Intentional Fragments: Bridging the Gap between Organizational and Intentional Levels in Business Processes

Mario Cortes-Cornax[1], Alexandru Matei[2], Emmanuel Letier[2], Sophie Dupuy-Chessa[1], and Dominique Rieu[1]

[1] University of Grenoble, CNRS, LIG
{Mario.Cortes-Cornax,Sophie.Dupuy,Dominique.Rieu}@imag.fr
http://sigma.imag.fr/
[2] University College London, Gower Street, London WC1E 6BT, United Kingdom
alexandru.matei.09@ucl.ac.uk, e.letier@cs.ucl.ac.uk

Abstract. Business process models provide a natural way to describe real-world processes to be supported by software-intensive systems. These models can be used to analyze processes in the system-as-is and describe potential improvements for the system-to-be. There is however little support to analyze how well a given business process models satisfies its business goals. Our objective is to address these problems by relating business process models to goal models so that goal-oriented requirements engineering techniques can be used to analyze how well the business processes for the system-as-is satisfy the business goals. The paper establishes relationships between BPMN 2.0 and the KAOS goal-oriented requirements modelling framework. We present the notion of intentional fragment to bridge the gap between process models and goal models. We conducted an evaluation to analyze use of this concept in the context of a university process.

Keywords: Process Modelling, Business Process Management, Goal-oriented Requirements Modelling, KAOS, BPMN 2.0.

1 Introduction

Business process models provide a natural way to describe real-world processes to be supported by software-intensive systems. These models are widely used in the industry as an important source of information about the current or future processes in a company. A widely recognized problem among the business analysts is the lack of a clear correspondence between business process models and business objectives, rules and constraints [1]. This fact decreases the value of such models, since it keeps the rationale behind each process implicit [2,3]. These problems have also been discussed in the context of the Business Process Model and Notation (BPMN) [4]. Indeed, most practitioners point out the lack of business rules behind BPMN models [5].

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Different approaches have been proposed in the academia for relating business process models with business objectives or constraints using frameworks such as Non-Functional Requirements (NFR) [6], i* [7], Tropos [8] or KAOS [9]. Their scope ranges from establishing semantic correspondences between process models and goal models [8] to addressing non-functional requirements satisfaction [6] or process variability and re-engineering methods [7]. These approaches either assume a pre-existing goal model or define a goal model too tied to the process model. They are generally not focused on how to create a goal model in the first place. However, generating a useful goal model represents a challenge for most business analysts.

Our aim is to relate business process models to goal models maintaining a clear separation of concerns between the two models. Traceability links between these two models will allow the business analyst to explicitly state the rationale of each process activity. A goal-based analysis based on this relation can therefore be applied to identify problems in the process model, such as missing or superfluous activities.

The paper establishes the relationship between BPMN 2.0 and the KAOS goal-oriented modelling framework through the concept of *Intentional Fragment*. An intentional fragment is a set of flow elements of the process with a common purpose. By means of intentional fragments goals are therefore related to the BPMN 2.0 process elements. The paper presents several heuristics to extract potential intentional fragments from the business process that will help constructing goal models from the business process model and also guide the goal-based analysis. We conducted an evaluation using the mission process in the Informatics Laboratory of Grenoble (LIG) to analyze the use of intentional fragment as an efficient and simple way to fill the gap between the organizational level represented by the business process model and the intentional level represented by the goal model.

The paper is organized as follows. Section 2 briefly presents BPMN 2.0 and KAOS framework thought a model used in our case study. Section 3 presents the relation between these two models and a precise definition of the notion of intentional fragment. The case study is discussed in Section 4. In Section 5 analysis questions derived from the notion of intentional fragment are raised. Section 6 presents the related works and finally, future work and conclusions are discussed in Section 7.

2 BPMN 2.0 Process Models and KAOS Goal Models

This section presents both BPMN 2.0 and KAOS languages through a running example that relies on the mission process (e.g., conference travel or speech invitation) in the Informatics Laboratory of Grenoble (LIG). We choose BPMN 2.0 since it is the de-facto standard to model business processes. KAOS on the other hand is a well known framework for goal modelling which comes with a powerful set of goal oriented analysis techniques.

2.1 Running Example Modelled in BPMN 2.0

The main scope of BPMN is to describe business processes in an accessible way at different levels of granularity (i.e., from abstract design models to detailed executable models). Figure 1 shows a design model of the mission process in the Informatics Laboratory of Grenoble (LIG) modelled in BPMN 2.0. A *Process* in BPMN 2.0 is defined as "a sequence or flow of activities in a specific organization with the objective of carrying out work" [4]. A *Process* in BPMN 2.0 might be enclosed in a *Pool* which identifies the process responsible (*Participant*)(e.g. *Travel Agency* and *LIG*). To organize and categorize *Activities* within a *Pool*, *Lanes* are used which usually represent different organizational units in a process (e.g. *Team Leader* and *Employee*). The flow of *Activities*, which represent the work (e.g. "E1: set the travel schedules"), is controlled by *Gateways*, which are the decision making (e.g. "Ok?"). A process starts with a *Start Event* and can finish in different ways captured by the *End Events*.

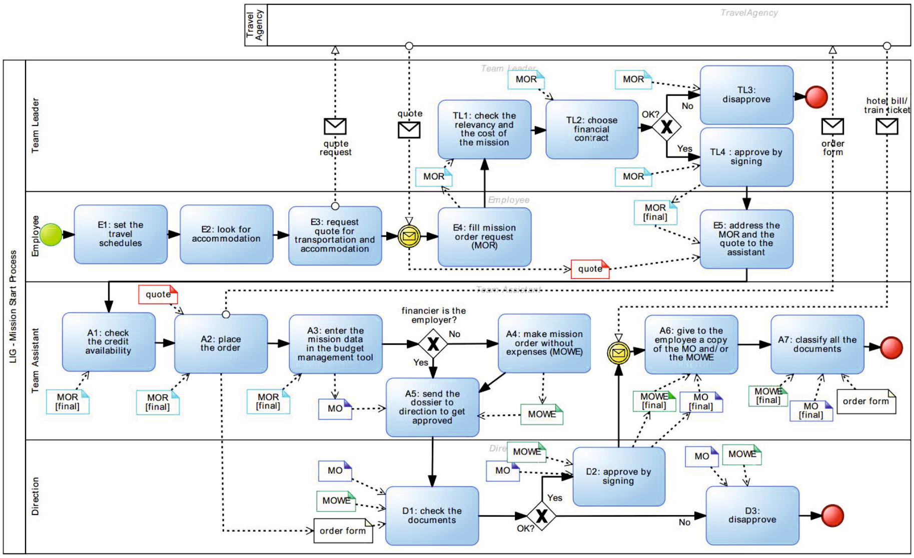


Fig. 1. Mission Process - Before Leaving

Figure 1 describes the steps that permit an *Employee* go in a journey as for example a conference, and then be refunded. An *Employee* must look for convenient travel times and hotel for her destination firstly. Then, she asks for a quote (*quote request*) to the *Travel Agency*. This request is a *Message* linked to a *Sequence Flow*. She calculates the mission costs filling the Mission Order Request (*MOR*) where she add the estimation for the staying expenses in addition to transport and hotel expenses. The *Team Leader* checks the appropriateness and cost of the mission and then approves or disapproves the mission. The *Team Leader* also chooses the contract from which the mission will be financed. Both the *MOR* and the *quote* are addressed to the *Team Assistant* who is in charge of doing all the administration documents so that the *Employee* can leave with warranties to be covered by an assurance and with the *Direction* approval. We present just the first part of the process model, before the *Employee* leaves. Further details in the BPMN 2.0 constructs may be found in the standard [4].

2.2 Goal-Oriented Requirements Modelling in KAOS

Goal-oriented requirements engineering (GORE) supports "the use of goals for eliciting, elaborating, structuring, specifying, analyzing, negotiating, documenting, and modifying requirements" [10].

The KAOS method for GORE offers a precise (formal) way to reason about Requirements Engineering (RE). It defines several complementary system models, including the goal model. *Goals* captured in the goal model are prescriptive statements about the system, capturing desired states or conditions. Goals are organized hierarchically, starting from high level goals (usually corresponding to business objectives). These goals are iteratively refined into *Sub-goals*. Requirements are under the responsibility of *Agents*. Agents are the active components inside the system.

Figure 2 shows an example of goal model (not fully developed) concerning the mission process of Fig. 1. On top, we find the high level goal "Go in a mission comfortably and covered by an assurance" refined into further sub-goals leading to requirements. The responsibility of the requirements are then assigned to the agents. For example, the *Employee* is responsible of the goal (requirement) "Program an informal discussion with the Team Leader to present the mission".

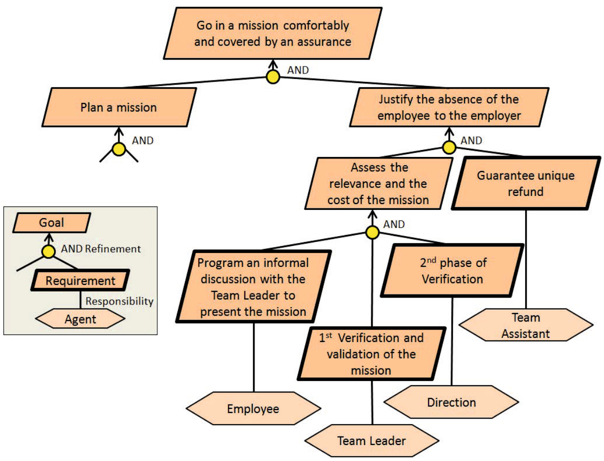


Fig. 2. Example of Goal Model related to the Mission Process

We choose the KAOS method as it has a well developed mechanism to reason about the goal models, including partial goal satisfaction [11] or obstacle analysis [12]. *Obstacles* are conditions that prevent the satisfaction of a goal. Relating

BPMN with KAOS allows the use of these techniques on the goal model inferred from the process model. Other goal-oriented frameworks such as i* [7] are not yet considered because they do not share neither the same terminology nor the theoretical background.

3 Relating Business Process Models and Goal-Oriented Models

This section presents a meta-model that integrates both BPMN 2.0 and KAOS meta-models without changing their individual meaning. It also presents a precise definition of the *Intentional Fragment*.

3.1 The Meta-model Relating BPMN 2.0 and KAOS

This section presents the meta-model in Fig. 3 which introduces the notion of *Intentional Fragment* as a mean to relate the BPMN 2.0 meta-model to the KAOS meta-model. On top of the figure, the KAOS constructs are represented. In the bottom, we represent the BPMN 2.0 constructs that we are interested on. A *Goal* in KAOS could be refined into sub-goals as well as *Agents* could also be refined. An *Agent* MAY be responsible of several *Goals* (0..*). Only the leaf-goals in the goal model are related (not necessarily) to an *Agent*.

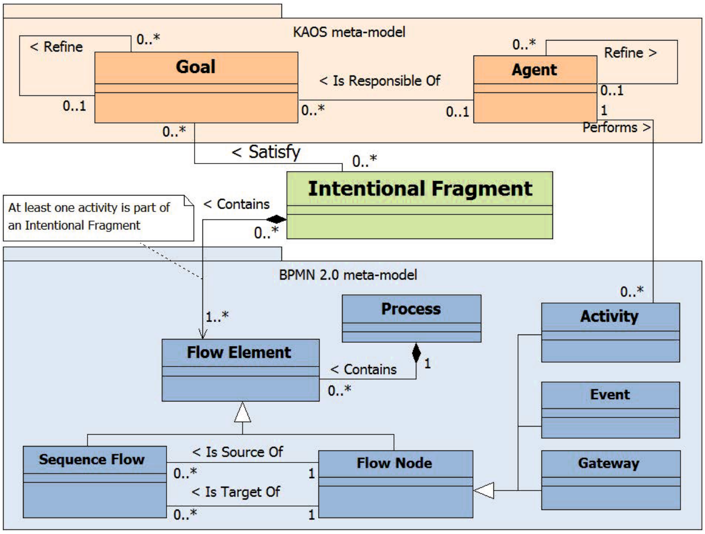
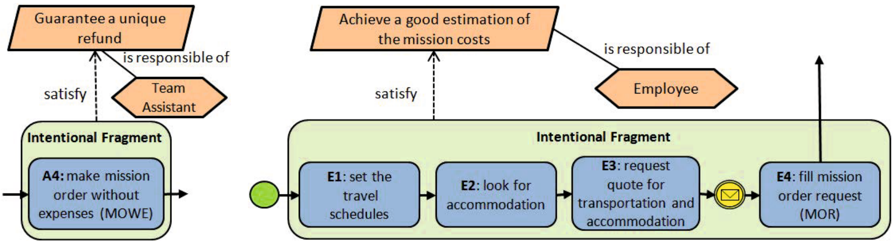


Fig. 3. Meta-model relating BPMN 2.0 and KAOS through Intentional Fragment

In BPMN 2.0 a *Process* contains a set of *Flow Elements* that could be *Flow Nodes* (i.e *Activity*, *Gateway* and *Event*) or *Sequence Flow* (an arrow which defines the sequence of the *Flow Nodes*). An *Intentional Fragment* contains one ore more *Flow Elements* (at least one activity). Several nodes in the process could be related to an *Intentional Fragment*(0..*). An *Intentional Fragment* therefore could be seen as a set nodes in a process (not necessarily connected) that MAY satisfy a *Goal*. A *Goal* MAY be satisfied by several *Intentional Fragments*(0..*). Each of these *Intentional Fragments* represent an alternative way to satisfy the *Goal*. An *Agent* is considered responsible of a *Goal* if it performs all the *Activities* related to a *Goal* through an *Intentional Fragment*.



(a) One-activity IF **(b)** Several-activities IF

Fig. 4. Examples of Intentional Fragments (IF) that Satisfy a Goal

Based on the mission process, Fig. 4 illustrates two examples of intentional fragments linked with their corresponding goals. In the first example, the intentional fragment contains one activity ("A4: make mission order without expenses (MOWE)"). This activity is performed by the *Team Assistant* when the financier sponsor of the mission is not the employer. The MOWE is the document that is needed to control that the *Employee* will not receive an extra refund because the expenses are in charge of an external financier. Therefore, the intentional fragment in Fig. 4a satisfies the goal "Guarantee a unique refund". The second intentional fragment satisfies the goal "Achieve a good estimation of the mission costs". All the activities within an intentional fragment are performed by the *Employee*. This implies that the latter is responsible to fulfill the goal. A more detailed definition of the *Intentional Fragment* is presented in the following section.

We rely on the work of Anaya et al. [13] to use the KAOS *Agent* term to refer to the participant BPMN 2.0 concept. In this work authors present the Unified Entreprise Modelling Language approach (UEML) as a mean of mapping different languages to a common ontology to interrelate construct descriptions at the semantic level (BPMN and KAOS among others). The work shows that an *Agent* in KAOS and a *Participant* in BPMN are both constructs used to show an active entity that do not refer neither to transformations nor states within the overall system. In addition, they could both refer to an abstract entity or a concrete instance. In our work, an *Agent* will also refer to *Lanes* if the latter represent roles in the organization like in our example. One of the advantages of using BPMN and KAOS is that both frameworks allow different levels of granularity: high level goals and sub-processes (compound activities) can be refined into more specific goals and activities, respectively.

Our approach may be developed using resource assignment models [14] to relate agents with performed activities.

3.2 The Intentional Fragment

The *Intentional Fragment* makes explicit a relation between its constituent activities and its corresponding goal that otherwise would not be visible. The identification of intentional fragments is guided by the underlying purpose of the activities. The scope of our discussion is a single process model although the concept of intentional fragment can be expanded in future work to include activities from several process models.

We define a state for an intentional fragment depending on whether or not it satisfies a goal. If the intentional fragment is related to at least one goal, the state of this class will be *Justified* (IFJ). On the other hand if an intentional fragment is not related to any goal, the state is defined as *Potential* (IFP). Following, the definition of this concept is given starting from the definition of a BPMN process:

A BPMN Process $\mathbf{P} = (N, Start, End, \delta)$ is defined by:

- A set N of flow nodes partitioned into *Activities*, *Events* and *Gateways*
- A set of start nodes $Start \subset Events$
- A set of end nodes $End \subset Events$
- A sequence relation $\delta \subset N \times N$ defined as a set of tuples of nodes from the process P satisfying a set of well-formedness constraints defined in the BPMN specification
  - $e_{start} \in Start$ has no predecessor in δ
  - $e_{end} \in End$ has no successor in δ
  - $act \in Activity$ has exactly one successor and one predecessor in δ
  - $gtw \in Gateway$ has either one predecessor and several successors or several predecessors and one successor

An *Intentional Fragment [Potential]* **IFP** of a BPMN process $\mathbf{P} = (N, Start, End, \delta)$ is a tuple $(N', Start', End', \delta')$ such that:

- $N' \subseteq N$
- $Start' \subseteq N'$ is the set of nodes that have no predecessors in **IFP**
- $End' \subseteq N'$ is the set of nodes that have no successors in **IFP**
- A sequence relation $\delta' \subset N' \times N'$ which is the smallest relation satisfying the following criteria:
  - if n_2 is reachable from n_1 in **P**, then n_2 should be reachable from n_1 in **IFP**. We verify whether n_2 is reachable from n_1 using the transitive closure of the sequence flow relation [15] $(\forall n_1, n_2 \in N') n_2 \in n_1.*\delta \Rightarrow n_2 \in n_1.*\delta'$.
  - if n_2 is not reachable from n_1 in **P**, then n_2 should not be reachable from n_1 in **IFP**: $(\forall n_1, n_2 \in N') n_2 \notin n_1.*\delta \Rightarrow n_2 \notin n_1.*\delta'$.

IFJ is an *Intentional Fragment [Justified]* in process $\mathbf{P} = (N, e_{start}, End, \delta)$ for goal **G** iff:

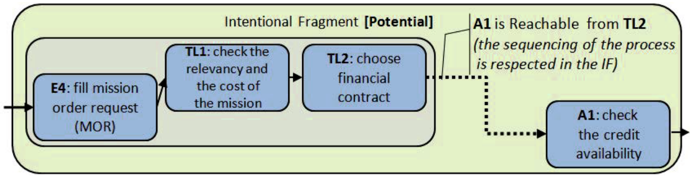
- **Inclusion** criteria: **IFJ** is an Intentional Fragment [Potential] of **P**, as defined above
- **Completeness** criteria: the execution semantic of **IFJ** should be enough to entail goal satisfaction: $[|\mathbf{IFJ}|] \models \mathbf{G}$
- **Minimality** criteria: there is no other fragment **IFJ**' such that $[|\mathbf{IFJ'}|] \models \mathbf{G}$ and $\mathbf{IFJ'} \subset \mathbf{IFJ}$

The definition of intentional fragment that is introduced imposes only the minimum set of constraints necessary to preserve the semantics of the process model. As long as these constraints are respected, analysts have the liberty to decide what constitutes an intentional fragment. However, in future work we will introduce additional well-formedness constraints to support formal verification of the completeness and minimality criteria.

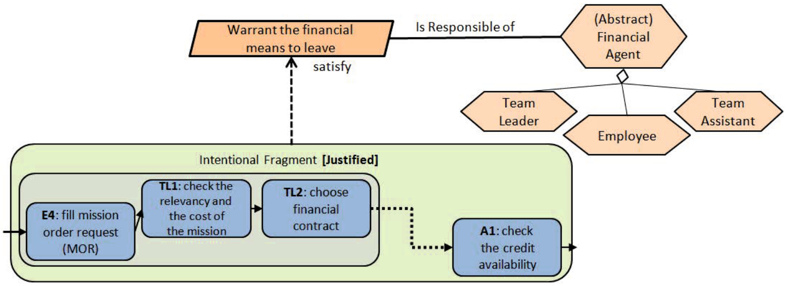
As a precondition to formally verify completeness and minimality criteria, we need to consider how execution semantics for the process are expressed. In the BPMN specification, the execution semantics is presented in a textual form, using the concept of token. A mapping to the Business Process Execution Language for Web Services (WS-BPEL) [16] is also presented, which gives an execution semantics. BPMN semantics have also been expressed using Petri Nets [17] or Calculus of Orchestration of Web Services (COWS) [18]. Although these approaches use event based semantics, state based semantics have also been explored [19].

In future work, we intend to develop automated support for verifying completeness and minimality criteria for IFJ using model checking. This requires expressing the semantics of an intentional fragment in terms of Labelled Transition Systems [20] that can be modelled checked against KAOS goal models [21].

Figure 5a shows an example of intentional fragment in a *Potential* state and we also indicate that the sequencing of disconnected elements follows the process directives (transitive closure property). Figure 5b shows how the *Potential* Intentional Fragment changes its state to *Justified* when it is related to a goal. Every agent that performs at least one of the activities that are part of the fragment is partially responsible for the goal. To represent this joint responsibility, we can introduce an abstract agent that represents the aggregation of all the agents involved. In the example on Fig. 5a the team Leader, the employee and the team Assistant perform activities that are part of the intentional fragment that satisfies the goal. Therefore, the three participants refined an abstract Agent that named *(Abstract) Financial Agent.*



(a) Potential Intentional Fragment (IFP). Not Linked to a Goal



(b) Justified Intentional Fragment (IFJ). Linked to a Goal

Fig. 5. Examples of the Different States of an Intentional Fragment

4 Case Study

This section presents the evaluation of the *Intentional Fragment* concept. This experiment was driven by Nadine Mandrin from the PIMLIG [1] team. Firstly, the evaluation protocol is described. Then, some interesting results are discussed.

4.1 The Evaluation Protocol

Table 1 describes the evaluation protocol that we set up for our case study. We wanted to validate the hypothesis that *"An intentional fragment is an intuitive and useful concept to relate business process models and goal models"*. The available material was the case study that describes the mission process presented in Section 2. Figure 1 shows one of the two parts of the process model that were used in the evaluation. An evaluation keeps the trace of how subjects were using the notion of intentional fragment.

To carry out the evaluation we choose a method recommended by sociology and also by computer designers : the semi-structured interviews [22]. This method belongs to the family of qualitative methods such as participant observation [23] or the focus groups [24]. We choose this interview method as it helps developing a lot of ideas, opinions, or habits, even if they are not frequent within the studied subjects. The goal is not to quantify these behaviors or needs but to make a list as large as possible. Sociology recommends a minimum of 20 interviews in order to reach saturation in this list. Experience shows that

[1] http://www.liglab.fr/pimlig

Table 1. Evaluation Protocol for the Case Study

Subjects
People involved in the mission process of LIG (employees, team assistant, team leader and direction).
Organization
21 personal semi-structured interviews. Around 45 minutes each one.
Evaluation method
The subjects understand, use and evaluate the concept of intentional fragment in a familiar process.
Protocol
• The evaluator explains the mission process (*10min*). • The evaluator proposes 3 intentional fragments and the subject identifies the associated goal for each one (*5 - 10min*). • The evaluator proposes 3 goals and the subject identifies the associated intentional fragment for each one (*5 - 10min*). • The evaluator proposes a free time to identify new goals or intentional fragments. The evaluator captures the trace of the subject's work. The evaluator asks for errors or gaps in the process (*15min*). • The subject comments the usefulness of the concept of intentional fragment (*5min*).

from 20 interviews there is a behavior redundancy and new and original ideas are rare. These interviews are organized face to face with an interview schedule grid. We conducted *21 qualitative interviews* with people that takes part of the process and whose demographic profiles were different in terms of gender, age and modelling experience.

When the process model was inferred, some errors and gaps were detected. We did not correct them so we could also evaluate if our approach could help stakeholders to analyze and detect problems in both the process and the model. We did not provide the complete definition of intentional fragment to subjects to avoid extra complexity. We just define it as *"a set of elements in the process related to a goal"*. After the interviews, we analyzed all the responses to the different exercises.

4.2 First Exercise: Identifying Goals from Intentional Fragments

Three main strategies were observed when during the first exercise. Subjects tended to rely on **abstraction** to identify goals. They grouped sequential activities in a more generic one, which they considered the goal. For example, for the first fragment (Fig. 4b), a common goal proposed was "prepare the mission". Another common strategy is that subjects were guided by the **data objects** that go out from the last activity of the proposed fragment (e.g., "get a mission request order" for the first fragment). Finally, what we consider being the best approach, 11 subjects **synthesized** the elements within the intentional fragment and go beyond abstraction. A good example of goal for the first intentional fragment would be: "achieve a good estimation of the mission costs".

4.3 Second Exercise: Identifying Intentional Fragments from Goals

The second exercise consisted on identifying the intentional fragment corresponding to a given goal. Two specific goals (the first and the third one) and a more general goal (the second one) were proposed: 1) "the benefit against the cost of a mission has to be evaluated", 2) "a financial settlement is established in line with the mission costs and regulated expenses" and 3) "the final financial settlement is approved by the employee". We analyzed the variability of the suggestions for the corresponding intentional fragment.

The identification of an intentional fragment that relates to the second goal (the more general) was difficult and depended on the subject's interpretation. We also observe much more dispersion in the activities involved. More than 50% of the subjects suggested disconnected activities to fulfill the goal.

4.4 Third Exercise: Identifying New Intentional Fragments and New Goals

The last exercise was the free part of the evaluation. Subjects had to reproduce what they had already done in the two first exercises with their own manner no matter what order. We also asked them during this exercise to identify errors or gaps in the process model.

A total of *43 different goals were inferred* in this exercise. The most common goals corresponded to the activities of the individual agents and also most of them related to passing documents. Subjects commonly distinguish the employee from the rest of the laboratory agents. The more repeated goal was: "The employee wants to do the mission with all the documents in order and then be refund".

Goals that had no corresponding intentional fragment were source of an error or gap. A total of *49 different errors and gaps were detected*. The most common ones were: "what happens if disapprovals?" or "there is a lack of notifications". This proves that that an exhaustive analysis could be done by means of intentional fragments.

4.5 Conclusions about the Evaluation

Some limits in our evaluation have to be considered. Firstly, the fact of using a qualitative approach do not permit to generalize the results. However, relevant feedback is given that permits refining our proposal. Secondly, the fact that all the participants were familiar with the process. In this work, we make the assumption that at least a part of the process model is already known. This helped them to infer goals that were not explicitly described in the process model.

On the other hand, we chose this approach to minimize the time dedicated to the explanation of the process and focus on the goal inference through intentional fragments. Another drawback that could be argued is that the ordering of the exercises may affect the outcome. We maintain this strategy because it helped to understand the approach and the notion of intentional fragment by giving them as first exercise some examples. We prioritize the analysis of subjects' behaviour facing the same structure in the evaluation.

The purpose of this evaluation was to evaluate the usage of the notion of *Intentional Fragment* to bridge the gap between goals and process models. We observed that even if the definition of intentional fragment was not completely given to the subjects, it appeared in a natural way. We also observed that this approach helped inferring goals.

5 Applications of the Intentional Fragment Concept

The relation between the process model and the goal model helps analysts to firstly justify the business process and then analyze the process as-is. We develop this points in the following section.

5.1 Inferring a Goal Model that Justifies the Process Model

We previously put forward the difficulty for an analyst to generate a correct goal model. Particularly challenging is the inference of goals. During the evaluation, a set of goals corresponding to the mission process were identified using the notion of intentional fragment. Figure 6 illustrates a goal model that we generate based on the goals elicited during the interviews. In structuring the goal model, we employ some standard goal refinement patterns from KAOS [10]. For example, the milestone driven refinement pattern is used to refine the goal "Plan a Mission". The pattern is applicable to goals where an intermediate condition has to hold true before reaching the prescribed condition. In our example, to be able to warrant the financial means for the mission, an estimation of the costs has to exist – this can be seen as a milestone in planning the trip.

Moreover, the different strategies that subjects used to group process nodes gave us some clues about what are the potential intentional fragments that could be automatically proposed and might be related to a business goal. We propose a set of heuristics (H) to identify potential intentional fragments of different sizes and scopes, based on visible patterns in the process model. The next step will be to establish a correspondence between these potential intentional fragments and goals. This can be done through GORE elicitation techniques [10] (e.g. asking *why?* questions). A potential intentional fragment might be composed by:

- H1. *nodes between a start event and the first sequence flow to another lane.* An example of application for H1 can be found in Fig 4b.
- H2. *nodes between a sequence flow to another lane and an end event.*

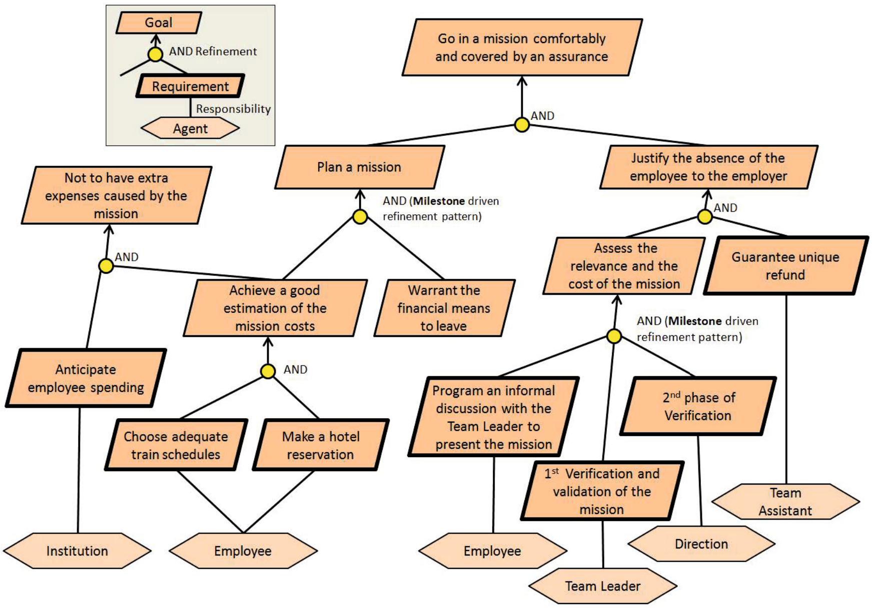


Fig. 6. A Resulting Goal Model Inferred from Goals Proposed by Subjects

H3. *nodes within the end events (other than the happy path end event) and the immediately preceding XOR gateway.* "Happy path" stands for the path where everything goes right. Figure 7 shows the application of this heuristic. In this case, the intentional fragment is not linked to any goal (subjects did not find a goal associated).

H4. *nodes immediately after and before a XOR gateway.* They could imply control goals.

H5. *nodes within the path of two consecutive sequence flows that transit from lane to lane.* Figure 7 shows the application of this heuristic where the intentional fragment satisfies the goal "1st verification and validation of the mission".

H6. *nodes between two consecutive messages to/from the same agent.*

H7. *nodes having as input the same documents.*

H8. *nodes labeled with similar verbs.* For example verify, inform, sign, etc ...

H9. *nodes within a lane.*

H10. *nodes within the "happy path".* They relate to a high level goal.

Although difficult to infer, the goal model is not an end in itself. Rather, it is useful because it supports further reasoning about the goals, for example through conflict or obstacle analysis. To validate the usefulness of the inferred goal model, we present one result that emerges from the obstacle analysis. Considering the goal "Achieve a good estimation of the mission costs", we can negate it and infer an obstacle. So, starting from the statement "Do not achieve a good estimation of the mission costs", a business analyst can ask what happens if some costs are

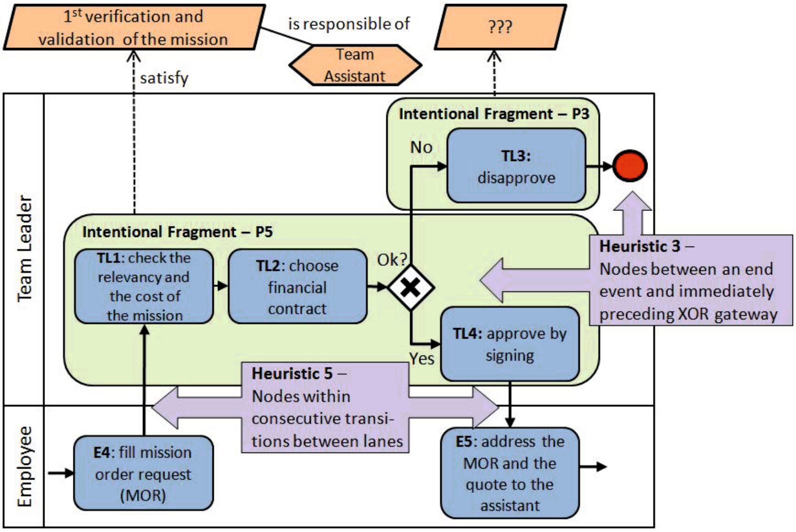


Fig. 7. Example of Application of Heuristics 3 and 5

not considered, or if estimations cannot be obtained, or estimations are much less than in reality. All of these are concerns that need to be addressed. As such, the utility of the intentional fragment is validated by the fact that, by analyzing the goal model inferred, we can identify problematic situations.

5.2 Alignment between the Process Model and the Goal Model

If both models are available and relations between intentional fragments and goals have been established, an alignment analysis can be performed. We present a set of heuristics that can be used to identify miss-alignments between the two models. Figure 8 gives an overview of the alignment between a part of the process model and a part of the goal model. It also illustrates the how we could apply the two last heuristics.

- *Check that for each goal identified in the goal model, there exists at least one corresponding intentional fragment* - this identifies objectives not fulfilled by the considered process or shows that additional process models should be considered. When there is any activity contributing to the satisfaction of goal, a critical problem is detected. An example in our use case regarding Fig. 2 is the goal "Program an informal discussion with the Team Leader to present the mission". There is no activity that clearly contributes to the satisfaction of this goal in the process model.
- *Check that each activity in the process model is part of at least one intentional fragment* - this step identifies superfluous activities. If an activity is not part of any intentional fragment, an organizational problem is detected. In our case study, the activity "TL3: Disapprove" (see Fig. 1) cannot be related

to any goal . Although there is probably a reason to disapprove the mission order request, the goal was not identified.

- *Check the Agents' responsibility* - for each goal, we may verify if we could assign all the activities that are part of the intentional fragment to an agent. Figure 8 shows that to warrant the financial means of the journey, three participants are involved that are the the team leader, the employee and the team assistant. Looking at the process we observe that there is a double verification of the warrant of financial means by the team leader and the team assistant. We could think about the possibility to delegate this verification to only one agent. Consequently, the performance of the process may be improved.
- *Detecting interlocking intentional fragments* - An interesting question that arises is: If two intentional fragments are intertwined, how do they influence each other? If the goals that relates the intentional fragments do not depend on each other, the possibility of performing the activities in parallel may be considered. In Fig. 8, the travel and hotel planning (i.e. activities E1, E2) may be done in parallel because each activity is related to non-dependent goals.

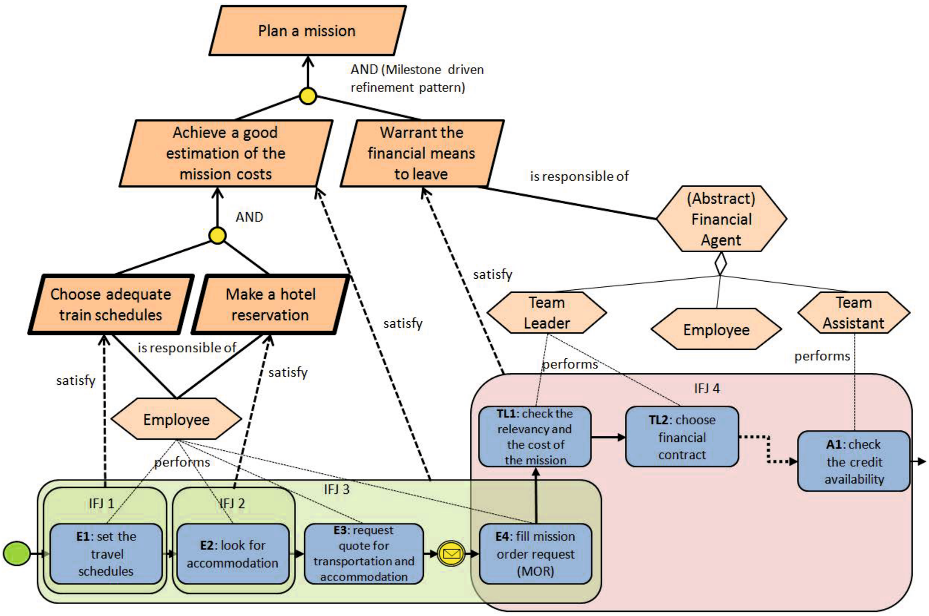


Fig. 8. Alignment between Goal Model and the Process Model

6 Related Work

Other researches have already presented some relation between goal models and business process models. Extending BPMN models to include additional artifacts that allow traceability to goals have been proposed [6,9,25]. However, these approaches add more complexity to the language. Alternatively, goal models are firstly mapped to process models and then enriched to support variability on the process models [7]. The problem here is that the goal model ends representing almost the same view that the process model rather than being a higher level intentional layer. This approach does not focus on reasoning about the rationale of activities and their purpose as part of the overall process. Hence, its scope is limited. In our approach one of our major aims is to maintain a clear separation of concerns between process models (the organizational layer) and the goal model (intentional layer): the *the Intentional Fragment* is a pivot to bridge the gap between both layers.

The notion of fragment has already been introduced in addition to standard BPMN 2.0 constructs. For example, using reusable fragments that are then mapped to BPEL blocks [26]. Fragments are identified based on certain structural patterns visible in the process model. Fragments have also been used to represent localized knowledge regarding the business process [27]. This approach starts from the assumption that each participant is aware of only some parts of the process, and this constitutes a fragment. These fragments need to be integrated to obtain a complete process model. Fragments are also used as a mean to propose change patterns in process models [28]. These approaches use the fragment concept as a connected set of nodes. In our approach, we also support disconnected parts of the process and in addition, we explicitly define a relation between fragments and goals.

In [29] authors present an aspect-oriented approach to modularize the crosscutting concerns in a business process modeling and they applied it using BPMN. However, they stay in an organizational level when they identify these concerns. In our approach we consider an intentional level represented by the goal model.

Automatic goal decomposition is performed to support cooperative team formation (process parts assignments) within the context of Instant Virtual Enterprise (IVE) [30]. This work describes how to create the IVE process dynamically matching goal requirements and agents capabilities. Our approach is more focused on facilitating the extraction of a goal model from a process-as-is and all the further analysis that may be applied to identify problems or improve the process model.

7 Conclusion and Future Work

In this paper we introduce the notion of intentional fragment as a mean to relate process models and goal models. As we have shown in the case study, the approach is a simple and very pragmatic solution for a well-known problem. Business analysts as well as stakeholders which are part of the process could be involved in the generation of the goal model from a process model. Goal based analysis could latter be performed and will help gaining a more structured understanding of the process. The critical analysis is supported by delimiting the organizational and intentional level. The BPMN 2.0 model and the KAOS goal model represent different perspectives over the system. These models complement each other and are used to identify new goals or possible organizational problems in the existing process. Intentional fragments permit establishing the relations between goals and process nodes at different levels of abstraction. These nodes could not be necessarily connected. Both high level goals as well as requirements (i.e. leaf-goals) could be related with one or more intentional fragments. The heuristics to extract potential intentional fragments facilitates goal elicitation and goal-based analysis of the process model.

The work presented here raises several interesting questions for the future. Most importantly, the identified heuristics could be the start-point to automate intentional fragment identification. These heuristics will be integrated into a tool that can help business analysts infer goal models from the business process model. This would allow generating better goal models with less effort and therefore help to justify them. Secondly, the semantics of intentional fragments will be formalized. We also acknowledge the potential to suggest ameliorations in the process, based on the results of the traceability analysis.

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