On the Use of Goal Models and Business Process Models for Elicitation of System Requirements

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Abstract. Goal modelling and business process modelling are two techniques that can be used for elicitation of system requirements of an information system. In general, goal-based approaches aim at supporting the objectives that an organization needs to achieve, whereas business process-based approaches aim at supporting the activity of an organization. Consequently, it could be assumed that these two types of approaches represent completely different perspectives for elicitation of system requirements. In this paper we argue that a correspondence exists between the perspectives and that they can be considered equivalent in some operational aspects. Therefore, the use of a perspective also implies support for the other. This argument is based on the definition of a set of guidelines that shows how a goal model can be derived from a business process model. As a result, we discuss when selection of one of the perspectives or their combination would be more suitable for requirements elicitation.

Keywords: goal modelling, business process modelling, requirements elicitation, requirements engineering, information system.

1 Introduction

Requirements elicitation is the fist activity of the requirements engineering (RE) process. This activity aims at discovering the purpose of a software system, which is later refined and mapped into system requirements. When having to elicit the system requirements of an information system (IS) for an organization, different techniques and types of approaches can be used [25, 36]. For example, goal modelling and business process modelling can be used for elicitation of system requirements. They have also driven many research efforts and been applied in industry [17, 31, 45].

Goals have long been recognized to be essential components of the RE process [45]. They can be defined as objectives that a software system should fulfil in order to meet stakeholders' needs. Therefore, goal-based RE approaches for elicitation of system requirements mainly aim at developing ISs that support the objectives that an organization needs to achieve by modelling and analysing its goals. Examples of well known goal-based RE approaches are i* [47], KAOS [45], and Map [39].

A business process is a set of structured and ordered activities that are performed in an organization to achieve some business goal [10]. A business process takes inputs

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from the business environment and creates outputs, and is executed coordinately and dynamically by people and/or technical components that exchange information. Therefore, business process-based RE approaches for elicitation of systems requirements mainly aim at developing ISs that support the activity of an organization by modelling and analysing its business processes. Examples of well-known business process-based RE approaches are EKD [5], ARIS [41], and some based on UML [13].

Both goal modelling and business process modelling deal with business requirements (aka early requirements) for elicitation of system requirements and can be very important for IS development. For example, business/IT alignment is reached when business goals, activities, and processes of an organization are in harmony with the technology that supports them [30]. However, it could be considered that goal-based RE approaches and business process-based ones are completely different and that no direct correspondence exists between them because of the explicit focus on different aspects of the application domain (objectives vs. activities). Indeed, existing research that has dealt with derivation of business process models from goal models (e.g., [26]) has had to extend goal models with business process-oriented details.

In this paper, we discuss the correspondence that exists between goal models and business process models for elicitation of system requirements. For this purpose, we present a set of guidelines that allow derivation of a goal model from a business process model without providing extra information. The guidelines are based on patterns that can be found in business process models.

As a result, we show how both models can be considered equivalent in some operational aspects, thus elicitation of system requirements from business process models also implies support for organizational goals, and vice versa. In addition, we discuss when combination of goal and business process models or use of one of these techniques would be more suitable. This is useful in practice when having to decide upon their use. To our knowledge, this issue has not been addressed in literature yet.

The rest of the paper is organized as follows. Section 2 reviews background work. Section 3 presents how a goal model can be derived from a business process model. Section 4 discusses their correspondence. Finally, Section 5 presents our conclusions.

2 Background

This section presents the background work on which the paper is based. First, operational goals in business processes are discussed. Next, related work is reviewed.

2.1 Operational Goals

Business processes have goals that must be fulfilled during their execution [24]. There are sub-goals that denote milestones within a business process and whose fulfilment is possible due to the actions of all the participants involved [35]. These sub-goals are called operational goals, and indicate when an instance of a business process (model) can be considered completed [2]. Therefore, an operational goal is an objective or state that is or may be reached in a business process and indicates its completion.

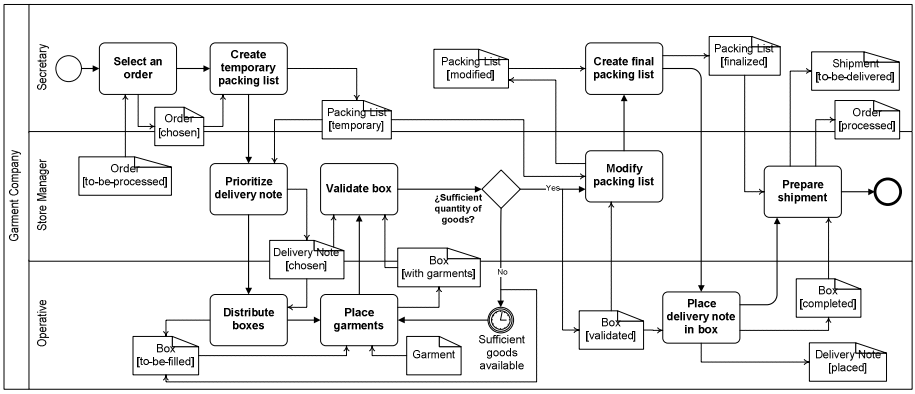

Fig. 1. Example of BPD

In most of the notations for business process modelling (e.g., BPMN [33]), operational goals are implicitly declared in the structure of a business process model and the states of its resources and data entities. These entities and resources are input or output of the activities of a business process, and their states can change during the execution of the business process. As an example, Fig. 1 shows a BPD (Business Process Diagram, a business process model in BPMN). A description of the business process is not provided due to page limitations. It can be found in [10].

Since operational goals are implicitly part of a business process model, then a business process model can be considered equivalent to a goal model at least in some aspects. Therefore, a goal model can be derived from a business process model. Nonetheless, the correspondence between the models must be determined. If such a correspondence is found, then a business process model could be mapped into a goal model from patterns of the business process.

In addition to a business process model, a domain data model (Fig. 2) may be necessary for derivation of a goal model. This model includes (1) the entities that are used in a business process and whose states change as a result of its execution, and (2) the relations between the entities (associations and aggregations).

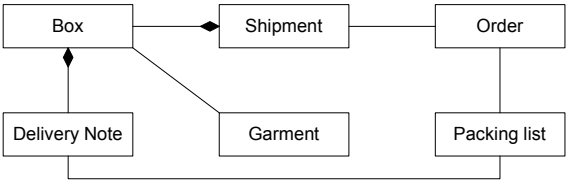

Fig. 2. Example of domain data model

2.2 Related Work

To our knowledge, this is the first paper that explicitly discusses the correspondence between goal models and business process models for elicitation of system requirements of ISs. Nonetheless, we are aware of works that have dealt with both types of models. These works are reviewed in this section.

In previous work, we dealt with elicitation of use cases from business process goals [11]. Although we also addressed derivation of a goal model from a business process model, the guidelines provided were not complete because some patterns of a business process model were not considered. A similar approach is presented in [7]. The authors proposed the concept of intentional fragments in BPDs as a set of elements of a process with a common purpose. These fragments are structured in the form of a KAOS model. However, the set of heuristics defined is limited if compared to, for instance, the number of guidelines presented in this paper.

In [12], we combined BPDs with Map models in order to represent the As-Is situation of an organization and analyse the strategic goals that an IS must help the organization to achieve. As a result, BPDs may change (To-Be situation). Task descriptions can then be elicited from BPDs.

Well-known business process-based RE approaches such as EKD [5], ARIS [41], and some based on UML [13] combine business process models and goal models by specifying the business goals that are fulfilled by executing a given business process. This is probably the most frequent way to combine goal models and business process models, and it can be found in other works such as [3, 19, 24, 37]. Guidance for discovering goals from scenarios and vice versa has also been proposed (e.g., [1, 38]).

Combination of BPMN with i* and with KAOS has been addressed in [21] and [22], respectively. Although derivation of business process models from goal models has been addressed in [8, 15], challenges and problems such as insufficient concept mapping have been found [9].

Some works have presented ways to extend business process models with information related to non-functional requirements and goals. For example, service-level agreement information has been interwoven in business process models in [14], combination of variability analysis and non-functional requirements to drive the configuration of a business process is presented in [40], systematic use of soft-goals in process design was addressed in [42], and value-oriented process modelling has been discussed in [46]. Examples of works that have proposed explicit specification of goals in business process models are [27, 28, 35]. A review of different approaches for business process modelling can be found in [2, 23].

With regard to the extension of goal models with business process characteristics, i* diagrams were extended in [26] with details such as sequence constraints and event happening. Similar approaches have been presented in [8, 14]. i* diagrams have also been used to identify business processes [29] and to represent business process goals [6]. Although Map models have been used to model business processes (e.g., [32]), they do not include important information such as business process participants.

In summary, much research has dealt with the combination of goal and business process modelling, focusing on improving the techniques with details of the other and aligning them. This shows the relevance of their combination and that the techniques are not completely equivalent. However, no work has discussed and thus justified under what circumstances (1) both techniques can be considered equivalent and (2) a technique could be more suitable. In addition, a complete set of guidelines for derivation of goal models from business process models has not been provided yet.

Last but not least, some works (e.g., [16, 18, 43]) have discussed the selection of approaches for elicitation of system requirements. However, they have not analysed business process-based approaches thus neither compared them with goal-based ones.

3 Derivation of Goal Models from Business Process Models

This section presents how goal models in the form of goal trees can be derived from business process models. For this purpose, a set of preliminary concepts is introduced and a set of guidelines is provided.

3.1 Preliminary Concepts for Derivation of Goal Trees

Derivation of goal trees from business process models is based on several concepts. The concepts also aim to facilitate the explanation and understanding of the derivation process.

A **goal tree** consists of operational goals that are decomposed into other goals or tasks by means of AND and OR decompositions. A task is an atomic activity that is performed to fulfil a goal. The contributions of other goals or tasks are necessary to fulfil an operation goal. The semantics of an AND decomposition is that all the descendant elements have to be fulfilled (for goals) or performed (for tasks) in order to fulfil the decomposed goal. For an OR decomposition, the decomposed goal will be fulfilled when some of the descendant elements are fulfilled or performed. Therefore, OR decompositions depict alternative ways to fulfil a goal.

Several concepts have been defined to specify the guidelines for derivation of a goal tree from patterns of a business process model. These concepts might be complicated, but they are necessary to simplify the explanation of the guidelines. Fig. 3 shows some patterns modelled with BPMN that are used to explain the concepts.

The **basic flow** of a business process model is the set of elements that are executed in all the instances of the business process. In Fig. 3, the basic flow of BP1 is the set of elements {1, 2, 3, 5, 6, 7, 10, 13}.

An **alternative flow** in a business process model is a set of flow objects that is not part of the basic flow of the model and does not have more than one connection to another flow (regardless whether the flow is basic or alternative). In Fig. 3, the alternative flows of BP1 are the sets of elements {4}, {8}, {9} and {11, 12}. The set {9, 11, 12} is not an alternative flow because it would have two connections with the basic flow (9 and 12 with 10).

A **loop** in a business process model is an iteration of a sequence of elements of the model. In Fig. 3, the sequence of elements {16, 15} is a loop in BP2.

A **loop with alternative executions** in a business process model is a loop that contains elements that are part of the basic flow of the model as well as elements that are not. In Fig. 3, the loop {20, 21, 19} in BP3 is a loop with alternative executions.

An **alternative execution of a loop** in a business process model is each possible execution of a loop with alternative executions. The sequence of elements of the loop that are part of the basic flow of the model is an alternative execution of the loop too. In Fig. 3, the sequences of elements {19, 20} and {21, 19, 20} in BP3 are the alternative executions of the loop.

A **branching place** of a business process model is a place in the model where:

a. an alternative flow begins, and;
b. some alternative flow that begins from the place is not part of a loop whose end condition is checked in the place.

In Fig. 3, the branching places of BP1 are (3), (7) and (11). In BP4, (25) is a branching place too. However, place (20) in BP3 is not a branching place because it does not fulfil the second condition.

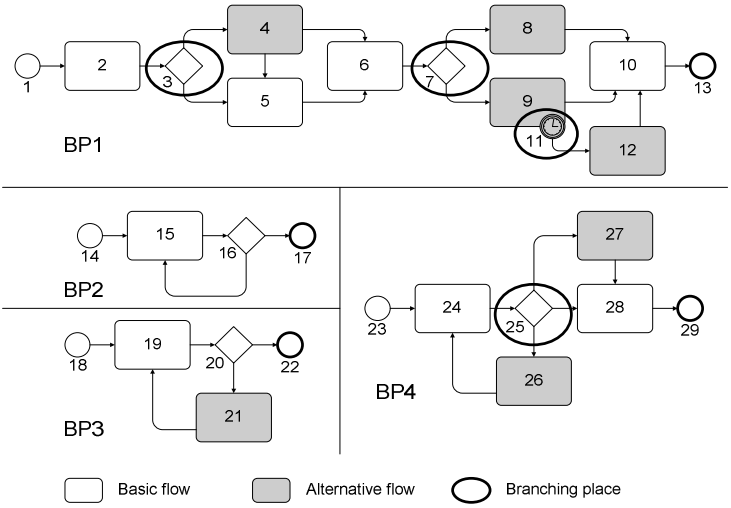

Fig. 3. Patterns in business process models

3.2 Guidelines for Derivation of Goal Trees from Business Process Models

Possibility of derivation of goal models from business process models was discussed and initially justified in Section 2.1 on the basis of the implicit (or explicit, depending on the notation) existence and modelling of operational goals in a business process model. This section presents the guidelines for derivation of goal trees.

We have defined these guidelines from the analysis of several, different BPDs, and also taking into account the structure of goal trees. The guidelines have been divided into four groups: derivation, refinement, contribution, and completion guidelines. For definition of the guidelines, BPMN terminology is used.

Derivation guidelines allow goals and tasks to be defined and named. Refinement guidelines allow the type of decomposition of a goal to be determined. Contribution guidelines allow contributions of goals and tasks to the fulfilment of other goals to be determined. Finally, completion guidelines allow a goal tree to be finished.

The contribution guidelines and the refinement guidelines are applied together. For example, the refinement guideline R.1 needs a contribution guideline (guideline C.1) in order to define the descendant elements of the goal that is refined.

Table 1 shows a summary of the guidelines. It presents the mapping of BPD elements and patterns into elements of a goal tree, as well as the elements of a goal tree and the type of decomposition that contribute to the fulfilment of a goal. Table 1 also provides the rationale of the guidelines implicitly. For example, a branching place in a business process model represents a goal that must be fulfilled in the process and can be fulfilled in different ways (i.e., by executing different branches).

Table 1. Summary of guidelines to derive a goal tree from a BPD

BPD element	Element of a goal tree	Decom-position	Descendent element
BPD	Goal	AND	Goals and tasks that do not contribute to another goal in the goal tree
Sub-process	Goal	-	-
Task	Task	-	-
Event with a trigger	Task	-	-
Loop with no alternative executions	Goal	AND	Goals and tasks derived from the BPD elements of the loop
Loop with alternative executions	Goal	OR	Goals derived from the alternative executions of the loop
Alternative execution of a loop	Goal	AND	Goals and tasks derived from the BPD elements of the alternative execution
Branching place	Goal	OR	Goals derived from the branches that follow the branching place
Branch that follows a branching place	Goal	AND	Goals and tasks derived from the BPD elements of the branch
Data object	Goal	AND	Goals and tasks derived from BPD elements that change the state of the data object and are not in a loop Goals derived from loops that change the state of the data object Goals derived from other data objects that are related to the data object by means of an inclusive aggregation relation

As an example, Fig. 4 shows the goal tree derived from the BPD in Fig. 1. The goal tree can be considered similar to a Tropos [4] or KAOS goal model [45]. In relation to this fact, a combination of the i* notation for modelling of goals and tasks and of the structure of the KAOS goal model is used in the goal tree.

Table 2 shows the guidelines that have been applied to derive the goal tree in Fig. 4. For each element of the goal tree, the guidelines applied for its derivation, refinement, and contribution are specified. It must be noted that completion guidelines are not applied in this example.

The next subsections present the guidelines of each group defined.

3.2.1 Derivation Guidelines

D.1 (BPDs). A BPD depicts a goal that corresponds to the root of a goal tree and is fulfilled when the business process ends. The name of the goal in the goal tree is the same as the name of the BPD.

D.2 (sub-processes). A sub-process in a BPD depicts a goal in a goal tree that is fulfilled when the sub-process ends. The name of the goal in the goal tree is the same as the name of the sub-process in the BPD.

D.3 (tasks). A task in a BPD depicts a task in a goal tree. The name of the task in the goal tree is the same as the name of the task in the BPD.

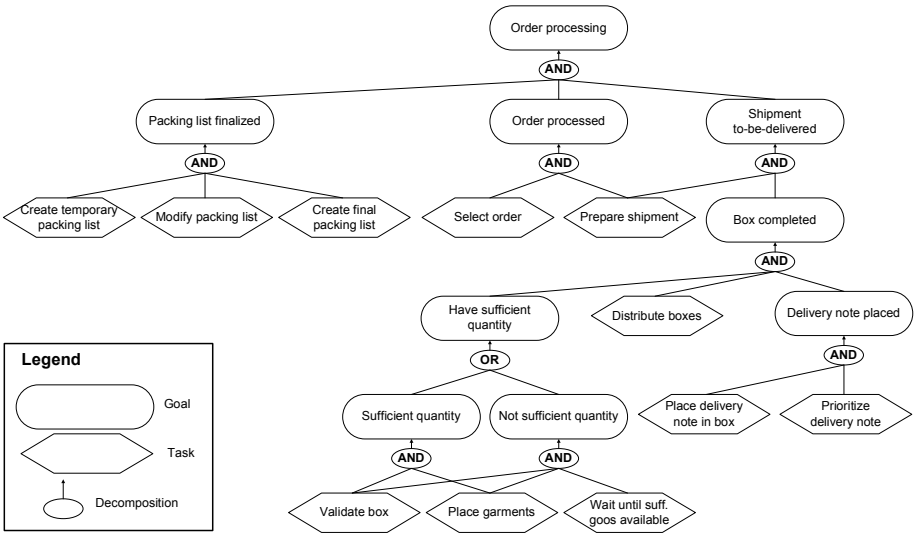

Fig. 4. Example of goal tree

D.4 (events). An event with a trigger in a BPD depicts a task in a goal tree (except link triggers, which are only used to link BPDs). The name of the task in the goal tree will depend on the criterion of the creator, but it has to refer to the event type (start, intermediate, final) and the event trigger (message, timer, cancel…).

D.5 (loops). A loop in a BPD depicts a goal in a goal tree that is fulfilled when the loop ends. The name of the goal will depend on the criterion of the creator, but it has to refer to the condition that is fulfilled when the loop ends.

D.6 (alternative executions of a loop). An alternative execution of a loop in a BPD depicts a goal in a goal tree that is fulfilled when the alternative execution is executed. The name of the goal will depend on the criterion of the creator.

Table 2. Guidelines applied to derive the goal tree of Fig. 4

Element of the goal tree	Guidelines
Order processing	D.1 / R.1 / C.9
Packing list finalized, Order processed, Delivery note placed	D.9 / R.1 / C.6
Create temporary packing list, Modify packing list, Create final packing list, Select order, Prepare shipment, Validate box, Place garments, Distribute boxes, Place delivery note in box, Prioritize delivery note	D.3 / - / -
Shipment to-be-delivered	D.9 / R.1 / C.6, C.8
Box completed	D.9 / R.1 / C.6, C.7, C.8
Have sufficient quantity	D.5 / R.2 / C.2
Sufficient quantity, Not sufficient quantity	D.6 / R.1 / C.3
Wait until sufficient goods are available	D.4 / - / -

D.7 (branching places). A branching place in a BPD depicts a goal in a goal tree that is fulfilled when all the branches that follow the branching place end or merge into the basic flow. The name of the goal will depend on the criterion of the creator.

D.8 (branches that follow a branching place). A branch in a BPD that follows a branching place depicts a goal that is fulfilled when the branch ends or merges into the basic flow. The name of the goal will depend on the criterion of the creator.

D.9 (data objects). A data object in a BPD whose state changes during the execution of the business process depicts a goal in a goal tree that is fulfilled when the data object reaches the last of its states in the BPD. The name of the goal is the name of the data object in the BPD followed by the last state that the data object reaches.

3.2.2 Refinement Guidelines

R.1 (BPDs, loops with no alternative executions, alternative executions of a loop, branches that follow a branching place, and data objects). A goal that is defined from a BPD, a loop with no alternative executions, an alternative execution of a loop, a branch that follows a branching place and whose first flow object belongs to an alternative flow, or a data object whose state changes during the execution of a business process, is refined in a goal tree by means of an AND decomposition.

R.2 (loops with alternative execution and branching places). A goal that is defined from a loop with alternative executions or a branching place is refined in a goal tree by means of an OR decomposition.

3.2.3 Contribution Guidelines

C.1 (elements of a loop with no alternative executions). The goals and tasks that are derived from the elements that are executed in a loop with no alternative executions contribute to the fulfilment of the goal of the loop in a goal tree.

C.2 (alternative executions of a loop). The goals that are derived from the alternative executions of a loop contribute to the fulfilment of the goal of the loop in a goal tree.

C.3 (elements of an alternative execution of a loop). The goals and tasks that are derived from the elements that are executed in an alternative execution of a loop contribute to the fulfilment of the goal of the alternative execution in a goal tree.

C.4 (branches that follow a branching place). The goals that are derived from the branches that follow a branching place contribute to the fulfilment of the goal of the branching place in a goal tree.

C.5 (elements of a branch that follows a branching place). The goals and tasks that are derived from the elements of a branch that follows a branching place and whose first flow object belongs to an alternative flow contribute to the fulfilment of the goal of the branch in a goal tree.

C.6 (data objects). The goals and tasks that are derived from tasks and sub-processes of a BPD, are not executed in a loop, and change the state of a data object contribute to the fulfilment of the goal of the data object in a goal tree.

C.7 (data objects in loops). The goals that are derived from loops whose execution changes the state of a data object contribute to the fulfilment of the goal of the data object in a goal tree.

C.8 (inclusive aggregation relations between data objects). The goals that are derived from a data object that is related to another data object in the domain data model by means of an inclusive aggregation relation (component data object) contribute to the fulfilment of the goal of the latter data object (composed data object) if defined in a goal tree.

C.9 (goals and tasks with no contribution). The goals or tasks in a goal tree that do not contribute to the fulfilment of some goal contribute to the fulfilment of the root of the goal tree.

3.2.4 Completion Guidelines

T.1 (goals with no descendants). The goals that do not have descendants in a goal tree and that have not been derived from a sub-process are changed into tasks.

T.2 (goals with only one descendant). The goals that have only one descendant are removed from a goal tree. The descendant will contribute to the fulfilment of those goals to which the parent goal contributes in the goal tree.

4 Discussion

Once the background, the guidelines for derivation of goal models, and an example of the correspondence between business process models and goal models have been presented in the previous sections, this section discusses the implications that this correspondence has in RE in general and how it is related to other works.

We have divided this section into four subsections to discuss (1) the correspondence between goal models and business process models, (2) when (only) goal models should be used, (3) when (only) business process models should be used, and (4) when both types of models should be combined.

Before presenting each subsection, it must be indicated that selection of goal modelling and/or business process modelling depends on more factors than those discussed in this section. For example, we have observed that many practitioners try to minimize combination of modelling techniques or that they may be reluctant to use a new technique [10]. Other authors have acknowledged similar issues (e.g., [16]). Therefore, these aspects must also be considered when adopting or proposing adoption of goal modelling and business process modelling for elicitation of system requirements. The discussion below does not take these issues into account, and simply present some recommendations based on our reflections and experience, both in academia [10] and in industry (e.g., [34]).

It must also be noted that business process models and goal models are similar and can be considered equivalent in some aspects, but not in all. Selection of one of the types of models should be justified and explained when modelling and analysing and organization or an IS, so that the decision and the rationale behind it are clear. As discussed below, the use of a type of model will depend on the part or aspects of the

application domain and of an IS with which system analysts and other stakeholders are mainly concerned.

The rest of this section presents each subsection defined, referring to other works when possible and considered relevant to support our arguments.

4.1 Correspondence between Goal Models and Business Process Models

As explained in the Introduction, goal-based RE approaches and business process-based RE approaches are initially and in general targeted at support of different aspects of an organization (objectives vs. activity). Nonetheless, we have shown how a goal model can be derived from a business process models, what implies that goal-oriented aspects are implicitly addressed when modelling business processes. As mentioned in Section 2.2, previous works have also studied the derivation of business process models from goal models. Although the goal models had to be extended with business process-oriented information, we think that these works support our argument about the fact that business process-oriented aspects are implicitly addressed when creating goal models.

Consequently, we think that these two perspectives should not be regarded as completely distinct. Past research on their combination has shown that they are complementary, and this paper shows that they can even be considered equivalent in some aspects (e.g., for modelling of operational aspects). Business process models allow specification of part of the information that is gathered and analysed in goal-oriented RE approaches, and goal models allow specification of part of the information that is gathered and analysed in business process-based RE approaches.

One interesting implication of this correspondence that we have found is related to compliance with safety standards in the development of critical systems. Two types of standards are distinguished commonly [20]: goal-based standards and prescriptive standards. The first type focuses on the definition of the objectives that the development of a safety-critical system must fulfil (e.g., "Requirements are specified"), whereas the second type focuses on the definition of the process, activities, and techniques to develop the system (e.g., determining how requirements must be specified by prescribing or recommending some specific techniques).

These two types of standards are usually considered to represent different perspectives for the development of safety-critical systems. However, and in line with the arguments presented in this paper, we think that they can be regarded as equivalent in some aspects. Indeed, compliance with any of the types of standards requires the definition and approval of a system lifecycle plan that meets the standards' criteria. This plan basically corresponds to a business process for system analysis, development, verification and validation, maintenance, and decommission.

As also acknowledged in the system safety community (e.g., [20]), probably the main difference between the two types of the standards lies in the fact that goal-based standards usually present more abstract safety criteria. Consequently, they provide more flexibility with regard to the final decisions upon the process and techniques to use for developing a safety-critical system. This is in line with some of the main reasons for using goal models in RE [36, 45], and with the discussion below.

With regard to our past work, we have always believed that ISs must support the business processes of an organization, thus we have initially focused on business

process modelling in the approaches that we have developed and applied. However, we have also realised that there are some aspects such as the system purpose that cannot be always accurately captured in business process models. As a result, and for instance, we combine BPMN and Map and analyse the need of their use on the basis of the characteristics of a project.

4.2 When Should Goal Models Be Used?

We consider that goal models and business process models can be regarded as equivalent for modelling of some operational aspects of an organization. Nonetheless, there are situations in which goals models might be considered better suited for modelling of business requirements.

For situations in which an organization does not have a clear procedure defined, or even it does not exist, we considered that the use of goal models would be more adequate. First, designing and modelling business processes "from scratch" could be very difficult because employees would not be able to provide information about the procedures they follow. Consequently, their validation could also be hindered. Second, by modelling and analysing (strategic) goals, system analysts can at least try to guarantee that the system requirements meet organizational goals. Support for the operational aspects, once the strategic ones have been refined, would imply support for business process aspects (i.e., for organizational activity).

Finally, we consider that in situations in which no procedure exists, goal modelling facilitates variability analysis. We think that it is easier to model and analyse alternatives in goal models than directly model business processes, trying to define alternative paths without any rationale such as the possible alternative ways to fulfil a given goal. In addition, guidance can easily be found regarding analysis of alternatives in goal models (e.g., [45]).

Goal modelling can also be regarded as an advisable initial step that facilitates modelling of new business processes in these situations.

4.3 When Should Business Process Models Be Used?

We consider that there is a situation in which the use of only business process models is the most suitable option: development of an IS for an organization that has defined procedures and that mainly needs automation support for its current procedures. Since no fulfilment of new goals or big changes (apart from automation) would be required and expected, we consider that goal models would not be necessary. At least, this is what we have experienced and observed in practice [10, 34]. In many situations, we only use BPMN and do not combine it with Map. It can be argued that this type of projects are not very complex to deal with, but it is also true that, to our knowledge, this is probably the most frequent situation when developing an IS.

In relation to the approach proposed in [11], we now consider that derivation of goal models from business process models for elicitation of system requirements would not be necessary in situations in which automation is the main benefit expected from a new IS. Automation can directly be analysed in business process models, thus modelling of goals may correspond to an unnecessary effort. Furthermore, goal trees

derived from business process models can become very tangled (thus difficult to understand and manage) for complex business processes. Therefore, derivation and analysis of goal trees may not be advisable for these business processes. Studying possible improvements on the guidelines presented might mitigate this problem.

On the other hand, and in line with the discussion above, derivation of a goal tree might facilitate the analysis of alternative, new ways to execute a business process.

4.4 When Should Goal Models and Business Process Models Be Combined?

We consider that combination of goal models and of business process models is clearly justifiable and even necessary in situations in which organizational procedures are (more or less) well-defined, but an organization expects a change in them as a result of the development of an IS and the system must also support fulfilment of some strategic goal. This is the type of situation we addressed in [12, 34], in which combination of BPMN and Map was proposed. This situation and the proposed solution is also line with works such as [3, 19, 26].

On the one hand, combination of goal models and business process models allow all types and abstraction levels of goals of an organization and of an IS to be addressed. In our approach, strategic goals are modelled and analysed on the basis of Map, whereas operational goals are modelled and analysed on the basis of BPMN.

On the other hand, Map complements BPMN by allowing system analysts to analyse the purpose of an IS on the basis of the strategic goals of an organization. BPMN complements Map by allowing system analysts to model details of organizational activity that cannot be modelled with the goal-oriented RE approach or whose modelling presents limitations.

In general and in summary, the combination of goal models and business process model allows analysis of the "why" (goals) and the "what" and "how" (business processes) aspects of the business requirements for an IS.

5 Conclusions and Future Work

This paper has discussed the use and correspondence of goal models and business process models for elicitation of system requirements of an IS. The discussion has been mainly driven by the possibility of deriving a goal model from a business process models. Such derivation is based on a set of 22 guidelines for mapping of patterns and elements of a business process model into a goal tree. The guidelines allow derivation and refinement of goal tree elements, determination of the elements to which another contributes, and completion of a goal tree. They show how both types of models can be regarded as equivalent in some operational aspects.

Although goal models and business process models can complement each other and can be considered equivalent in some operational aspects, we consider that there are situations in which their combination is not necessary or use of only one technique is more suitable. Goal models should be used when dealing with new situations in an organization, with strategic goals, or with variability, whereas business process models should be used when an IS is mainly aimed at supporting and automating

existing, running activity of an organization. Both types of models should be combined if both strategic and known operational issues had to be addressed.

As future work, we want to validate the guidelines presented by analysing their support to workflow patterns [44], and to analyse in detail the quality of the goal models derived. We also want to gain further insights into the use of goal models and business process models in practice. Finally, we would like to analyse how this paper relates to others on the selection of RE approaches (e.g., [18, 43]).

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