

Practical Challenges for Methods Transforming i* Goal Models into Business Process Models

Ken Decreus¹, Monique Snoeck², Geert Poels¹

¹ Faculty of Economics and Business Administration, Ghent University, Belgium
{ken.decreus | geert.poels}@ugent.be

² Department of Applied Economic Sciences, Katholieke Universiteit Leuven, Belgium
Monique.Snoeck@econ.kuleuven.be

Abstract

The field of requirements engineering for business processes has grown during the last several years. As business processes are assumed to fulfil organizational goals, goal models could be transformed into business process models that specify how business processes fulfil the organizational goals. Although both the fields of Goal-Oriented RE (GORE) and Business Process Management (BPM) received a lot of attention from researchers, the methods to transform goal models into business process models still need further research. This scientific evaluation paper analyses current methods to identify the practical challenges that need to be addressed for an effective transformation of goal models into business process models. We illustrate the discovered challenges using the case study of Seven-Eleven Japan. The main challenges that were discovered are a lack of responsible role, insufficient concept mappings, informality of the transformation algorithm, no full support for organisational structure and a lack of inter-model consistency checks. Our expected contribution of discovering these challenges is to lower the barriers of transferring new goal-to-process methods to industry. As we consider i constructs the most adequate in GORE for our purposes, we limit our study to transformations that start from i* goal models.*

1. Introduction

In the domain of Requirements Engineering (RE), Wieringa [1] distinguishes two schools of thought, i.e. problem-oriented RE (PORE) and solution-oriented RE (SORE). The author defines a *problem* as a difference between what we perceive to be the case and what we would like to see, and a *solution* as an action that reduces this difference. PORE techniques include James Martin's IS engineering [2], Jackson's problem frames [3] and goal-oriented RE techniques [4, 5]. So-

lution-oriented requirements could be specified by means of the IEEE 830 standard for requirements specifications [6] or the Volere Requirements Specification Template [7].

As business processes are assumed to fulfil organizational goals [8], goal models could be transformed into business process models that specify how business processes fulfil the organizational goals. While GORE techniques aim at describing the problem space, business process models could be used to represent both problems (cfr. Business Process Reengineering – BPR [9]) and solutions (cfr. BPM Systems [10]). The importance of obtaining business process models in a structured way has been recognised during BPR projects, as coming up with AS-IS process models is a nontrivial task, and is currently practiced in a very ad-hoc fashion [11]. Inspired by workflow application development [12], we consider business process models here as a way to specify solutions to the fulfilment of organizational goals that have been described in goal models. So the issue we look into is how goal models, documenting a problem, can help to construct business process models, documenting the solution to the problem. In other words, how can the understanding of the problem (i.e. what organizational goals?) help in conceiving a solution to the problem (i.e. what business processes?).

The literature study that we conducted and which is presented in the paper provides an overview of the current methods that transform goal models into business process models. These methods solve a world problem [13], i.e. they help to reduce the difference between the way the world is and the way we think it should be. Unfortunately, the practical usage of methods for transforming goals models into business process models is still immature [14]. In order to improve the current practice of goal-to-process methods, we encounter a knowledge problem [13] (a lack of knowledge about the world), i.e. which challenges need to be overcome in order to make effective usage

of goal-to-process transformations. This paper offers an answer to this knowledge problem and will provide a list of challenges for methods to be effective in transforming goal models into business process models. The structure of our paper is inspired on the recommended structure of RE papers describing a knowledge problem [13].

Section 2 introduces the case study of Seven-Eleven Japan (SEJ) [15], which will facilitate the analysis of methods done in Section 6. Section 3 will detail how the knowledge problem looks like and Section 4 elaborates on the research design. Section 5 discusses what controls were taken to alleviate possible threats to validity, and the evaluation of the reviewed goal model to business process model transformation methods is presented and discussed in Section 6. Next, Section 7 provides an answer to the research question and Section 8 deals with remaining points of discussion.

2. Introduction of Case Study

Seven-Eleven Japan (SEJ) manages a national network of convenience stores and has successfully established an innovative business model that is changing the retail industry in Japan. The case study of Nagayama & Weill [15] describes the information-based strategies that have helped SEJ become a top performing retailer in Japan, selling high quality products through an industry-wide supply chain network of manufacturers, distributors, third-party logistics providers and franchise shops.

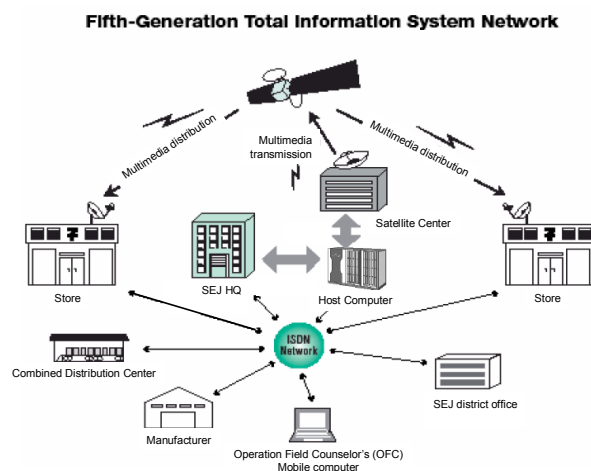


Figure 1. SEJ's Information Systems Network

SEJ leverages IT to provide franchise-storeowners with information about what customers want, at what time and when these needs are estimated to change. The combination of information strategies going bot-

tom-up (sending information from each franchiser to SEJ) and top-down (interpret all data centrally and deliver the estimated products just-in-time to franchisers) uniquely shape the organisation's IT infrastructure (See Figure 1).

3. Knowledge Problem

Given that the practical usage of goal models to obtain business process models is immature, we need to investigate which problems currently available methods suffer from. In order to describe this knowledge problem, we focus on phenomena, variables, relationships among the variables, the research question and priorities [13]. The phenomena of our knowledge problem are methods to transform goal models into business process models.

The variables we introduce to investigate these phenomena are given by two categories. The variables were discovered and discussed (in the context of the SEJ case study) in one closed session where three observers, i.e. the authors of this paper, were present. Firstly, a clear method should be proposed. So, a first set of variables assesses the *methodological* properties of the *transformation* from *goal modelling language* to *business process modelling language*, such as level of detail per step provided, level of formality, concept mappings between goals and processes, and inter-model consistency. Secondly, it should also be clear who has to perform what step. So, a second set of variables is used to assess the *organisational* properties of the *transformation* from *goal modelling language* to *business process modelling language*, such as the responsible role to execute the method, the extent to which business-oriented business process models are considered (Platform Independent Model), the extent to which technically-oriented business process models are considered (Platform Specific Model), the degree to which the organisational structure is supported (e.g. hierarchies in departments) and the level of attention given to modelling of organisational context (e.g. modelled actors and relationships between these modelled actors – Computer Independent Model).

Possible relationships among the variables include, for instance, the connection between details per step and the level of formality; however, we did experience sufficient difference between these variables during our analysis. Although we expect that methods will focus on either the business side or the technical perspective, we regard business focus and technical focus as orthogonal variables, because authors could elaborate on both business and technical details.

The operationalization of our knowledge problem is done in the form of a research question:

Q *What are the challenges for the effective usage of methods transforming i* goal models into business process models?*

The priority in tackling this knowledge problem is given to the challenges coming from the practical viewpoint, in order to discover possible blocks when transferring these methods to industry.

4. Research Design

4.1. Population

The selected RE papers originate from journals and conference proceedings in the area of information systems, requirements engineering, business process management and conceptual modelling. Queries were made using keywords *goal*, *objective*, *intention* OR *purpose* in combination (AND) with *process* OR *workflow*. More specifically, we selected all papers that employed an i*-based agent-oriented modelling language. As we consider i* constructs the most adequate in GORE for our purposes, we limit our research scope to this area. As indicated by Ayala et al. [16], three main variations of the i*-based languages can be distinguished, i.e. Yu's original i*, GRL and Tropos. Our research takes methods starting from all three variations into consideration. The selected papers are displayed in Table 1.

Table 1. Initial findings

Source	Years	i* Specific
BPM Conference	2000 – 2008	[17]
BPM Journal	All	0
RE Conference	2000 – 2008	0
RE Journal	All	[18]
ER conference	2000 – 2008	[19]
CAiSE conference	2000 – 2008	0
BPMDS	2000 – 2008	0
ScienceDirect	All	[20-22]
SpringerLink	All	[23, 24]
InterScience	All	0
EDOC	All	[25]
ECOWS	All	[26]

We have chosen to exclude keywords *use case* and *scenario*. Use Cases and scenarios are oriented towards the *use of a system* and the description of the operational steps to achieve a goal. In this respect, even if they describe a problematic situation, use cases and scenario's are techniques of *late requirements* (focusing on requirements of a system-to-be), whereas goal oriented models are *early requirements* (focusing on the environment of a system-to-be). Furthermore, we decided to exclude the papers that bypassed *business*

processes and solely focused on the RE process. Note that we considered i* goal models to be given at the start of the methods. Hence, approaches to construct i* models such as [27, 28] are not included in our scope.

As given by Table 1, ten papers were found that combined i* goal models with business process models. When having a closer look at the papers, we eliminated the PRiM method [20] and the method proposed by Schmitz et al. [23] as these methods create i* models from business process models and not the other way around. Furthermore, we discovered that same methods were proposed in different papers, resulting in six methods given in Table 2 and identified with means of a code (method name or combination of authors' last names). Using the terminology of Wieringa & Heerkens [13], these methods are the phenomena of our knowledge problem.

Table 2. Overview of selected methods

Full names	Code	Reference
Séguran, Hébert & Frankova	SHF	[26]
Kazhamiakin, Pistore & Roveri	KPR	[21, 25]
Koliadis, Vranesovic, Bhuiyan, Krishna & Ghose	KVBKG	[24]
Bleistein, Cox, Verner & Phalp	B-SCP	[18, 22]
Lapouchnian, Yu & Mylopoulos	LYM	[17]
Lo & Yu	LY	[19]

4.2. Evaluation Procedure

Initially, all observers read the SEJ case study to have the same context during subsequent discussions. During the session in which the three observers discovered and discussed the variables (by means of the SEJ case study), all samples were scored on the variables. Attention was paid to achieve a common understanding of all variables (as defined in Section 3) in order to score as objectively and consistently as possible. Deviating results among observers were discussed and a consensus was found for all results. The scores are given in the range of 0% (worst case), 25% (low), 50% (medium), 75% (high), 100% (best case).

4.3. Analysis Method

At the end of the first session, the scores displayed in Table 3 were obtained. During a second joint session, the practical analysis results were summarized and differences were discussed. Finally, all scores were processed in Microsoft Excel in order to obtain Figure 2 and Figure 3 in Section 7.

5. Alleviating Threats to Validity

An important aspect in the research cycle of a knowledge problem [13] is discussing the validity of measurements and analysis results. Traditionally, three kinds of validity (construct, internal and external) are discussed in RE papers. As we felt that a different structure fits better into the setting of this paper, we choose to discuss validity by means of six topics, i.e. *completeness of samples*, *completeness of variables*, *representativeness of case study*, *correctness of method understanding*, *correctness of scoring*, and *external validity*.

The *completeness of samples* relates to including all important methods without missing one. Due to a bottom-up search approach, going from specific RE and BPM literature to the more general field of Information Systems and the databases of ScienceDirect, Springer-Link and InterScience, we are confident that we found the most relevant papers. In fact, we found several versions of the same papers (e.g. [21, 25] and [18, 22]).

The *completeness of variables* should guarantee that all variables were included to operationalize the research question. Given the research question Q, we distinguished two aspects, i.e. effective transformation methods, and practical challenges in using the method, and related them to the two categories of variables as presented in Section 3. Based on a brainstorm output, the three observers decided on a representative set of variables per category.

The *representativeness of the case study* is the extent to which the case study can illustrate the discovered practical challenges. Bleistein et al. [22] state that the RE research literature is devoid of well-documented examples of organizational IT that encompass business strategy and propose to employ the SEJ [15] case study. Therefore, as our research investigates practical challenges within the scope of RE, we consider the SEJ case study as a good choice.

The *correctness of method understanding* relates to how correct the observers understood the method by reading the papers written by the original authors. We hoped to minimise method interpretation errors to choose observers with general Information Systems knowledge complemented with specific Requirements Engineering expertise. All papers were read by all three observers and interpretation errors were discussed during the first closed session. Important was the choice to limit the method understanding by reading only the selected method papers, without reading previous research of the same authors. This choice was made to prevent one observer to convince other observers based on his expertise in one specific method, and because we believe that a good method paper em-

beds all required information for novel readers. Unfortunately, the brevity of this paper does not allow us to add our resulting models, and we were limited to discussing the results in the results part (Section 6).

The *correctness of scoring* deals with how the observers applied the scoring scales and with the exact definition of the scales. To start with the extremes, when there was no mentioning of the aspect (e.g. lack of responsible role), a score of 0% was given, and when all method steps detailed the complete aspect (e.g. an overview table of responsible roles per step), a score of 100% was given. The score of 50% was given to aspects that were correctly discussed, but lacked completeness (e.g. mentioning some responsible roles but forgetting others). The nuances of 25% and 75% were used to indicate the position of aspects relative to the other methods (e.g. briefly talking about responsible roles is better than not mentioning, but not sufficient to achieve a score of 50%; a method that forgets to describe a responsible role, next to a method that is perfectly complete that aspect, will be scored 75%).

Finally, *external validity* reports on how we can generalize the discovered practical challenges (in transforming i* goal models into business process models) to the entire population of goal modelling techniques. The conclusions within the context of this paper are only valid for methods that start for i* goal models, as different constructs in other goal languages could influence the entire transformation method.

6. Presentation of Results

6.1. Short Overview of Methods

The method of Séguran et al. (SHF [26]) was proposed to develop secure workflows (in BPEL2WS) from early requirements analyses (in Secure Tropos). Firstly, several Secure Tropos goal models are designed to capture actors, functional dependencies, authorization and trust issues. After obtaining the goal models, high-level mapping rules are specified to convert the Secure Tropos model to (Secure) BPEL, yielding a technical process representation with BPEL partner and partnerLinks concepts, control flow information, web service operations and related security annotations.

Kazhamiakin et al. discuss their method (KPR [21, 25]) in the context of requirements-driven verification of web services. Firstly, the high-level goals of one actor are refined into subgoals and eventually operationalized into high-level tasks. Secondly, these high-level tasks are decomposed into detailed subtasks, adding control flow annotation to the goal models. Thirdly, messages that describe interactions among actors are associated to the basic tasks, which adds data

flow to the goal model. Fourthly, the graphical goal model is formally represented by means of the Formal Tropos language and temporal constraints on how to achieve the goals are specified. Finally, the Formal Tropos specification of the goal model is converted to a BPEL process model using high-level mapping rules.

The work of Koliadis et al. (KVBKG [24]) offers a method for business process model lifecycle management, which enables users to create business process models from goal models and discover goals from business process models. Only the conversion of goals to business process models is considered within the scope of this study. Firstly, the actors that are internal and external to the related organisation are identified in the goal model. Secondly, the organisation and external actors are mapped to BPMN pools, whereas internal actors become BPMN lanes in the pools. Thirdly, a business analyst should decide whether a task in the goal model converts to a subprocess or to an atomic activity. Fourthly, control and data flow annotations are added to the BPMN model by having the business analyst analysing the fulfilment conditions. Finally, remaining details are modelled in the subprocesses that were left open.

Bleistein et al. (B-SCP [18, 22]) propose a requirements analysis framework for validating strategic alignment of organizational IT based on strategy, context and process. Goal modelling is used to express strategy, next to Jackson context diagrams to capture the complete organisational context and Role Action Diagrams (RAD) to represent business processes. Firstly, the business model participants are identified on a strategic level. Secondly, the relationships between these participants are captured in a related Jackson context diagram. Thirdly, the strategic requirements of the business model are identified and represented as a goal model. Fourthly, a recursive decomposition takes place via projection of certain goal elements, which allows modellers to descend through all layers of the organisational structure of a company. Finally, based on the obtained goal models and context diagrams, business process models are defined by adding control and data flow, events and actors.

Lapouchnian et al. (LYM [17]) offer a method to design and configure business processes in a requirements-driven fashion. Firstly, analysts and users capture and refine the goals of business processes with emphasis on variability. Secondly, the requirements engineer helps the analyst to enrich the goal model with control flow and input-output annotations. Thirdly, the analyst analyses business process alternatives and removes the infeasible ones. Fourthly, an automated step will generate a high-variability BPEL process model from the high-variability goal model, keeping the control and data flow aspects that were

specified in an earlier stage. Finally, the integration developer completes the high-variability BPEL process by implementing the process using web services.

Lo & Yu (LY [19]) propose a reference catalogue approach to derive service-oriented designs from high-level business models. Firstly, reference business models are selected from a reference catalogue and the limitations are evaluated vis-à-vis the desired model. Secondly, i^* business models are instantiated from these reference models and refined for the specific case. Thirdly, business service patterns are extracted from the business models, which illustrate a recurring business service. Fourthly, the business service patterns are refined into high-level business process models (called business collaboration diagrams) that have control flow, data flow and actor annotations. The authors mention that technical, automated process models could be generated from their high-level business process models, but do not provide details about this step. Note that Lo & Yu make use of the goal-to-process transformation steps of the KPR method.

6.2. Evaluation of Methods

6.2.1. Methodological Properties of the Transformation from Goal Models to Business Process Models

Level of Detail per Step. Within the context of this research, we considered the level of details given in the original method papers without reading previous research of the same authors. Three methods (KVBKG, B-SCP, LYM) elaborate on a detailed case study and score 75%, two methods (KPR, LY) show the beginning and ending of the transformations without motivating all choices (score = 50%) and the SHF method merely provides an introduction to the transformation (score = 25%). Applied to SEJ, only KVBKG, B-SCP and LYM were sufficiently detailed to support us in obtaining meaningful results.

Formality of Algorithm. Unfortunately, no method provides details on a fully described formal transformation algorithm. The KVBKG method scores 75% due to its provision of rules and semi-formal steps, and LYM was evaluated 50% as tool support is offered to execute certain steps automatically. The remaining methods (SHF, KPR, B-SCP, LY) contain informal descriptions which could lead to ambiguous results (score = 25%). Applied to SEJ, we managed to formalise the main steps of the transformation only using KVBKG. As KVBKG proposes to “apply intentional reasoning” without specifying how, it was unclear how to manually sequence the process activities with the help of fulfilment conditions.

Table 3. Scores

	SHF [26]	KPR [21, 25]	KVBKG [24]	B-SCP [18, 22]	LYM [17]	LY [19]
Methodological Properties						
Level of Detail per Step		¹				¹
Formality of Algorithm		¹				¹
Concept Mappings		¹				¹
Inter-Model Consistency		¹				¹
Organisational Properties						
Responsible Role						
Business-Oriented Process Model						
Technical-Oriented Process Model						
Organizational Structure						
Context Modelling						

Concept Mappings. The specification of mapping goal concepts onto business process concepts is an important aspect. Ideally, a common meta-model between goals and processes should be provided, e.g. as given by the excluded PRiM method ([20], p85). If no common meta-model is provided, clear mappings rules should be provided to guide the transformation. Unfortunately, only KVBKG provides semi-formal concept mappings (score = 75%). B-SCP shows full traceability by means of graphical mapping annotations (score = 50%), while the other methods (SHF, KPR, LYM, LY) merely illustrate the mapping by means of an high-level example (score = 25%). For instance, in the case of SEJ, it was unclear whether -during consumer checkout- *product* should be modelled as actor or as data entity needed in a message flow from sales clerk to consumer. Even as KVBKG and B-SCP provided guidelines on this, it was difficult to reach a consensus.

Inter-Model Consistency. Verification mechanisms should allow modellers to verify the obtained business process model in relation to the original goal models. As semi-formal verification rules were given by KVBKG and traceability annotations are discussed by B-SCP, these methods scored 75%. The LYM method did not go into detail about verification rules, but provides tool support to translate goal models into business process models (score = 50%). An example

case was used to illustrate consistency in methods KPR and LY (score = 25%), while SHF did not provide an overall example (score = 0%). Applied to SEJ, both KVBKG and B-SCP allowed us to have traceability between the obtained models, although full verifications checks were absent.

6.2.2. Organisational Properties of the Transformation from Goal Models to Business Process Models

Responsible Role. For an organisational point of view, it is crucial to know what the responsible role is to put the method into practice. The LYM method understand this importance and provides an overview of the responsible role per method step (score = 100%). Furthermore, the KVBKG and B-SCP method state that an *analyst* should execute the method, but do not provide step by step details (score = 50%). The remaining methods (SHF, KPR, LY) have no implicit or explicit details about responsible roles (score = 0%). Applied to SEJ, we obtained a detailed responsibility chart of all method steps using the LYM method, while other methods causes discussions without successful results.

Business-Oriented Process Model. This variable assesses the extent to which methods deal with technology-agnostic business process models (inspired by

¹ LY employs the transformation method of KPR, yielding the same scores for these variables

the Model-Driven Architecture view of Platform Independent Models – PIM). Three methods (KVBKG, B-SCP, LY) have a strong focus on technology-agnostic models (score = 100%). LY annotates goal models with process algebra elements, which formally specify the process semantics and are considered less business-friendly due to the higher learning curve (score = 75%). Method SHF consider business-oriented process models as input material, but does not use these models during the transformation, and method KPR briefly introduces an activity level model between strategy and message level (both methods were scored 25%). Applied to SEJ, we were able to obtain clear PIM models by using KVBKG, B-SCP, LY and LYM.

Technically-Oriented Process Model. This variable assesses the extent to which methods deal with technology-specific business process models (inspired by the Model-Driven Architecture view of Platform Specific Models - PSM). Three methods score 100% due to resulting BPEL specifications (SHF, KPR, LYM). The three remaining methods (score = 25%) did not explicitly provide details about technology, but KVBKG includes technical details of routines, B-SCP deals with events and message flow, and LY briefly mentions the technical extension. Applied to SEJ, the technical IT support is fully outsourced to third parties, which makes translation between PIM and PSM process models by means of the reviewed methods at SEJ challenging. Nevertheless, we succeeded in obtaining resulting BPEL models for the SEJ customer checkout process using methods SHF, KPR, LYM.

Organisational Structure. This variable assesses the extent to which the method takes the organisation's structure of actors into account. One typical aspect of an organisational structure is the hierarchical relationships between actors (e.g. International Head Quarter, European Head Quarter, Belgian Head Quarter, etc.). Although the *i** notation provides Strategic Dependency models to represent the dependencies between actors, it does not fully support the hierarchical structure of an organisation [22]. Five methods (SHF, KPR, KVBKG, LYM, LY) implicitly inherited *i**'s capability to support organisational structure (score = 25%), while B-SCP recognizes the importance of this aspect by combining several hierarchical *i** models. Applied to SEJ, B-SCP was the only method sufficiently supporting organisational structure and allowed us to obtain a fully specified hierarchical goal-to-process tree.

Context Modelling. This variable assesses the level of attention given to modelling of actors and relationships between actors. Methods (SHF, KPR, KVBKG, LYM, LY) based on the *i** notation scored quite high

(75%), while B-SCP complements the *i** notation with explicit help of Jackson Context Diagrams to allow the modeller more expressiveness in representing all entities in the full domain of interest. Applied to SEJ, all methods provided sufficient possibilities to represent context, with special attention to B-SCP which allowed us to create very detailed context diagrams.

7. Answers to Research Question

With regard to the research question Q, we will provide an answer from two different perspectives, i.e. the *effectiveness ranking of the reviewed methods* and the overall *practical challenges*.

The *effectiveness ranking of the methods* was obtained by summarizing all scores per method, and plotting the sub-scores per property category (displayed by Figure 2). In this way, the sum of the methodological properties and the organisational properties have an equal weight in the final score (individual categories have max. 1, sum is max. 2).

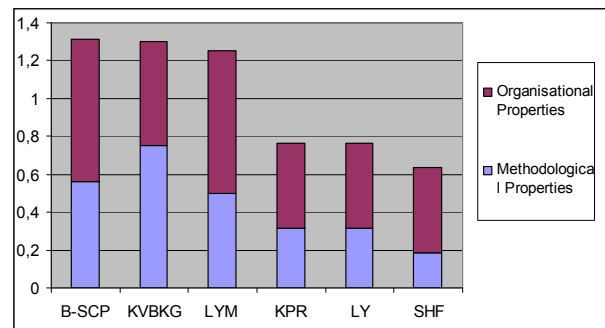


Figure 2. Effectiveness of reviewed methods

We discovered that B-SCP and KVBKG were the two most effective methods from an overall point of view. B-SCP scores higher with regard to organisational properties while KVBKG scores better on methodological properties. The third place is given to LYM as it enjoys strong organisational properties and good methodological properties. Remaining methods (KPR, LY and SHF) were scored lower on organisational or methodological properties as the first three methods.

A summary of *practical challenges* was discovered by adding all scores per variable (expressed in percentage) and ranking the lowest scores at the top (displayed in Figure 3). We discovered two clusters of variables: one cluster of five variables scoring equal or less than 40% and another cluster of four variables scoring equal or less than 60%.

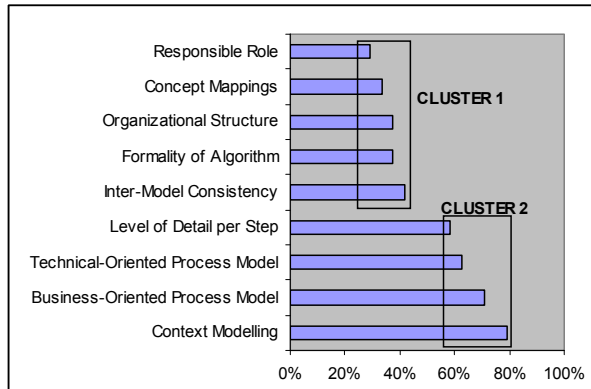


Figure 3. Organisational Challenges

The main practical challenges for effective methods transforming i* goal models into business process models are considered to be all variables from the first cluster:

1. Lack of responsible role
2. Insufficient concept mappings
3. Informality of transformation algorithm
4. No full support for organisational structure
5. Lack of inter-model consistency checks

Note that we started our research assuming a possible relationship between level of detail per step and the formality of transformation algorithm. As displayed in Figure 3, we discover a difference of 21% which indicates that informal descriptions might be clearly illustrated by means of a detailed example.

8. Discussion

This research was motivated by need for an effective goal-to-process transformation. The assessment of existing methods was executed based on the study of Wieringa & Heerkens that investigated the methodological soundness of RE papers. Many RE papers describe techniques but do not report on any research, while papers investigating the properties of these techniques could stimulate the transfer of RE results to practice. We stipulated that effective i* goal-to-process methods are challenged by five factors, which might be helpful for authors of future goal-to-process methods. Unfortunately, this paper does not provide any detailed guidelines how to overcome these challenges. That these challenges can be overcome is demonstrated by the PRiM method [20]. Even though PRiM was excluded from our method comparison (as PRiM creates goal models from process descriptions and not the other way around), we feel that PRiM is a perfect example of how a method description should look like, as

it excels in clear method descriptions, rules, guidelines, checks, metrics and validation.

Furthermore, looking at the reviewed methods from an organisational science perspective, one could introduce other organisational properties such as the level of (de)centralisation of the actors executing the method. Overall we assumed all methods in a central context, where goals and business processes are central to the organisations and where individual goals and ways of working are subsumed into a larger, central set.

One of the limitations of this paper is the extent to which we described our analysis. Our future work will address this gap by including all published transformations from all existing goal models into all known business process models, and thoroughly report on the exact work done, how many models each observer created and what efforts were involved (e.g. person hours). Finally, this research was focused on quantitative results. As not all published papers can be considered to be complete methods, we need to take qualitative aspects into account for future comparisons.

9. References

- [1] R. Wieringa, "Requirements researchers: are we really doing research?," *Requirements Engineering*, vol. 10, pp. 304-306, 2005.
- [2] J. Martin, "Information Engineering (3 Volumes)," *Prentice-Hall Inc*, 1989.
- [3] M. Jackson, *Problem Frames: Analysing and Structuring Software Development Problems*: Addison-Wesley, New York, 2000.
- [4] E. Kavakli, "Goal-Oriented Requirements Engineering: A Unifying Framework," *Requirements Engineering*, vol. 6, pp. 237-251, 2002.
- [5] J. Mylopoulos, L. Chung, and E. Yu, "From object-oriented to goal-oriented requirements analysis," *Communications of the ACM*, vol. 42, pp. 31-37, 1999.
- [6] IEEE, "Recommended Practice for Software Requirements Specifications - IEEE Standard 830-1998," 1998.
- [7] Atlantic Systems Guild, "Volere Requirements Specification Template," <http://www.volere.co.uk/template.htm>, 2008.
- [8] P. Kueng and P. Kawalek, "Goal-based business process models: creation and evaluation," *BPMJ*, vol. 3, pp. 17 - 38, 1997.
- [9] W. J. Kettinger and J. T. C. Teng, "Business process change: a study of methodologies, techniques, and tools," *MIS Quarterly*, vol. 21, pp. 55-80, 1997.

- [10] D. R. Shaw, C. P. Holland, P. Kawalek, B. Snowdon, and B. Warboys, "Elements of a business process management system: theory and practice," *BPMJ*, vol. 13, pp. 91-107, 2007.
- [11] K. Lyytinen, L. Mathiassen, J. Ropponen, and A. Datta, "Automating the Discovery of As-Is Business Process Models: Probabilistic and Algorithmic Approaches," *Information Systems Research*, vol. 9, pp. 275-301, 1998.
- [12] M. Weske, T. Goesmann, R. Holten, and R. Striemer, "Analysing, modelling and improving workflow application development processes," *Software Process: Improvement and Practice*, vol. 6, pp. 35-46, 2001.
- [13] R. Wieringa and J. Heerkens, "The methodological soundness of requirements engineering papers: a conceptual framework and two case studies," *Requirements Engineering*, vol. 11, pp. 295-307, 2006.
- [14] G. Regev, P. Soffer, and I. Bider, "Coordinated development of business processes and their support systems," *Requirements Engineering*, vol. 10, pp. 173-174, 2005.
- [15] K. Nagayama and P. Weill, "Seven Eleven Japan: Reinventing the Retail Business Model," in *CISR Working Paper 338 - MIT Sloan WP 4485-04*, 2004.
- [16] C. P. Ayala, C. Cares, J. P. Carvallo, G. Grau, M. Haya, G. Salazar, X. Franch, E. Mayol, and C. Quer, "A Comparative Analysis of i*-Based Agent-Oriented Modeling Languages," in *International Workshop on Agent-Oriented Software Development Methodology - SEKE Conference, Taipei, Taiwan*, 2005.
- [17] A. Lapouchnian, Y. Yu, and J. Mylopoulos, "Requirements-Driven Design and Configuration Management of Business Processes," in *Business Process Management*, 2007, pp. 246-261.
- [18] S. Bleistein, K. Cox, J. Verner, and K. Phalp, "Requirements engineering for e-business advantage," *Requirements Engineering*, vol. 11, pp. 4-16, 2006.
- [19] A. Lo and E. Yu, "From Business Models to Service-Oriented Design: A Reference Catalog Approach," in *Conceptual Modeling - ER 2007*, 2008, pp. 87-101.
- [20] G. Grau, X. Franch, and N. A. M. Maiden, "PRiM: An i*-based process reengineering method for information systems specification," *Information and Software Technology*, vol. 50, pp. 76-100, 2008.
- [21] M. Pistore, M. Roveri, and P. Busetta, "Requirements-Driven Verification of Web Services," *Electronic Notes in Theoretical Computer Science*, vol. 105, pp. 95-108, 2004.
- [22] S. J. Bleistein, K. Cox, J. Verner, and K. T. Phalp, "B-SCP: A requirements analysis framework for validating strategic alignment of organizational IT based on strategy, context, and process," *Information and Software Technology*, vol. 48, pp. 846-868, 2006.
- [23] D. Schmitz, G. Lakemeyer, G. Gans, and M. Jarke, "Using BPEL Process Descriptions for Building Up Strategic Models of Inter-organizational Networks," in *On the Move to Meaningful Internet Systems 2004: OTM 2004 Workshops*, 2004, pp. 520-532.
- [24] G. Koliadis, A. Vranesevic, M. Bhuiyan, A. Krishna, and A. Ghose, "Combining i* and BPMN for Business Process Model Lifecycle Management," in *Business Process Management Workshops*, 2006, pp. 416-427.
- [25] R. Kazhamiakin, M. Pistore, and M. Roveri, "A Framework for Integrating Business Processes and Business Requirements," in *Proceedings of the Enterprise Distributed Object Computing Conference, Eighth IEEE International*: IEEE Computer Society, 2004.
- [26] M. Séguran, C. Hébert, and G. Frankova, "Secure Workflow Development from Early Requirements Analysis," in *The 6th IEEE European Conference on Web Services*, 2008.
- [27] G. G. d. C. Neto, A. S. Gomes, and J. Castro, "Mapping Activity Theory Diagrams into i* Organizational Models," *JCS&T*, vol. 5, 2005.
- [28] A. Oliveira, J. C. S. d. P. Leite, L. M. Cysneiros, and C. J. P. Lucena, "i* Diagnoses: A Quality Process for Building i* Models," in *CAiSE Forum*, 2008.