# Using Model-based Approach for Assessing Standard Operating Procedures

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Keywords: Standard Operating Procedure, Model-Driven Engineering, Requirement Engineering, Goal Model, Scenario Model, GRL, UCM.

Abstract: Standard Operating Procedures are essential for organizations that want to maintain an efficient and organized local tasks. They are used develop the activities important for completing their internal operations in accordance with industry regulations and business standards. A growing interest and investment have been taken regarding developing and assessing the SOPs. It is desirable to detect any deficiencies in the SOPs that contradict with the policies and regulations and do not allow achieving the business goals early in the process when corrective actions can be more easily made. This paper proposes a model-based approach that generates goal and scenario models for the standard operating procedures, augmented with quantitative indicators. The generated models allow to model the behaviour of the standard operating procedures in a formal way and evaluate their performance measures.

## 1 INTRODUCTION

Many organizations are using standard operating procedures (SOPs) to develop the activities essential for completing their local tasks in accordance with industry regulations and business standards. SOPs are a set of instructions and guidelines that formalize the business processes in an organization. They define the blueprint of the actions, templates and forms necessary to complete an organization workflow. Organizations are using SOPs to improve the productivity, formalize the communication and responsibilities between the working teams and maintain the consistency and quality of the business process in a timely manner.

A periodic process of developing and maintaining the SOPs is described in figure 1. The business goals describe the expected accomplishments of an organizations in the near future and support the performance chart to measure the organization situation. The business goals are used to outline the organization's guidelines that governs its actions in a form of policies and regulations. They also are used to identify the measures of the organization's abilities and behaviour quality in a form of performance metrics. The policies and regulations consist of the formal statements, consents that are defined to achieve the business goals. They are also defined to achieve the main principle of creating and maintaining the SOPs continuously. The performance metrics and feedback are used to evaluate the SOPs which are augmented back to the business goal for further improvements.

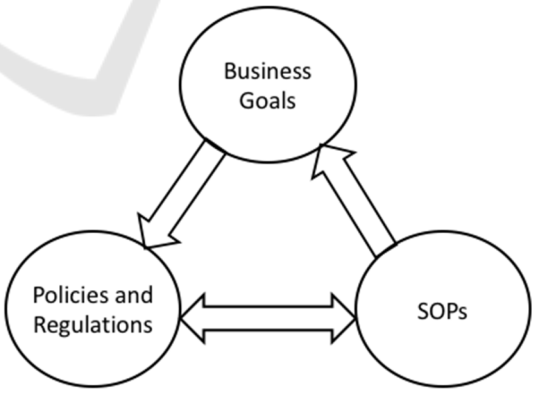


Figure 1: Periodic process of developing and maintaining the SOPs.

A growing interest and investment have been taken regarding developing and assessing the SOPs. However, the typical approaches of the development often neglect the assessment procedure that supposed to be realized with respect to the defined regulations,



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policies and business goals. It is desirable to detect any deficiencies in the SOPs that contradict with the policies and regulations and do not allow achieving the business goals early in the process when corrective actions can be more easily made.

In this paper, we present the exploration of a model-based approach where we model the evaluation process of the SOPs using User Requirement Notation (URN). URN supports two modelling languages: the Goal-oriented Requirement Language (GRL) which models business goals with stakeholders, behaviours, and key performance indicators (KPIs) represent performance metrics; and the Use Case Map language (UCM) that models business scenarios with sub-scenarios, actions and artifacts. The new approach aims to evaluate the SOPs at the early phases of the development and provide and formalized way of assessment. The paper is organized as follows: section 2 presents the background and related work; Section 3 an overview of our model-based approach; Section 4 A case study of evaluation modelling and analysis followed by conclusions and future work in Section 5.

## 2 BACKGROUND AND RELATED WORK

The user requirement modelling is used to model the notion of organization hierarchy and its relationship with the stakeholders; also model the behaviour of different constituents within the organization. It is used in recent literature researches such as quality assurance (Alhaj, 2019) and business process management (Weiss and Amyot, 2005). User requirement modelling allows modellers to identify requirements for the target system and validate their compliance with the user demand. It combines between the requirement's objectives and behaviour; and bridge the gap between the informal presentation of the user requirements and the formal one.

User requirement notation (URN) (ITU-T, 2018) is an international standard notation for the International Telecommunication Union (ITU-T) that models graphically the requirement's goals and scenarios. URN supports the elicitation, specification, analysis, and evaluation of requirements. URN modelling is used to discover and describe requirements for a proposed system or process and analyze any kind of responsive structure. URN language supports two graphical modelling languages: a) the GRL that describes business goals and allows the modelers to describe intentions (e.g., goals, tasks, indicators) their decomposition structure (e.g., sub goals, stubs), link types (e.g., dependencies, contribution) and the corresponding stakeholders (actors, agents, teams); b) the Use case Map (UCM) that describes business scenarios and models scenarios as a sequence of actions (responsibilities) and sub-scenarios (stubs) synchronized by timers (Timers and waiting places) and controlled by concurrencies and branches (And/Or Fork, And/Or Join). The workflow of the scenario can be owned by different components, such as actor, team, process, object and agent. The goal models and scenario models are created using an open source graphical editor called jUCMNav (jUCMNav, 2016). jUCMNav supports generating and managing GRL and UCM models and provides features to utilize strategies using various analysis algorithms. Other examples of goal languages such as i star (i*) that models both as-is and to-be situations (Ayala, 2005) and KAOS (Darimont, 1997) that allows building requirements models and used capture user requirements at the problem domain. Different modelling languages are also used to describe behaviours and scenarios such as Business Process Management (BPM) (OMG, 2011) and UML Activity diagram (OMG, 2017).

Different researches and case studies have been conducted for designing and evaluating SOPs. In ( Federal Emergency Management Agency United States Fire Administration, 1999) authors provide a guide that explains how SOPs can be developed, lists topic areas that should be covered, and describes various styles and formats. While in (Community Workers, 2014) researchers outline a process to assist with the development of workplace-specific Safe Operating Procedures for plant, hardware, chemicals, work tasks and processes that have the potential to cause harm to workers, plant, material or the environment as identified from risk assessments. Roza_Albareta in (Roza Albareta and Mursanto, 2019) used the scrum method to design a standard operating procedure in software development based on three steps: Initiation, Development, and Iteration Planning. de Ferluc in (de Ferluc, 2018) propose a new approach to formalize the test and procedure activities using the open-source Capella modelling tool and its associated methodology Arcadia. de Freitas (Freitas, 2016) propose an evaluation for three standard operational procedures (SOPs) using an application of a questionnaire and to verify whether the SOPs are effective and assess the necessity for improvement.

In summary, it is learned that the above proposed works are paper-based describing the process of

developing and evaluating SOPs with respect to the industry regulations and business standards. The major advantage of our proposed approach compared to the others is that it is model-based that uses URN notations for SOPs evaluation.

# 3 APPROACH OVERVIEW

## 3.1 The Development Process of SOP

Constituencies in organizations are using SOPs at different levels of management to facilitate and organize their regularly recurring work. The SOPs describe step by step details of the work instructions that conduct the operations correctly and always in the same routine. They are supported by different organization forms and templates which can be presented as paper-based or web-based. Many constituencies at are participating in the process of developing and validating the SOP. Ideally, all constituencies need to participate actively at all levels, however, it is recognized that this ideal approach may not be achieved with ease and become consistent all the times. The SOP development process is an end to end activities that is used to build an efficient and reliable work instruction to meet the organization goals and comply with the internal policies and regulations.

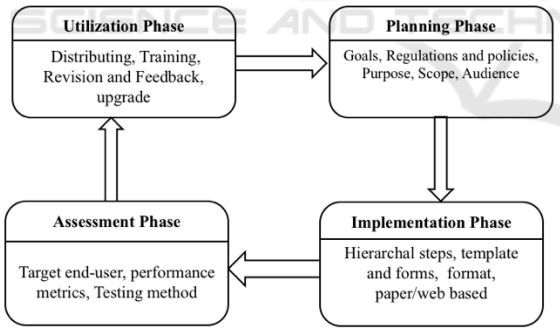


Figure 2: The Development Process of SOP.

Figure 2 describes the periodic process of SOP development:

1. Planning phase: it clearly identifies the initial definitions of the SOP such as the purpose of the development, the scope and limitations, the related policies and regulations, the performance metrics that will impact the organization goals. Also, it specifies the involved constituencies, the target audience, their expected skills and language.
2. Implementation phase: it focuses on the template format and writing style of the SOP based on whether it is a new or an existing. In many cases, the layout of the implemented SOP is built from a pre-existing one.
3. Assessment phase: the implemented SOPs are evaluated and reviewed using different kinds of assessment methods and feedback, such as surveys, periodic progress reports and log files. Target audience are involved in assessing and adjusting the SOPs under test.
4. Utilization phase: SOPs are distributed as paper-based or web-based in this phase. Training session could be provided, if needed, to elevate the audience skills. Also, feedback from audience is documented for future SOP update and enhancement.

Standard Operating Procedures (SOPs) are written documents or work instructions that detail all of the steps involved in a procedure or process. The SOP development services include end-to-end level mapping of processes and formatting SOPs to the template and organization structures. In this section, we propose a model-based approach that can be used to review systematically the measures of the SOPs with respect to the goals and objectives of an organization. Our proposed approach provides two levels of modelling:

a. The Goal model which describes the objectives and goals of an organization. These goals represent what the organization expects to accomplish over the next years. The objectives and goals can be achieved by a multiple of tasks with the ability to assessed by different performance metrics. Each Task represents an SOP in the organization which can be realized as operation behaviour described in the underlying scenario models. Different kinds of constituencies are also involved as active actors and stakeholders.
b. A group of scenario models to describe activities of the underlying SOPs. A Scenario is a collection of procedures and steps owned by different stakeholders and executed in a certain order based on multiple rules and constraints.

The performance of SOPs can be measured using different performance quality metrics. These measures are added to the goal model and scenario model of the SOPs, such as:

- Processing time: the expected completion time of an SOP.

- Efficiency: the ratio between the active time and the waiting time during the processing time of an SOP.
- Usability: the ease of use and learnability.
- Throughput: the number of completed SOPs per month.
- The number of constituencies involved in completing the SOP.

## 3.2 The Model-based Approach

In our proposed approach, we introduce the user requirement notation (URN) to describe two level of modelling as in figure 3. The proposed approach is supported by jUCMNav, an open source eclipse plugin. jUCMNav is a graphical editor that is used to improve the goal and scenario modelling through rich graphical formatting features. The coloring scheme is one of these features. It measures and monitor the achievement degree of the model elements using three main levels and different shades for values in between: unsatisfied (red), neutral (yellow), and satisfied (green).

We use GRL modelling to build a hierarchical goal model. The organization mission defines the high-level goals (softgoal) while the SOPs define the tasks. The contribution relationship describes how an element participate to the other elements in GRL model; the contribution impact can be within a range of +100% (positive) to -100% (negative). The performance metrics are also defined in the goal model as key performance indicators (KPIs). KPI defines the performance quality metrics that contributes to different SOPs in the model. A KPI has an evaluation value that measures the current situation. It ranges between the +100% (positive), +0% (neutral) or -100% negative values. Stakeholders are represented as actors to define their ownership and responsibility in the goal model.

There is also a group of usecase map models (UCM) that describe the behaviour of each SOP where components represent actors and artifacts, responsibilities represent actions, stubs represent sub-maps and workflow is modelled using starting points, ending points, and sequential, alternative and concurrent flows.

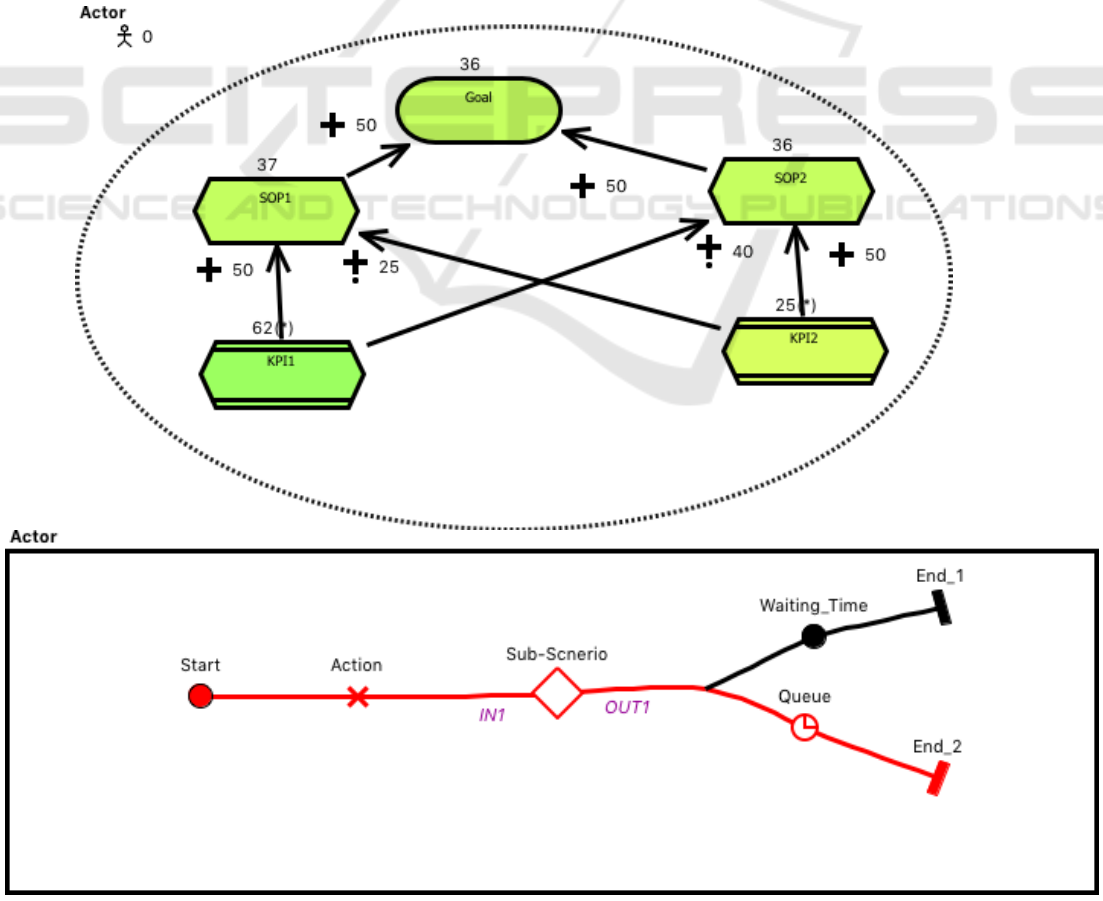


Figure 3: An arbitrary SOP goal model and Scenario model.

# 4 CASE STUDY

In this section, we introduce a sample of our SOP evaluation modelling approach (figure 4). The sample is a goal model and scenario model developed at the Admission and Registration department in Al-Ahliyya Amman University (2019) as a part of an on-going project. The project aims to monitor and improve of the Standard Operating Procedures at Al-Ahliyya Amman University to obtain the best quality of service. The values of performance metrics defined in the SOP model are extracted from several admission and registration reports. These reports are issued weekly, biweekly and monthly. They contain the number of the new applications, the day and time of submission/completion, the names and roles of the involved constituencies, the delay time and cause of the delay, …etc. These values are used in evaluating the performance of the SOPs with respect to the target values.

Figure 4 describes the GRL goal model where the Admission and Registration Department represents the actor. The top-level goal is the University Mission as defined in (Al-Ahliyya Amman University, 2019). A sample of three SOPs: College Admission, Semester Registration and Course Withdraw, contributes to the university mission by 25%. The goal model also defines three key performance indicators (KPIs): processing time, throughput and efficiency. Each one of them contributes to the SOPs in a range of 10% to 75%. The evaluation values of these KPIs are calculated using the underlying UCM scenario models. These values are: Processing time=14, Efficiency= 85 and Throughout= 28. The goal model shows that the performance of the College Admission (evaluation value= 23) and the Course Withdraw (evaluation value= 49) are relatively weak this is due to long processing time and throughput. The performance of the Semester Registration is acceptable (evaluation value= 77). The overall performance of the University Mission is weakly acceptable (evaluation value= 35).

Figure 5 describe is a sample of College Admission SOP. In this scenario two actors are involved: the New Applicant and the Admission Office. The scenario begins when a new applicant performs a preliminary preparations which may include, accrediting of high school degree and language test. The new applicant can either applies an online or paper-based admission application. The admission office is then review the application and the waiting time depends on the queue of new applications. The admission office is then check for the completion of the required documents and contact the new applicant if it is not complete. When the admission application is complete, it creates an admission file for a new application. During the daily meeting of the admission committee, a decision is made regarding accepting or rejecting the new applications. The new applicant is then contacted and informed of the status of his application. If the application is accepted, the new applicant is informed with the pre-approved admission and requested to pay the admission fees. If the applicant is rejected, he will be informed with reason of the rejection.

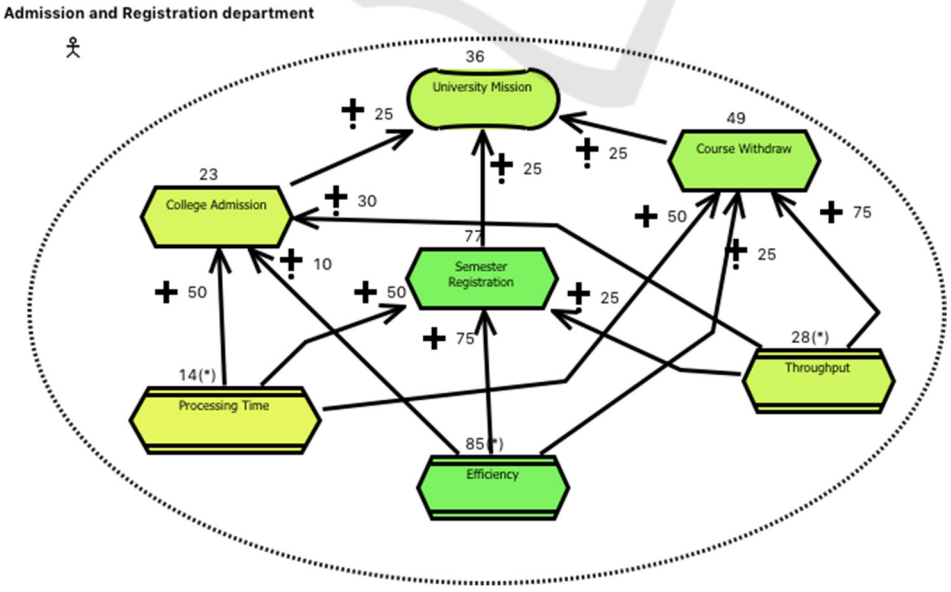


Figure 4: Case study goal model.

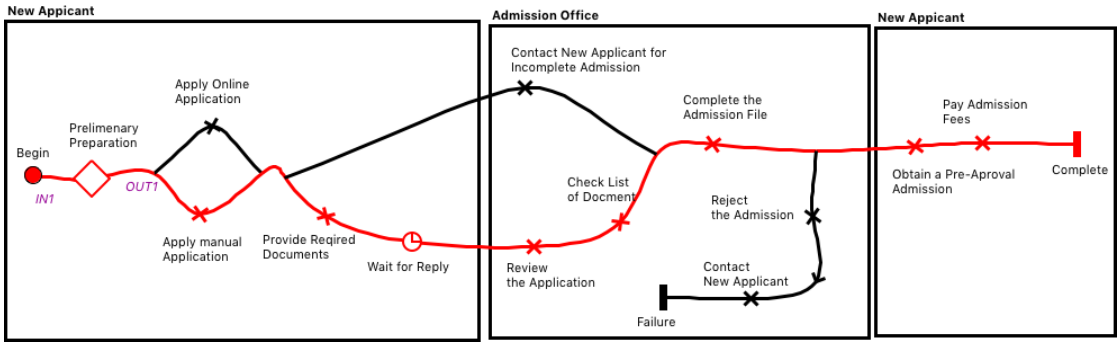


Figure 5: Scenario model of College Admission SOP.

## 5 CONCLUSIONS

The paper proposes a new model-based approach that allows the SOPs to be modelled using GRL language for goal modelling and UCM language for scenario modelling. In our approach, we use GRL models at the validation and verification phase to describe the organization goals, associated with the SOPs, while the UCM models are used to describe the behaviour of the SOPs using branching, concurrency and conditional workflows. Our proposed approach describes the performance metrics in GRL models as KPIs, to measure the quality of the SOPs and their compliance with the organization goals. The UCM model can be used for performance analysis in order to calculate the throughput, branching delays and the overall delay. Stakeholders are represented as actors to define their ownership and responsibility in the goal model and scenario model.

As future work, we are planning to extend the model-based approach to include the industry regulations and business standards in the GRL model and extend the performance metrics. Also, we are planning to use our approach to model more complex case studies.

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