to a certain degree control the process, e.g. by issuing and routing work orders, or triggering escalation alarms. In summary the quality management application of the proposed service management platform will need, as depicted in figure 5, to be complemented by a tool for the management of ITSM business processes, an *ITSM BPM tool*, and integrate this with tools of device oriented IT infrastructure management.

The next section will discuss what kind of tools can be used to support and control the execution of ITIL processes.

III. A Classification Scheme for IT Service Management Processes

When approaching tool support for an ITIL process, the first question should be what kind of system is best suited for making this particular process more efficient. This is more complicated than one might intuitively assume: What life cycle phase should the tool support? Can one type of tool, e.g. workflow management systems, be used for supporting the execution of all processes, or are there ITIL processes that are not well suited for this?

A. Business Process Management Life Cycle

ITIL stresses the *Quality Management* aspects of organizational IT Service management (see e.g. Appendix D in [3]),

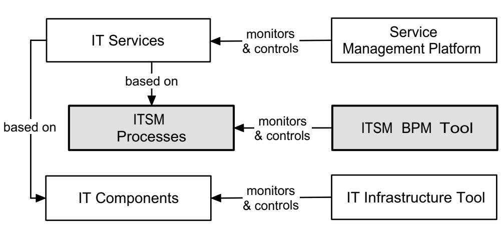

Fig. 5. Classes of IT Service Management tools

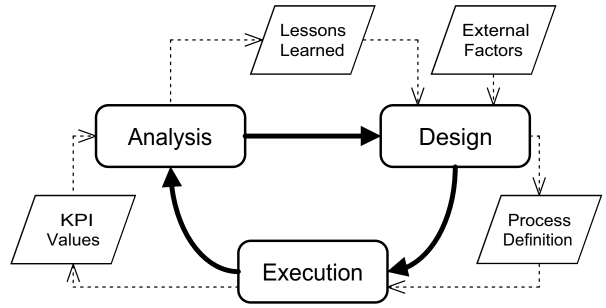

Fig. 6. Generic life cycle model of process management

meaning that processes should be subject to a continuous improvement effort. Management of ITSM processes therefore is not limited to the execution of the process, but should extend over all phases of continuous improvement.

There is a multitude of models for phases of process management, which are usually arranged in a continuous improvement wheel or a life cycle (see e.g. [15] [14]). Most specify between four and six phases, but many more could theoretically be identified, since the focus of the models varies considerably and one phase in a specific model might map to two or more phases in another cycle – or not be present at all (e.g. the Deming Wheel [14] does not explicitly include process execution).

Figure 6 introduces a simplified, generic model limited to three basic life cycle phases based on clearly distinguishable requirements of tool support. In the *Design* phase the process definition is specified, which is carried out in the *Execution* phase. During process execution, relevant parameters are constantly monitored, which are combined and summarized into KPI values, which are the basis of process *Analysis*. Results of the analysis, e.g. evaluation to what extent the last change in process definition has been beneficial for the effectiveness and efficiency of the overall process, are then, possibly together with changes in external factors, the basis for adjusting the process design.

Each of the phases can be associated with specific methods and IT tools. The design of processes is often done with the help of graphical *modeling tools*, which facilitate the creation of process definitions. The modeling method used for process definition is dependent on its purpose. Definitions that should be easily understood by humans are often done in a graphical and semi-formal format, while definitions primarily aimed at being executed by computer systems must be documented in a formal, computer-processable format.

Since all ITSM processes handle information, process execution can be associated with the rather broad category of CSCW (*Computer-Supported Cooperative Work*) systems, which includes messaging, conferencing, workflow management and other system subtypes [15]. Process analysis depends heavily on *analysis and reporting tools*, that perform statistical calculations and facilitate graphical representation of data and report generation.

However, before integrating support functionality for all life cycle phases of IT Service Management into a single system, tools for the individual phases should be in place. While there are interesting research questions concerning the tool support of all phases of ITSM, the problems involving design and analysis of processes from a tool support perspective are less domain specific than those of process execution. Existing design and analysis tools, even when not designed with ITSM processes in mind, should be easier adaptable for application in IT Service Management, than tools supporting execution of non-IT processes (e.g. ERP systems). The remainder of the discussion will therefore focus on tools for the execution phase of ITIL processes.

B. Related Research in Computer-Supported Cooperative Work

A tool offering comprehensive support of an ITIL process *X*, a "*X* Management System", should be more than just a loose collection of systems and applications, each supporting only an individual process activity. For example, email clients, remote desktop software and network analyzers – all can be put to good use in the context of Incident Management, but they do not by themselves constitute an Incident Management System. What we are looking for is a comprehensive system that helps address the organizational problems in ITSM by facilitating communication and coordination between the involved parties.

Addressing organizational problems in efficiency, communication and information management with IT means is a classic topic of research in computer-supported cooperative work (CSCW) [15]. CSCW tools comprise many classes of software systems. Figure 7 depicts the 3C Model for CSCW systems, classifying tools by their main support focus: *Communication*, *Cooperation* or *Coordination* [15]. It classifies tools really just by their main purpose – communication, cooperation and coordination support are not mutually exclusive. In fact coordination support builds upon communication and cooperation support [16].

The term "coordination support system" can be seen as synonymous with *Workflow Management System* (WfMS). Workflow management systems execute "workflows" through the execution of software whose order of execution is driven by a computer representation of the workflow logic [17]. Since these systems exact the highest level of control on process execution and can therefore provide extensive data for analysis, their application to IT Service Management processes seems attractive. However, the benefits of using WfMS or coordination support systems vary, depending on characteristics of the targeted processes [18], and not all processes are equally suited for their application [16]. As a consequence, ITIL processes need to be examined and characterized.

C. Criteria for Classifying ITSM Processes

There are many general characteristics that could be used for classifying ITSM processes. For other purposes there could be be other, rather different classifications - the one proposed in the following paragraphs is aimed towards determining the

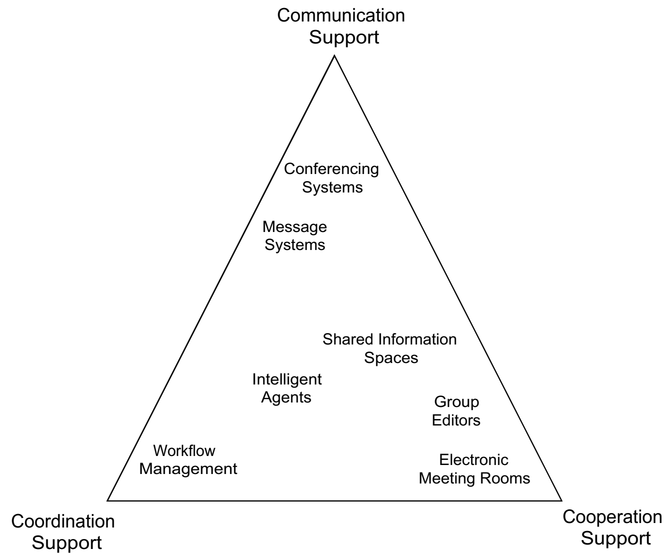

Fig. 7. 3C model for classifying CSCW systems [15]

need for tool support, and the applicability of specific types of tools, especially workflow management systems.

Lead time and *recurrence* (number of process instances per time interval) are variables almost always tracked in business process management, and hence obvious choices for fundamental characteristics. Long lead times will usually necessitate tools enabling effective asynchronous communication between actors, a high recurrence points to a higher potential benefit of tool deployment.

Processes involving many actors in different locations or even organizations will increase the need for communication and cooperation support. Therefore a measure of the *organizational complexity* of process execution is useful for narrowing down the suitable tool classes in the 3C model.

Contribution to corporate goals has been proposed as a criterion for choosing processes for WfMS support [18]. In the domain of IT service management, this can be translated to the level of impact that the effectiveness of process execution has on service level compliance, as discussed in section II. Of course, failure to achieve the desired results in any ITSM process can have unwanted impact on service levels. But for some processes this effect is immediate and direct – for other processes, those that are more directed towards improving efficiency than effectiveness of IT service providing, effects on QoS levels will be indirect, more protracted and to some degree correctable.

Finally, processes or workflows can be more or less structured: The "workflow continuum" [16] ranges from *ad-hoc*, over various degrees of *semi-structured* to *structured* workflow. These classification schemes are usually applied in the analysis of existing as-is processes though, and their concepts need to be adapted for classifying abstract ITIL processes. An as-is processes of ad-hoc structure is not necessarily so due to its nature, but possibly due to low process maturity. Such a process might over time mature into a semi-structured and eventually a structured process [16]. The concept of process maturity is however not applicable to abstract processes and needs not be considered in their evaluation. Nevertheless the level of structure is an important criterion for classifying ITIL processes. Of course, since ITIL defines activities for every process, there cannot be completely ad-hoc ITIL processes. Nonetheless, the ITIL documentation gives more structure to some processes than to others. For some, all activities of the process are closely connected, follow a clear path and work on common information objects. Other processes however, have much looser relationships between their activities, and might therefore be called semi-structured. This is not necessarily a flaw in ITIL – more creative processes, like planning activities for example, as they are found in Service Delivery, tend to have less structure than clear cut service, manufacturing or administrative processes. In summary, we distinguish the following basic process characteristics:

1) **Recurrence** Degree of the recurrence frequency of process instances. A measure of how many process instances will typically be executed in a given time frame.
2) **Lead Time** Average duration of a process instance from the event that triggers it (e.g. a customer call reporting an incident) to its conclusion (e.g. closure of the incident record).
3) **Organizational Complexity** (short: Org. Complexity) A compound measure, based on the number of distinct parties (process operatives and organizations) involved in the process and the complexity of their interactions.
4) **Service Level Impact** (short: SL Impact) Immediacy of impact on typical, especially availability-related QoS parameters. A measure of how lacking effectiveness in process execution influences the service level compliance.
5) **Structure** A measure of how concrete a workflow structure can be defined for the process.

These criteria will be applied to ITIL Service Management and Service Support processes in the following section.

IV. Classifying ITIL Processes

Prior work on classifying processes has mostly concentrated on categorizing existing as-is processes, hence the following analysis of abstract ITIL processes will first require the definition of some assumptions in section IV-A. Section IV-B illustrates how characteristics of ITIL processes can be compared and summarizes the determined ranking of each Service Support and Service Delivery process for each category. Subsection IV-D introduces a yet further simplified quadrant classification scheme, illustrating which processes are suitable for WfMS support.

A. Scenario Assumptions

When trying to gauge characteristics of abstract ITIL processes, there is one fundamental problem. ITIL documents best practices in a non-formalized way, using mostly freeform text, and many practices are formulated as a suggestion or an option. Also some chapters, especially in Service Support, even contain some minor inconsistencies[3]. Even though there are some figures and basic flowcharts, these do not strictly follow a common notation, are not comprehensive and do not include all activities described in the text. The lack of formalism in the process descriptions is a widely held criticism of ITIL [20], and ITIL is lacking too much in structure and clarity to be considered "orderly modeled" [19] [21]. Consequently ITIL is often referred to as "descriptive" rather than "prescriptive" guidance that needs to be "adopted and adapted" for each IT organization.

It should be noted that at least the descriptive nature of the guidance is intentional, as the proclaimed goal of ITIL is to offer guidance for IT organizations across all sectors and sizes. For example, a small IT unit located in single large office might do away with quite a lot of ITIL's best practices, that pay off only for larger and geographically dispersed IT organizations, and still be in accordance with ITIL.

We can therefore make sound statements about the characteristics of the ITIL processes only, if we make some basic assumptions about their implementation. We limit our discussion to a specific type of scenario, namely "large-scale IT service provider environments". We define this for the purpose of the following discussion as follows:

IT service provider environments that feature such organizational and infrastructure complexity, that efficiency benefits of near-complete implementation of all service management processes and guidelines, as they are documented in ITIL Service Support and Service Delivery, can significantly outweigh the cost in incurred overhead. Typical characteristics of such a scenario would be:

- 1000s or more of supported clients
- 10s or more of IT staff
- 10s or more of supported services and applications
- More than one customer
- Some in-house software development[4]
- More than one external supplier

For smaller scenarios, the presented classification scheme would probably still be applicable in principle, but the assessment of the specific ITIL processes might be harder to execute and come to different results.

B. Determining Criteria

A precise quantification of the criteria for abstract ITIL processes is not possible. However, comparative analysis of one ITSM process against another can yield clear "greater than", "lower than" or "approximately equal" conclusions. Consider the following example of a comparison of Incident Management to Problem Management:

[3]For instance, where is the fork into *Service Request Procedures* in the Incident Management workflow? After *Classification and Initial Support* as figure 5.2 in Service Support [3] depicts, or right after *Incident Detection and Recording* as Annex 5E suggests? See also discussion of ITIL in [19].

[4]relevant only for classifying Release Management, as lack of in-house development will result in a greatly simplified Release Management process

1) **Recurrence** Greater value for Incident Management. By ITIL's definition of *problem*, "unknown underlying cause of one or more incidents" [3], one can safely assume that problems are less numerous than incidents and consequently so are Problem Management instances. It could be argued that proactive problem management identifies some problems before they can cause incidents, i.e. there are problems not related to incidents. But these are definitely very few in number compared to all the incidents that are resolved directly by the Service Desk and whose occurrence does not lead to creation of new problem records: For end-user services, assuming a stable infrastructure environment and that the Service Desk is well accepted among users, 85% is an example of a typical first-line fix rate (ratio of incidents solved by first-line support) [3].
2) **Lead Time** Lower value for Incident Management. Of all ITIL processes, Incident Management is the most time-driven one. As mentioned, the majority of Incidents can usually be resolved by first line support (Service Desk) immediately. The remainder should be resolved within agreed resolution times. Specified values for maximum resolution time in SLAs vary in practice, but are typically in the range from 2 to 48 hours. Problem Management by comparison has the goal of improving the quality of the infrastructure, and should consequently put more emphasis on thoroughness than quickness. Problems by their very nature, usually require lengthy analysis and can practically never be resolved instantaneously.
3) **Organizational Complexity** Greater value for Incident Management. Both Incident and Problem Management can involve multiple units within the IT organization as well as supplier organizations. A still significant number of incidents, not resolved by the Service Desk (staying with above example, around 15% of all incidents), needs to be escalated to second-line support (*functional escalation*, see [3]), thus involving at least a second process actor usually associated with a another organizational unit. Also, due to the time critical nature of Incident Management, the ownership of urgent incidents frequently has to be transferred when shifts change.
4) **Service Level Impact** Greater value for Incident Management. Effectiveness of both processes directly impacts availability: Incident Management through *mean time to repair* (see discussion in Section II), Problem Management, aiming at improving infrastructure quality, through *mean time between incidents*. The influence of Problem Management on the quality of the infrastructure comes into effect after a significantly longer time though, whereas for Incident Management, failure to timely resolve a single incident of a critical service inevitably leads to a service level breach.
5) **Structure** Slightly greater value for Incident Management. Incident Management and Problem Management both feature a clear workflow structure, comprising all major activities, which all handle the same information object (incident record and problem record respectively). However Incident Management is slightly more specific in coordinating the collaboration of the different parties involved (e.g. through functional escalation).

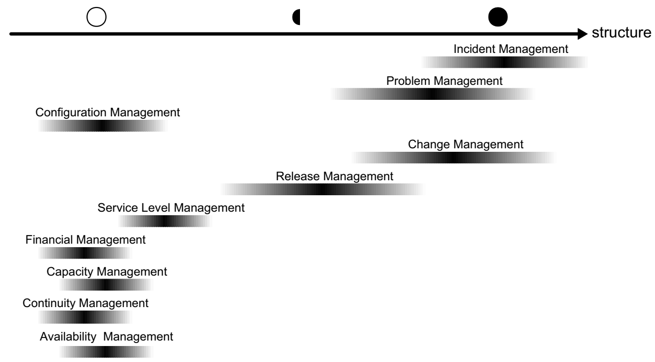

Fig. 8. Classification of ITIL processes according to workflow structure

After an analogous analysis of a sufficient number of other process pairings[5], we can establish a ranking of processes for each characteristic, like illustrated for the criterion *Structure* in figure 8. For ease of use, the ratings can be grouped into three clusters, high relative value ("●"), low relative value ("❍") and intermediate ("◗"). Note that all these values are relative and valid only in the context of the set of investigated processes. For example ad-hoc processes like discussed in [16] will feature a lower level of structure than IT Service Continuity Management, and many manufacturing processes might be much more structured than any implementation of Incident Management could be.

C. Summary of Results

Evaluating all proposed criteria, ITIL processes can be classified according to their characteristics as shown in table I.

Values which could not be determined are marked by "na" in the table. This was the case for the *recurrence* and *lead time* values of Configuration Management and all the Service Delivery processes, save Service Level Management.

This is closely related to the lack of structure that can be assessed for these processes. These processes, as they are described in ITIL, resemble not so much processes in the usual sense, but rather more or less unordered assemblages of various activities. These activities all serve a common high-level goal, but often have otherwise only loose relations to each other. Often some sections on activities in the chapters of these processes are about nonrecurring activities of planning and setting up the process, others deal with periodic reviews, while yet others give guidance on quite low-level procedures. So rather than being structured and controlled by a single workflow, these are are collections of smaller

[5] We do not have to compare all pairings, since we can profit from the transitivity of the "greater than" and "lower than" relations - although due to the impossibility to assign precise values, "approximately equal" is neither an equality relation in the mathematical sense, nor transitive.

TABLE I
CHARACTERISTICS OF ITIL'S ITSM PROCESSES

	Incident Management	Problem Management	Configuration Management	Change Management	Release Management	Service Level Management	Financial Management for IT Services	Capacity Management	IT Service Continuity Management	Availability Management
Recurrence	●	◗	na	◗	❍	❍	na	na	na	na
Lead Time	❍	◗	na	◗	●	●	na	na	na	na
Org. Complexity	●	◗	❍	●	●	◗	❍	❍	❍	❍
SL Impact	●	◗	❍	◗	◗	❍	❍	❍	❍	❍
Structure	●	●	❍	●	◗	❍	❍	❍	❍	❍

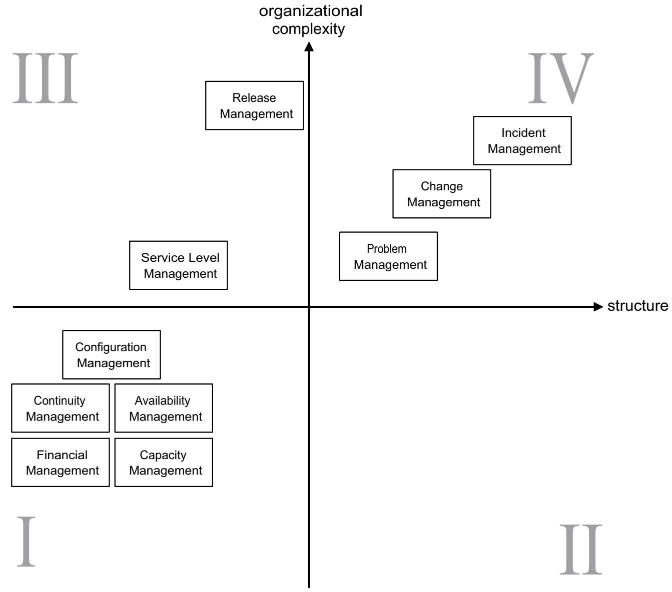

Fig. 9. Taxonomy of ITIL processes

processes, procedures and policies assembled under a common quality goal. Consequently, it is impossible to clearly identify process instances of these processes. Since the sub-processes and procedures are quite different in nature, simply averaging estimates in order to come to results for *recurrence* and *lead time* would incur too much error and hardly yield any useful result. These values were therefore left undefined. While Service Level Management is not much more structured, it focusses to a large extent on a somewhat structured "on-going process" (monitoring, reporting, service improvement, SLA maintenance) that can be attributed a recurrence and a cycle time.

Nevertheless, the recurrence of the sub-processes and activities has to be considered when determining *Organizational Complexity* for less structured processes. For example, of the activities defined by ITIL for Configuration Management ([3], section 7.6), *Identification* can be seen as highly collaborative – but this is an usually nonrecurrent activity. *Status Accounting* and *Control of CIs* are highly recurrent, but hardly cooperative, so in summary Configuration Management features a rather low organizational complexity.

D. Quadrants of Tool Suitability

Concentrating on the aspect of what kind of tool is suited for which ITIL process, the above classification and the conducted analysis of ITIL processes can be distilled into a concise taxonomy.

In the above classification the criteria *recurrence* and *service level impact* are useful for gauging the potential benefit of supporting a process with tools, but less so the processes' suitability for application of a specific types of tool. For this purpose *lead time* might be more useful, but since we cannot determine it for a significant number of ITIL processes, it is of limited use for classifying this specific process group and its integration into the taxonomy is for now left to later research.

The taxonomy depicted in figure 9 consequently arranges a subset of the above classification scheme into four quadrants, based on the dimensions *structure* and *organizational complexity*. The position of processes within the quadrants represents the tendency in their placement, e.g. Release Management has more structure than Service Level Management and is therefore closer related to Quadrant IV processes. The nature of the processes contained in each quadrant can be summarized as follows:

Quadrant I: Neither very structured, nor necessarily requiring the cooperation of many parties. The ITIL processes in this quadrant are primarily planning and controlling processes, which can require an extensive amount of information exchange with other ITIL processes. However exchange of information and collaboration with other ITIL processes does not represent cooperation in a strict sense - this would require cooperation of a team towards a common goal. But even though all ITIL processes of course share a common higher-level goal (improving the quality and efficiency of service providing) there are natural conflicts of interest between the processes, as each focuses on its own specific quality goal. Tool support for these processes is therefore likely to remain limited to support of communication with other processes and isolated tools for specific activities.

Quadrant II: Processes classified into this quadrant are highly structured, but of small organizational complexity. Typical representatives of processes in this quadrant would be formalized step-by-step procedures (e.g. for patch management) that are to be executed by a single administrator or a small team of technicians. There is not a single ITIL service management process in this group – this is not really surprising since ITIL focusses on management and not on detailed administrative procedures or infrastructure operations. Most existing IT management tools support the processes, or rather procedures, of this quadrant - focusing on making the work of individual operators more efficient.

Quadrant III: These processes do not have a single, clearly-cut workflow and are therefore not well suited for control by a workflow management system. They are of high organizational complexity though, i.e. they require the cooperation of many actors, often across organizational boundaries, working towards a common goal. They might therefore be an application area for cooperation-oriented systems.

Quadrant IV: This quadrant contains "classic" processes, involving multiple actors in a clearly structured workflow. This makes them best suited for support by coordination-oriented workflow management systems. Only three of ITIL's IT Service Management processes are located in this quadrant. Incidentally, those are also the processes that were determined to have the most immediate impact on service level compliance and shortest lead times.

E. Outlook

Processes located in Quadrant IV, and to a lesser extent those in Quadrant III, can be considered suitable for workflow management. Thanks to their relatively high level of structure, they also lend themselves well to development of reference process models. A thereby formalized and substantiated view of these processes could be used as a basis for eliciting tool requirements. Those in turn could be utilized for determining tool evaluation criteria, or of course as a foundation for tool development projects.

This does not exclude the application of tools specialized for specific activities in these processes, rather these will need to be integrated with the workflow management system for optimal efficiency in process execution. For example an Incident Management system can and should interface with tools for sophisticated infrastructure diagnosis (e.g. using event correlation techniques [22]) supporting the *Investigation and Diagnosis* activity.

V. Related Work

A. Classifying Business Processes

Most classifications of business processes are conducted from a strategic management perspective, e.g. starting by dividing processes into a "Core" and a "Support" category and further classifying these into general domains (e.g. "Finance", "Marketing", "Human Resources", ...), dividing up these again into subclasses and so on.

Taxonomies from an IT tool support perspective have been developed in CSCW research, mostly in the area of workflow management systems. In [16] processes are classified by their position in a "workflow continuum" - a concept adopted by the work presented here, though adapted for application to abstract ITIL processes. Also the development of criteria catalogs has been proposed for identifying business processes suitable for workflow management (i.e. support by a workflow management system) [18]. The classification scheme outlined in section IV-B could be seen as a simple instance of such a criteria catalog - but one specialized for application to abstract IT Service Management processes.

B. ITIL Tools

Published research on supporting ITIL by IT tools is mainly focused on automating selected activities and workflow subsets of ITSM processes. In [23] the aim is a better incident prioritization, [24] addresses automating Change Management activities, concentrating mainly on change scheduling. Both approaches fit into the context of the respective processes, but do not address them comprehensively – their focus is clearly more on supporting the work of individual actors than supporting the cooperation and coordination of all diverse parties involved in the process.

An example of a very basic classification scheme for IT management tools can be found on the web [25], which enables to sort tools "supporting the ITIL process model" according to the processes supported, as well as general (e.g. price) and technical (e.g. supported operating system) criteria.

PinkVerify by Pink Elephant [26], is the best known of several ITIL tool certification schemes offered by consultancies, and the only one to publish the basic criteria for its certifications. Certification is process specific, so for instance a tool can be specifically certified to support Change Management. Assessments are made for all Service Support processes, as well as Service Level Management, Availability Management and Capacity Management. In light of the findings presented in this paper, the inclusion of the latter two Quadrant I processes seems surprising – however, inspection of the published criteria reveals that the assessment for tools supporting them focusses on support of only a subset of the process activities, mainly evaluating monitoring and reporting functionality.

C. NGOSS and eTOM

NGOSS (New Generation Operations Systems and Software) [27] is an initiative by the TM Forum (Telemanagement Forum) for development of OSS/BSS components. NGOSS systems support processes of eTOM (enhanced Telecom Operations Map) [28], also by by TM Forum, an "industry owned" business process framework for the information and communications services industry (primarily telecommunication services providers). eTOM is the only framework for ITSM processes, not based on or otherwise closely related to ITIL, that has experienced considerable adaption in the IT industry [29] (if still being much less widespread than ITIL). Despite their similar aims, eTOM and ITIL differ considerably in structure and what issues they stress [30]. Consequently, until there is more alignment between eTOM and ITIL, NGOSS systems are just as unlikely to be applicable to ITIL processes, as ITIL tools will be likely to comprehensively support eTOM.

VI. Conclusion and Outlook

IT Service Management as a whole cannot succeed without management of IT's business processes. The classification ITSM processes presented above follows a novel approach: not by their goal or functional domain, but from from a tool support perspective.

The proposed simple classification scheme allows evaluating abstract process definitions, like the ones documented in ITIL, by assessing five fundamental criteria. The evaluation of ITIL's IT Service Management processes and the their placement into an *organizational complexity / structure* taxonomy can serve as a basis for approaching ITIL tool issues top-down. They also shed some light on why attempts at defining formal workflow models of ITIL processes (e.g. *ARIS ITIL* [31]) have for many processes come up with either somewhat unhelpful or no results at all.

More research into issues of organizational ITSM and the applicability of ITIL is needed. Surveys of the ITSM processes implemented in the industry could validate the executed assessment of ITIL processes – or provide foundations for improving the taxonomy. Especially an empirical analysis of average recurrence and lead times – hard to determine for abstract, but relatively easy to measure for real-world processes – could yield new insights.

Also it remains to be examined to what extend the taxonomy is applicable to tool support issues for the other process life cycle phases: For the design phase, obviously the definition of formal models of expressive value is not easily accomplished for the less structured Quadrant I processes – at least not with common process modeling methods. For the analysis phase, e.g. process structure could have impact on the measurability of time-based KPIs.

In the more immediate future however, planned work focusses on defining reference processes on basis of ITIL guidelines and the documented scenario assumptions for the processes identified as being workflow management suitable. These could be used as a basis for documenting requirements and use cases, thus laying the foundation for later work in benchmarking existing tools and top-down tool development.

For the latter the greatest challenges are likely to be integration issues: not only a seamless as possible integration of the process management life cycle phases, i.e. defining interfaces to process design and process analysis tools – also, and maybe most importantly, the integration of existing and future infrastructure management tools with the ITSM BPM tool to be developed. IT Service Management will only achieve maturity, when organizational and technological measures, and thus the tools supporting them, will become aligned and integrated.

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References

[1] *ISO/IEC 20000-1:2005 – Information Technology - Service Management - Part 1: Specification*, ISO/IEC, Dec. 2005.

[2] J. Dugmore, "BS15000: past, present and future," *Servicetalk*, vol. 04, Apr. 2004.

[3] CCTA, Ed., *Service Support*, ser. IT Infrastructure Library. The Stationary Office, 2000.

[4] OGC, Ed., *Service Delivery*, ser. IT Infrastructure Library. The Stationary Office, 2001.

[5] H.-G. Hegering, S. Abeck, and B. Neumair, *Integrated Management of Networked Systems — Concepts, Architectures and their Operational Application*. Morgan Kaufmann Publishers, Jan. 1999.

[6] *ITIL Back Catalogue*, The Stationary Office. [Online]. Available: http://www.tso.co.uk/itil/

[7] *ITIL Qualification Scheme*, OGC, Aug. 2005, v 1.4, http://www.itil.co.uk/includes/ITILQS.pdf.

[8] C. Rudd, *An Introductory Overview of ITIL*, itSMF. [Online]. Available: http://www.itsmf.com/publications/ITIL%20Overview.pdf

[9] L. Lewis, *Service Level Management for Enterprise Networks*. Artech House, 1999.

[10] G. Dreo Rodosek, "A Framework for IT Service Management," Habilitation, June 2002.

[11] J. J. Lee and R. Ben-Natan, *Integrating Service Level Agreements – Optimizing Your OSS for SLA Delivery*. Wiley, 2002.

[12] D. Scott, *Making Smart Investments to Reduce Unplanned Downtime*, Gartner, Mar. 1999.

[13] "OSI Networking and System Aspects – Quality of Service," ITU-T, Recommendation X.641, Dec. 1997.

[14] OGC, Ed., *Introduction to ITIL*, ser. IT Infrastructure Library. The Stationary Office, 2005.

[15] U. M. Borghoff and J. H. Schlichter, *Computer-Supported Cooperative Work*. Springer, 2000.

[16] C. Huth, I. Erdmann, and L. Nastansky, "Groupprocess: Using process knowledge from the participative design and practical operation of ad hoc processes for the design of structured workflows," in *Proceedings of the 34th Hawaii International Conference on System Sciences*, 2001.

[17] D. Hollingsworth, *The Workflow Reference Model*, Workflow Management Coalition, Jan. 1995. [Online]. Available: http://www.wfmc.org/standards/docs/tc003v11.pdf

[18] M. zur Mühlen, "Additional application areas and further perspectives – beyond re-engineering," in *Process Management*, J. Becker, M. Kugeler, and M. Rosemann, Eds. Springer, 2003.

[19] C. Probst, *Referenzmodell für IT-Service-Informationssysteme*, J. Becker, Ed. Logos Verlag Berlin, 2003.

[20] *ITIL Refresh – Results of public consultations*, OGC, Apr. 2005. [Online]. Available: http://www.itil.co.uk/includes/consult.pdf

[21] A. Hochstein, R. Zarnekow, and W. Brenner, "ITIL as common practice reference model for it service management: – formal assesment and implications for practice," in *Proceedings of the 2005 IEEE International Conference on E-Technology, E-Commerce and E-Service*, Hong Kong, Mar. 2005.

[22] A. Hanemann, M. Sailer, and D. Schmitz, "Towards a Framework for IT Service Fault Management," in *Proceedings of the European University Information Systems Conference (EUNIS 2005)*. Manchester, England: EUNIS, June 2005.

[23] C. Bartolini and M. Salle, "Business driven prioritization of service incidents," in *Proceedings of the 15th IFIP/IEEE International Workshop on Distributed Systems: Operations and Management (DSOM 2004)*, IFIP/IEEE. Davis, CA, USA: Springer, Nov. 2004.

[24] A. Keller, "Automating the change management process with electronic contracts," in *Proceedings of the Seventh IEEE International Conference on E-Commerce Technology Workshops (CECW 05)*, 2005, p. 99.

[25] *Tool Selector*, Inform-IT. [Online]. Available: http://tools.itsmportal.net

[26] *PinkVerify*, Pink Elephant. [Online]. Available: http://www.pinkelephant.com/en-GB/PinkVerify/

[27] *The NGOSS Technology-Neutral Architecture – TMF053*, Telemanagement-Forum, Feb. 2004, release 4.0.

[28] *enhanced Telecom Operations Map (eTOM) – GB921*, Telemanagement-Forum, Nov. 2004, release 4.5.

[29] R. Blum, *IT Service Management and ITIL*, INS, Nov. 2004, Network Industry Survey. [Online]. Available: http://www.ins.com/downloads/surveys/sv_itil_1104.pdf

[30] M. Brenner, "enhanced Telecom Operations Map (eTOM)," in *Vom LAN zum Kommunikationsnetz — Netze und Protokolle*. Interest Verlag, June 2004.

[31] *ARIS ITIL*, IDS Scheer AG. [Online]. Available: http://www.ids-scheer.com/sixcms/media.php/2188/ARIS_ITIL_FS_en_2005-07.pdf