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Decision-making in IT service management: a simulation based approach

Elena Orta *, Mercedes Ruiz, Nuria Hurtado, David Gawn

Department of Computer Science and Engineering, University of Cadiz, C/Chile, 1, 11003 Cadiz, Spain

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ABSTRACT

Simulation modeling is widely used to support decision-making in different business areas and management tasks. Given the growing importance for real-world organizations to improve Information Technology Service Management (ITSM), this paper focuses on the application of these techniques to support decision-making in this field. A review of published research articles that describe an application case has been conducted and it shows that different simulation approaches are extensively used to solve particular problems in the context of several processes. However, in these works there is no evidence of a systematic use of both ITSM frameworks and simulation model development methodologies. Given their importance to build valid simulation models, this paper proposes a novel decision-making framework whose main component is a specific methodology to systematically build simulation models that help solve real-world organization problems applying ITIL recommendations. To illustrate the usefulness of this framework, two application cases in the context of the ITIL capacity management and incident management processes are summarized. The model simulations provide information about the process results, performance and behavior with different process configurations. Moreover, optimization experiments allow managers to determine the optimal process configuration that meets the established objectives.

1. Introduction

Information Technology Service Management (ITSM) refers to the implementation and management of quality IT services that meet the needs of a business. ITSM is performed by IT service providers through an appropriate mix of people, processes and IT [41]. This discipline is focused on providing a framework to structure IT-related activities and the interactions of IT technical personnel with business customers and users. ITSM is generally concerned with operational issues of information technology management and not with technology development.

The growing importance for organizations to improve the management of their services has led to the emergence of international standards and frameworks such as ISO/IEC 20000 [43,44], ITIL [42] and CMMI-SVC [14], that provide process models and best practices for ITSM. ITIL (Information Technology Infrastructure Library), developed by the Office of Government Commerce (OGC), is nowadays one of the reference models most used in organizations. The empirical works realized by Marrone and Kolbe [61,62] show the operational and strategic benefits that organizations gain with ITIL implementation.

Although ITSM frameworks provide important benefits, their implementation in real organizations is a complex process and for this it is necessary to make very important and difficult decisions [71–75]. Specific examples of such decisions are as follows: a) What changes to make in process and service management strategy configurations to improve process results, behavior and performance; and b) Determining the process configurations that optimize the process results and meet the organization objectives, among others. Decision Support Systems (DSS) help managers make better decisions in this field [12,17,23,48,51,90,97].

Considering the dominant architectural component that provides the functionality to support decision-making, Power [81] differentiates *communication-driven DSS*, *data-driven DSS*, *document-driven DSS*, *knowledge-driven DSS*, and *model-driven DSS*. By definition, one or more quantitative models are the dominant components of *model-driven DSS* [82]. This type of DSS emphasizes access to and manipulation of quantitative models, such us, algebraic, decision analytical, statistical, financial, optimization or simulation models to provide decision support. They are designed so that users can manipulate model parameters to analyze the output sensitivity or to conduct a more ad hoc "what if?" analysis. Moreover, the model is accessible to a non-technical specialist, such as a manager, through an easy user interface. Power and Sharda present in [81] an overview of model-driven research and show the applicability and usefulness of *simulation-driven DSS* to support business and engineering decision-making. Simulation models are the main component of *simulation-driven DSS*. The authors of [55,56,65,83,92] emphasize the importance of using simulation model development methodologies to build valid and credible simulation models.

* Corresponding author.
E-mail addresses: elena.orta@uca.es (E. Orta), mercedes.ruiz@uca.es (M. Ruiz), nuria.hurtado@uca.es (N. Hurtado), david.gawn@mail.uca.es (D. Gawn).

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The goal of this paper is to explore the application of simulation modeling to support decision-making in the scope of ITSM. Its main contributions are as follows:

- A study of published research articles that apply simulation modeling in an ITSM context. The simulation approaches used, the processes modeled and the issues addressed in the selected articles have been identified.
- A decision-making framework to improve ITSM focused on simulation modeling. Its main components are a specific methodology to develop simulation models in this context and the simulation models built.
- Two application cases of the proposed framework in the field of the ITIL capacity management and incident management processes.

The rest of this paper is structured as follows. The next section presents the results of the study we conducted of published research articles that apply simulation modeling in an ITSM context. Section 3 describes the decision-making framework proposed for ITSM improvement. The two application cases of this framework are explained in Sections 4 and 5. Finally, Section 6 contains our conclusions and identifies further work to carry out in this area.

2. Simulation and IT service management: related work

The common goal of simulation models is to provide mechanisms for experimentation, system behavior prediction, the resolution of questions such as "What would occur if …?", and learning more about the system represented. These models facilitate the experimentation of different decisions and observing the results in systems where the cost, time or risk of experimentation with the real system could be high [49]. They are usually built to understand how systems behave over time and to compare their performance under different conditions.

A very useful simulation technique is sensitivity analysis. This technique allows one to study the effects on model outcomes of varying the values of model input parameters over a range of values. Thus, it helps managers determine the likely range of results when there are uncertainties in the key input parameters, and identify which input parameters produce greater effects on model outcomes [49].

There are a variety of simulation approaches, such as state-based process models, discrete event simulation, system dynamics, agent-based simulation, Petri-net models, queuing models, Monte Carlo simulation, probabilistic simulation, and traditional mathematical simulation [81].

This section explores the use of simulation modeling to support decision-making in ITSM, looking specifically into the processes and issues modeled. Moreover, the use of both ITSM frameworks or standards, and methodologies to build simulation models in this field is also analyzed. We think that this study is appropriate for the following reasons:

- Simulation modeling is widely used to support decision-making in different business areas and management tasks. An extensive variety of practical questions can be addressed with simulation, such as strategic management, planning, control and operational management, process improvement and technology adoption [16,24,26,36,39,50,82,95,108].
- The growing global diffusion of ITSM frameworks and standards due to the fact that organizations that implement them obtain important benefits [15,61,62].
- The use of an adequate simulation model development methodology is one of the most influential aspects in the building process to obtain valid and credible models. This is fundamental since a well-designed model significantly improves the probability of a successful outcome of a simulation study [55,56,65,83,92].

The study conducted focuses on a review of published research papers that describe an application case of simulation modeling in an ITSM context. The intent is not to provide an exhaustive study but rather to offer an overview of the use of these techniques in this field. We address the following three research questions:

- Q1: Is simulation modeling used to support decision-making in an ITSM context?
- Q2: Are ITSM frameworks used in the analyzed research papers?
- Q3: Are simulation model development methodologies used to build the models proposed?

The literature review undertaken follows three stages: 1) identifying the main issues addressed in the selected articles and associating these works with the most related ITIL process, 2) classifying the articles according to the issues addressed, and 3) studying the articles to see if they propose the use of ITSM frameworks and standards or simulation model development methodologies.

2.1. Identifying the issues addressed and associating the articles with ITIL processes

This section presents an overview of published research articles that describe an application case of simulation modeling in an ITSM context. For each article found a study of the issues addressed has been performed and it has been associated with the most relevant ITIL process. We have used ITIL since it is one of the ITSM frameworks most frequently adopted in organizations and provides important benefits [15,61,62]. In addition, ITIL recommends using simulation to support decision-making in the continual improvement of processes [71].

ITIL structures service management processes in five modules which correspond to the service lifecycle phases: *Service Strategy* [74], *Service Design* [72], *Service Transition* [75], *Service Operation* [73] and *Continual Service Improvement* [71]. In the following paragraphs, the articles found are referenced by process inside each of the service lifecycle phases. For each the issues addressed and the simulation approaches used are introduced. The simulation approach names have been abbreviated as follows: discrete event simulation (DES), system dynamics (SD), agent-based simulation (ABS), Petri-net models (PNM), queuing models (QM), Monte Carlo simulation (MCS), probabilistic simulation (PS), and traditional mathematical simulation (MS). In some situations simulation is used to validate conceptual or formal models. In this study we have introduced some works of this type and the simulation approach is named "other models simulation (OMS)".

a) Service strategy module
The purpose of service strategy is to design, develop and implement service management as an organizational capability and as a strategic asset [74]. The articles found by process for this module are as follows:

a.1) Strategy management for IT services process
The goal of this process is to ensure that the service strategy is defined and maintained, and achieves its purpose. This process is responsible for defining the strategic goals and the appropriate strategies for compliance [74]. Table 1 summarizes the publications assigned to this process.

a.2) Financial management for IT services process
The purpose of this process is to secure the appropriate level of financing to design, develop and deliver services that meet the strategy of the organization [74]. The articles associated with this process are shown in Table 2.

a.3) Demand management process
The purpose of this process is to understand, anticipate and influence customer demand for services. This process works with capacity management to ensure that the service provider has enough capacity to meet this demand [74].
The system dynamics model that Orta et al. [77] propose in the context of capacity management allows one to study if the