(This paper has been published in the Journal of Database Management, 24 (2) 35 - 71)

Cover Page

Geert Poels[1]
Faculty of Economics and Business Administration, Ghent University, Tweekerkenstraat 2, 9000 Gent, Belgium
E-mail: geert.poels@ugent.be
Telephone: +32 9 264 34 97

Ken Decreus
Deloitte Consulting, Berkenlaan 8c, 1831 Diegem, Belgium
E-mail: kdecreus@deloitte.com
Telephone: +32 486 39 10 04

Ben Roelens
Faculty of Economics and Business Administration, Ghent University, Tweekerkenstraat 2, 9000 Gent, Belgium
E-mail: ben.roelens@ugent.be
Telephone: +32 9 264 35 19

Monique Snoeck
Faculty of Economics and Businesss, Katholieke Universiteit Leuven, Naamsestraat 69, 3000 Leuven, Belgium
E-mail: Monique.Snoeck@econ.kuleuven.be
Telephone: +32 16 32 68 79

[1] Corresponding author for this revised manuscript

Research Review: Investigating Goal-Oriented Requirements Engineering for Business Processes

Abstract: Business processes are designed to execute strategies that aim at achieving organisational goals. During the last decade, several methods have been proposed that prescribe the use of goal-oriented requirements engineering techniques for supporting different business process management activities, in particular business process modelling. The integration of goal modelling and business process modelling aims at increasing the alignment between business strategies and the processes with their supporting IT systems. This new research area, which we call Goal-Oriented Requirements Engineering for Business Processes (GORE-for-BP), is developing rapidly, but without a clear conceptualization of the focus and scope of the proposed GORE-for-BP methods. Furthermore, an overview is lacking of which methods exist and what their level of maturity is. This paper therefore presents a research review of the GORE-for-BP area, with the aim of identifying relevant methods and assessing their focus, scope, and maturity. Our study used Systematic Literature Review and Method Meta-Modelling as research methods to identify and evaluate the state of the GORE-for-BP research area and to propose a research agenda for directing future research in the area. Nineteen methods were identified, which is an indication of an active research area. Although some similarities were found with respect to how goal models are transformed into business process models (or vice-versa), there is also considerable divergence in modelling languages used and the extent of coverage of typical requirements engineering and business process management lifecycle phases. Furthermore, the exploitation of requirements engineering techniques in the full business process management lifecycle is currently under researched. Also, the maturity of the methods found in terms of the formalisation of the transformation activity, the elaboration of method guidelines, and the extent to which methods are validated, can be further improved.

Keywords: *Goal-Oriented Requirements Engineering, Business Process Management, Goal Modelling, Business Process Modelling, Systematic Literature Review, Method Meta-Modelling*

INTRODUCTION

Gartner Research estimates that by 2015 30% of business software applications will be developed in Business Process Management System (BPMS) environments (Woods and Genovese, 2006). A BPMS environment is an integrated collection of modelling, execution and management tools for supporting Business Process Management (BPM), i.e., the practice of (re)designing business processes, (re)configuring software applications that enact these processes and monitor their execution, and analysing process execution data to discover opportunities for process improvement (van der Aalst, ter Hofstede, and Weske, 2003; Smith and Fingar, 2004; Shaw et al., 2007).

The knowledge about business processes that is required to configure BPMS applications is represented in business process models. These models describe business processes in terms of how to sequence the different process steps (i.e., the orchestration of process activities and the choreography of different collaborating processes), organize the flow of information (e.g., document flows), and assign the responsibility and allocate the required resources for executing process activities to organizational departments or functions, individual process workers or automated devices (e.g., software services in the enterprise's service-oriented IT infrastructure). Hence, business process models present both the operational design of business processes and the functional requirements for the BPMS applications that are intended to support these processes (Vondrák, 2007).

In the field of Requirements Engineering (RE), which studies the elicitation, documentation and analysis of information system requirements, there is growing awareness that also the organizational context of information systems needs to be taken into account in order to obtain a complete and reliable picture of the system requirements (Rolland, 2005). Goal-Oriented Requirements Engineering (GORE) (Mylopoulos, Chung, and Yu, 1999; van Lamsweerde, 2001; Kavakli, 2002) is an approach for capturing the context in which information systems fulfil their role. The GORE approach externalizes this context by means of goal models that show the strategic goals that an organization is pursuing and the decomposition of these goals into operational objectives for which designated organizational actors are responsible. Operational objectives can be achieved through the proper use of organizational resources (including information systems) that are allocated or made available to the responsible actors. As information systems help achieving organizational goals, goal models can be seen as describing high-level requirements for information systems which can be gradually refined into lower-level functional and non-functional system requirements. The high-level ‘business’ requirements provide the rationale for the more detailed system requirements (van Lamsweerde, 2001; Rolland, 2005).

Most process modelling languages that are used for designing business processes and specifying the functional requirements of BPMS applications do not contain modelling constructs for goals and goal refinement relationships nor do they offer mechanisms to link processes and process activities to the objectives they intend to achieve (Kazhamiakin, Pistore, and Roveri, 2004a; Soffer and Rolland, 2005; Lapouchnian, Yu, and Mylopoulos, 2007; Soffer and Kaner, 2011). Although RE is recognized as a key success factor for systems development, it has received little attention in business process modelling research (Frankova, Massacci, and Séguran, 2007a). Some researchers have recognized, however, the need to clarify the wider organizational context of business processes. Strategies are formulated to configure an organization’s capabilities in such a way that the goals of the organization can be achieved. Business processes that use and operate these organizational resources should therefore be designed in accordance with the formulated strategies (Bleistein, Cox, and Verner, 2004b; Kazhamiakin et al., 2004a; Lapouchnian et al., 2007).

The increasing recognition of the advantages that a GORE approach can bring to business process design and BPMS application development (see e.g., Regev, Soffer, and Bider (2005)) has resulted in a number of proposals integrating in some way or another goal modelling and business process modelling. A preliminary research review by Decreus, Snoeck, and Poels (2009b) has identified six so-called GORE-for-BP (Goal-Oriented Requirements Engineering for Business Processes) methods, which differ widely in focus (i.e., what do they want to achieve with the integration?), scope (i.e., what type of business, process and system requirements are considered in the integrated method?), and degree of maturity (i.e., is the integration just an idea based on loosely defined language construct mappings or are a precise transformation algorithm and practical guidelines for applying the method offered?). A major conclusion of the study was that the area of GORE-for-BP is not well understood and that the research in the area heads in different directions.

This paper presents a more comprehensive research review of the GORE-for-BP area. While the study of Decreus et al. (2009b) was limited to methods employing one particular goal modelling language, i.e., i* (Yu, 1997; Yu, Giorgini, Maiden, and Mylopoulos, 2011), and only considered top-down methods that transform goal models into skeletons of business process models, a thorough review of the area is missing. Our goal is therefore to identify a wider set of GORE-for-BP methods and analyse them in order to better understand the concept and classify existing methods according to focus, scope, and maturity. The contribution that this paper attempts is not just an assessment of the current state of GORE-for-BP research, but also to identify research gaps and explore future research opportunities. To identify relevant methods, a Systematic Literature Review (SLR) (Brereton, Kitchenham, Budgen, Turner, and Khalil, 2007) was conducted. The analysis of the results was partly based on Method Meta-Modelling (Rolland, Souveyet, and Moreno, 1995), which is the other research method we employed in our review. The paper presents the design, conduct and results of the research review, which we hope will create a better understanding of the GORE-for-BP area and direct future research in the area.

The second section clarifies the background of the research review by defining, explaining and exemplifying key concepts (business process, BPM, RE, GORE, GORE-for-BP) and discussing related studies in this area. The second section also formulates specific research questions derived from this background. The third section explains the methodology used for answering these research questions. The results of the research review, i.e., the identification of GORE-for-BP methods and their analysis, are presented in the fourth and fifth sections respectively. The sixth section synthesizes the findings of the research review to develop a GORE-for-BP research agenda. After acknowledging the limitations of our research review in the seventh section, the research contributions of our study are summarized in the eighth section.

BACKGROUND AND RESEARCH OBJECTIVES

The first sub-section defines and illustrates the main concepts underlying the research review: business process, Business Process Management (BPM), Requirements Engineering (RE), and Goal-Oriented Requirements Engineering (GORE). The second sub-section reviews two prior studies to explain the research area that is the focus of the research review, i.e., Goal-Oriented Requirements Engineering for Business Processes (GORE-for-BP). The third sub-section states the objectives of the research review.

Definition of Concepts and Illustrative Example

Although different definitions of *business process* exist, in general these definitions emphasize that business processes specify ways to achieve business goals (Lapouchnian et al., 2007). For instance, Van Looy, De Backer, and Poels (2011), after reviewing and comparing different definitions for different process types (e.g., operational versus support versus management processes, fully structured versus semi-structured versus unstructured processes, case management or knowledge-intensive versus automated processes), propose the following comprehensive definition: "*A business process is (1) a repeatable set of coherent activities, (2) triggered by a business event and (3) performed by people and/or machines, (4) within or among organizations, (5) for jointly realizing business goals (6) in favor of internal and/or external customers*" (p. 1123), which also stresses (in point (5)) that processes are purposeful.

An example business process that is found in many enterprises is the order-to-cash (O2C) process that (1) contains activities for order taking, order fulfillment and payment collection, (2) is triggered by the arrival of a customer order, (3) requires mostly a combination of manual work (e.g., order picking and assembly) and (semi-)automated activities (e.g., order registration, customer verification, invoicing), (4) is largely performed within the supplier or vendor organization, (5) has as purpose to generate revenues for the enterprise and to deliver objects of value (e.g., goods, services) to the (6) external customer.

Jeston and Nelis (2006) define *Business Process Management* (BPM) as "*the achievement of an organization's objectives through the improvement, management and control of essential business processes"* (p. 5). Other definitions mention the methodical means and information technology (i.e., BPMS environments) that enable BPM and emphasize the use of these instruments in concrete activities for managing and improving business processes, e.g., "*supporting business processes using methods, techniques, and software to design, enact, control, and analyze operational processes, involving humans, organizations, applications, documents, and other sources of information"* (Weske, van der Aalst, and Verbeek, 2004, p. 2).

To organize the BPM activities, the lifecycle concept can be used. The BPM lifecycle consist of 4 phases: process design, system configuration, process enactment and process diagnosis (van der Aalst, 2004). The cyclical nature of the phases emphasizes that BPM aims at a continuous monitoring and gradual improvement of processes rather than a one-shot radical redesign as advocated by the *Business Process Reengineering* thinkers of the nineties (Davenport, 1993; Hammer and Champy, 1993). Business process models (e.g., BPMN business process diagrams, UML activity diagrams, Event Process Chain (EPC) diagrams, Role Activity Diagrams (RAD), etc.) play an important role in BPM. They help in analysing processes, diagnosing problems, discovering opportunities for process improvements and simulating the behaviour and performance of newly conceived or redesigned processes.

In a large logistics company, the use of process mining techniques (applied to the event log constructed by the O2C process monitoring system) revealed that a considerable portion of customers pay their invoices only after a reminder has been sent. The existing process model of O2C, which was the basis for configuring the current workflow management system, shows that the sending of reminders is an automated activity that is triggered by elapsed time, e.g., 7 days after passing of the normal invoice payment term. The process owner, after consulting with the accounting department and members of the company's cross-functional BPM team, decides to redesign the process such that reminders for unpaid invoices are automatically sent directly after passing of the payment term. If this change, which is aimed at increasing process efficiency and shortening the company's cash cycle, is effected in the business process model, then it can immediately be implemented in the company by reconfiguring the O2C's workflow management system in the BPMS environment. The effectiveness and significance of the change can later be verified by analysing the data on average O2C throughput time collected by the process monitoring system. Alternatively, the effect of the change can be assessed before it is implemented through simulation, based on the modified business process model and certain assumptions about customer payment behaviour.

As business process models represent both the design of business processes and the functional requirements (e.g., data and control flow requirements) for workflow management systems and other BPMS applications that execute and monitor these processes, they can be seen as artefacts that specify requirements for business processes and their supporting systems. Requirements specification is an activity within *Requirements Engineering* (RE) which is the *"process of discovering the intended purpose of a software system, by identifying stakeholders and their needs, and documenting these in a form that is [suitable for] analysis, communication and subsequent implementation"* (Nuseibeh and Easterbrook, 2000, p.35). Apart from specification, RE includes other activities like domain analysis, requirements elicitation, negotiation and agreement of alternatives, analysis of requirements models (e.g., identifying conflicting requirements), user validation of requirements models, etc. (van Lamsweerde, 2000), which have little counterpart in BPM (Frankova et al., 2007a). Nevertheless, the importance of developing business process models in a structured way has been recognized (Lyytinen, Mathiassen, Ropponen, and Datta, 1998). According to Koliadis, Vranesevic, Bhuiyan, Krishna, and Ghose (2006a), effective business process model development is based on contextual models of the enterprise that describe its motivations and resources and the social and strategic interdependencies between its internal and external actors. They further argue that purposeful changes in business process models need to be analysed against the greater context of the enterprise.

Several BPM research studies have demonstrated the importance of aligning business strategy and processes for a successful application of BPM (Elzinga, Horak, Lee, and Bruner, 1995; Zairi, 1997; Gagnon and Dragon, 1998; Lee and Dale, 1998; Hung, 2006). It is thus important that the requirements for business processes capture both the strategic objectives of the enterprise and the activities by which those objectives are achieved (Bleistein et al., 2004b). The mainstream business process modeling approach (i.e., activity-based modeling) revolves around the discovery of these activities. There is, however, little academic research into their identification and prioritization (Dumas, La Rosa, Mendling, and Reijers, 2013). Current approaches employ conceptual frameworks (e.g., Porter's Value Chain (Porter, 1985)) or reference models (e.g., SCOR, eTOM) to identify the processes that need attention or use techniques like case/function matrices (Dijkman, Vanderfeesten, and Reijers, 2011) to identify business processes based on a consideration of the product/service types handled by the organization, types of customers served, distribution channels, and organizational business functions involved (purchasing, production, sales, etc.). Although it is recognized that strategic relevance of a process is a main element in the prioritization of those processes that BPM should focus on (Dumas et al., 2013), the mapping of the discovered processes and their relations in so-called process architectures or landscapes does not explicitly link these processes to organizational goals. The same shortcoming is exhibited by alternative process modeling approaches like data-, artifact-, or object-centric modeling (see e.g., Liu, Wu, and Kumaran (2010) and Vanderfeesten, Reijers, and Van der Aalst (2011)) that start the process modeling effort by identifying the business artifacts, e.g., products or documents, handled by the business activities of an organization.

In the RE field, several approaches for eliciting, specifying and validating requirements have been proposed. Use case-based (Cockburn, 2000) and scenario-based (Sutcliffe, Maiden, Minocha, and Manuel, 1998; Araujo, Whittle, and Kim, 2004) RE techniques aim at identifying desirable system behavior and system features by considering the different possible ways in which a system is going to be used. Viewpoint-based RE (Finkelstein, Kramer, Nuseibeh, Finkelstein, and Goedicke, 1992) and frame-based RE (Jackson, 2001) approaches also include domain analysis activities that relate required system features to the domain in which the system users operates. Even more context is taken into account in value-based RE (VBRE) (Gordijn and Akkermans, 2001) in which requirements are looked upon from three related viewpoints: (1) the business value viewpoint; (2) the business process viewpoint; and (3) the system architecture viewpoint. First, the business value viewpoint results in the specification of the enterprise's value model describing the activities and resources needed and the actors involved in the creation and exchange of valuable objects (i.e., goods and services). Second, the business process viewpoint results in the specification of the business processes (i.e., work flows and information flows) required to operationalize the value model. Third, the system architecture viewpoint results in the specification of the required data, software processes, data and control flow, hardware and other components and features of the systems that are needed to support the execution of the business processes. Although the VBRE approach derives process and system requirements from the business requirements captured in the value model, the business context described in the value model expresses the business logic required to realize business strategies, but not the strategies and the organizational goals they help to achieve.

Overall, the RE approach that pays explicit attention to the strategic context of system requirements is *Goal-Oriented Requirements Engineering* (GORE). It is defined as an RE approach that is *"concerned with the identification of goals to be achieved by the envisioned system, the operationalization of such goals into services and constraints, and the assignment of responsibilities of resulting requirements to agents as humans, devices, and software"* (van Lamsweerde, 2000, p. 5). When business requirements are elicited and formulated in terms of goal models (using the goal modelling formalisms of approaches such as i* or KAOS (Dardenne, van Lamsweerde, and Fickas, 1993) or a meta-model such as the Business Motivation Model – BMM (OMG, 2010)), several benefits for the RE process result: (1) the organizational goals provide a criterion for deciding when the specified requirements are complete (i.e., when meeting the specified requirements is sufficient to achieve the stated goals); (2) the goal decomposition allows assessing the impact of organizational changes on lower-level system requirements; (3) alternative goal decompositions help exploring system design choices; and (4) contradicting or inconsistent requirements can be traced back to conflicting goals for which mechanisms can be devised to resolve them (Rolland, 2005).

By integrating goal modelling and business process modelling, more purposeful requirements for business processes and their supporting systems can be derived from higher-level business requirements (Rolland, 2005). The integration also helps incorporating non-functional requirements with respect to security and quality of business processes (Cysneiros, do Prado Leite, and de Melo Sabat Neto, 2001) (e.g., service level agreements that guarantee a certain quality of execution (Frankova, Yautsiukhin, and Séguran, 2007c)), which are not well represented using functionally-oriented process modeling techniques (Aburub, Odeh, and Beeson, 2007). The integration will also improve requirements traceability across different levels such that it becomes easier to redesign business processes and reconfigure BPMS applications in response to organizational changes (e.g., changes in strategy) (Lapouchnian et al., 2007). In the other direction, operational improvements in business processes can more easily be mapped back to organizational objectives to assess their impact and importance (Koliadis et al., 2006a) which is important as the strategic context of a BPM program must be recognized, understood, and used to guide the design and improvement of business processes (Powell and Dent-Micallef, 1997; Hung, 2006).

Going back to the example of the O2C process in the large logistics company, the executive management team argued that the proposed change to speed up payments will not be effective, and even be counter-effective, as a recent customer satisfaction survey indicated a general dissatisfaction with the O2C process, mainly because of its lack of transparency. One of the problems indicated by customers was the incomprehensibility of the bills sent to them. Customers were hesitant to pay their bills as they had difficulties in tracing back the amounts charged to them to the actual services delivered. Management feared that sending reminders for late payments sooner will not solve this problem. Given that the company saw its customer base seriously decrease over the last couple of years, customer retention was formulated as an overall priority goal for the company and an increase in customer satisfaction as a more concrete goal to realize in the next coming years. From this goal, concrete objectives were derived, including the objective to create more transparency for customers with respect to order handling and invoicing. The BPM team was made responsible for the achievement of this objective. Therefore, they launched a strategic initiative that aimed at creating an ‘open window’ on the O2C process using a web-based platform with services for order status monitoring, tracing deliveries, and e-invoicing. Within this strategic context, a more strategically aligned choice for resolving the problem of late payments would be to replace in the O2C process the current paper-based invoicing sub-process by an e-invoicing sub-process. However, this option was not obvious to the process owner and other stakeholders in the O2C process, as they saw this process purely as a means to generate revenues for the company and hence their focus of attention was limited to assuring and improving process efficiency.

GORE-for-BP: Previous Studies

The last example in the previous sub-section illustrates the advantages of a GORE approach to business process (re)design. The contextualisation of requirements for business processes and their supporting systems is achieved through the integration of goal models and business process models and several proposals have been made in this respect. A first attempt to conceptualize the idea of GORE-for-BP and understand the relationships between different proposed methods was made by Decreus, El Kharbili, Poels, and Pulvermueller (2009a) who consider, based on the work of Kavakli and Loucopoulos (1999a), RE as a knowledge-modelling process. Throughout a typical RE lifecycle (e.g., (van Lamsweerde, 2000)), RE activities are performed to increase the state of knowledge about requirements. Three broad knowledge states are identified:

- *Elicited Requirements state*. As a result of using RE elicitation techniques, the requirements and domain assumptions are identified.
- *Specified Requirements state*. Using conceptual modelling languages, the requirements and domain assumptions are specified in a precise way.
- *Validated Requirements state*. The requirement specifications are checked for deficiencies (such as incompleteness or inconsistency) and for feasibility (in terms of resources or development costs).

The customer satisfaction survey held by the logistics company revealed the business requirements of increasing customer satisfaction and creating more transparency in order handling and invoicing (‘Elicited Requirements’). A goal model is developed that shows that the goal of increasing customer satisfaction contributes to the higher-level goal of customer retention and is contributed to by the lower-level objective of increasing transparency in the O2C process. The goal model further shows the ‘open window’ strategy for achieving this objective and identifies the actions and resources required to realize the strategy, here to develop a web-based platform with customer services (‘Specified Requirements’). E-invoicing is identified as a priority customer service to be developed as it directly addresses the observed problem of incomprehensible bills. The goal model is further refined by recognizing that e-invoicing may also help in achieving the objective of speeding up the collection of payments, which contributes to the higher-level goals of process efficiency and shortening the company's cash cycle ('Validated Requirements').

These three knowledge states are connected by Decreus et al. (2009a) to the four-phased BPM lifecycle (van der Aalst, 2004) to create the *Requirements Engineering for Business Process Management* (REBPM) framework (Figure 1), in which the four main BPM activities are also considered to result in certain states of knowledge (or completion):

- *Process Designed state*. The business processes are (re)designed.
- *System Configured state.* Based on the process design, the system configuration is realized.
- *Process Enacted state*. The configured processes are deployed to the run-time component of a BPMS environment.
- *Process Diagnosed state*. The currently enacted processes are analysed to improve performance.

The O2C process is redesigned such that in several steps of the process customers can access the services provided by the web-based platform ('Process Designed'). Once the web-based platform is developed, the workflow management system for the O2C process is reconfigured such that in several steps of the process, notifications are sent to customers with links to applicable services they can use (e.g., order status monitoring, deliveries tracking, access to the on-line invoice, etc.) ('System Configured'). From the moment the new way of order handling has become operational, customers are no longer sent paper invoices but are invited to access their invoices on-line ('Process Enacted'). After three months, the proportion of customers that make use of the new services will be calculated and a sample of customers will be interviewed by telephone to get their opinion about the new services and to solicit suggestions for further improvement. Also a new average throughput time will be calculated to see whether the changes also improve process efficiency, and hence shorten the company's cash cycle ('Process Diagnosed').

As shown in Figure 1, the REBPM framework includes a *transformation* activity between the RE and BPM lifecycles. According to Decreus et al. (2009a), this activity helps to transform a RE knowledge state into a BPM knowledge state or vice-versa. The framework shows that in principle any RE (or vice-versa BPM) state can be transformed into any BPM (or vice-versa

RE) state, although it is likely that the integration of goal models and business process models is the aim of the transformation activity (e.g., mapping tasks (i*) or tactical actions (BMM) described in the goal model onto the activities (BPMN) or functions (EPC) in the business process models). The framework also shows that, despite their cyclical nature which indicates a natural flow of activities, the RE activities and the BPM activities can in principle be executed in almost any order and iteratively, both before and after the transformation(s).

The REBPM framework makes clear that the transformation activity is the essential feature of any GORE-for-BP method as it is through this activity that the results of a given RE (or vice-versa BPM) activity can be used as a valuable input for a BPM (or vice-versa RE) activity. Referring again to our example we could say that it is by means of this step that knowledge of the business requirements, e.g., increasing customer satisfaction through an ‘open window’ on the O2C process, is used to gain knowledge of O2C process and system requirements, e.g., replacing the paper-based invoicing sub-process by an activity that offers an e-invoicing service to customers. A GORE-for-BP method should contain methodical prescriptions on how to execute the transformation activity, e.g., how to derive process and system requirements from business requirements.

Figure 1: The REBPM framework (adapted from (Decreus, El Kharbili, Poels, and Pulvermueller, 2009a))

In another study, Decreus, Snoeck, and Poels (2009b) identified six GORE-for-BP methods that transform i* goal models into (skeletons of) business process models. The six methods were all applied to the Seven-Eleven Japan exemplar case-study (Nagayama and Weill, 2004) and the results and experiences in applying the methods were compared, focusing on the transformation activity. The main findings were that the analysed GORE-for-BP methods have insufficient construct mappings (e.g., how should an actor in an i* goal model be represented in a process model?), lack formality in the transformation algorithm (e.g., if the transformation is executed by different people, will the results be the same?) and have little attention for inter-model consistency checks (e.g., is the information in the process model consistent with the goal model?). Further also a number of methodological aspects (e.g., what is the level of detail in which method steps are described?) and organisational issues (e.g., what organizational roles or functions are targeted as method users?) were evaluated with mixed results. These findings point to the immaturity of the GORE-for-BP area. Further, the differences in the results obtained by these methods indicate a wide variety of purposes and applicability constraints or assumptions which may be a symptom of a lack of understanding on how to apply a GORE approach to the design of business processes and development of BPMS applications.

Research Questions

As explained before, many researchers agree that the integration of goal modelling and business process modelling can be beneficial for the application of BPM in organizations. Given the immaturity of the field and at the same time the great opportunities that a GORE approach can offer, we need to better understand and critically assess the current state in GORE-for-BP in order to identify research gaps and future research directions. The studies that were discussed in the previous sub-section lead to the formulation of specific research questions to be addressed by the research review. From these questions a number of operational analysis criteria are derived that facilitate answering the research questions.

As other goal modelling languages than i* exist and the REBPM framework indicates that the transformation activity can also be directed from BPM to RE, the review of GORE-for-BP methods in (Decreus et al., 2009b) is far from complete. A first research question is therefore *"What GORE-for-BP methods can be identified?"*. A logical second question, given the differences observed in (Decreus et al., 2009b), is *"What is the focus of the identified GORE-for-BP methods?"*, where focus is operationalized in terms of coverage of the REBPM framework. The nature of the integration that is attempted by GORE-for-BP methods can be discovered by mapping the method activities onto the framework, i.e., what systematic progression through the states identified in the framework is prescribed by the method? When answering this question we will specifically look into the transformation activity, identifying which RE states are transformed into which BPM states or vice-versa. A first analysis criterion for the identified GORE-for-BP methods is thus completeness in terms of coverage of the REBPM framework.

A third research question is *"What is the scope of the identified GORE-for-BP methods?"*, where scope is understood as application domain. The study of Decreus et al. (2009b) pointed out that the transformation activity is founded on language construct mappings, so GORE-for-BP methods make assumptions about which goal modelling and business process modelling languages to use, which restricts the application domain of the method. The modelling languages used will be a second analysis criterion in our review of identified GORE-for-BP methods. Also other applicability restrictions (third analysis criterion), e.g., deriving only non-functional requirements for business processes or only focusing on an organisation's primary value-adding processes related to production and delivery, will be investigated. Finally, a fourth research question is aimed at assessing the state of the (methodical) knowledge in the field: *"How mature are the identified GORE-for-BP methods?"*. Here we will address first of all the maturity of the essential feature of these methods, i.e., the transformation activity. The review of GORE-for-BP methods in (Decreus et al., 2009b) showed that the transformation of i* goal models into business process models is often done in an ad-hoc way. The question therefore is whether the transformation is described by a formal algorithm such that it becomes executable with repeatable results (fourth analysis criterion).

Method maturity also depends on the level of detail of the methodical guidance that is offered to users (fifth analysis criterion). The inclusion of this criterion is based on the study of Davies, Rosemann, Indulska, and Gallo (2006) who investigated the factors that inhibited the use of modelling in organisations. An important conclusion of this study was that the relative advantage and usefulness from the perspective of the modeller is the major driving factor influencing the decision to continue (or discontinue) modelling. Related to this perceived usefulness, the complexity of the modelling method plays an important role, and could be tackled by providing the modeller clear and practical guidelines. For instance, the modeller could be provided by cookbook-like guidelines to create a model, or might just be provided with a software tool without any further guidelines on how to use it.

Finally, the level of quantitative or qualitative validation of a proposed GORE-for-BP method in a realistic context is an indicator of the method's maturity. Therefore, the extent of the validation of the method in realistic usage contexts (sixth criterion) will be assessed.

RESEARCH METHODS AND PROCEDURES

To analyse the focus, scope and maturity of existing GORE-for-BP methods, six analysis criteria were derived in the previous section:

1. Completeness in terms of the REBPM framework
2. Conceptual modelling languages used
3. Application restrictions
4. Maturity of the transformation activity
5. Practical guidelines offered to modellers
6. Validation in practical context

Before these criteria can be applied, the existing GORE-for-BP methods need to be identified. As our goal is a research review of the area, rather than an assessment of the degree of adoption and state-of-the-practice, our research scope is limited to those methods which development and evaluation has been documented in the academic literature, i.e., where the research has resulted in papers in academic journals or conference proceedings. To identify these methods in a scientifically rigorous way, the research method of Systematic Literature Review is applied (see second sub-section).

We consider the first analysis criterion as the most important as it attempts to provide insights into how researchers understand the GORE-for-BP concept. Specifically, the research review assesses the extent to which the REBPM framework of Decreus et al. (2009a) is a common conceptualization of GORE-for-BP that underlies the development of methods that integrate goal modelling and business process modelling. The breadth of coverage of the REBPM framework in terms of which transformations of knowledge states the methods help achieving, will reveal for what purposes the different methods were proposed. Knowing the focus of existing methods helps in identifying research gaps and future research opportunities for extending existing methods or developing new methods (e.g., for addressing yet uncovered state transformations). To be able to analyse methods according to this first criterion, we use Method Meta-Modelling as a research method (see first sub-section).

Finally, analysis criteria two to six may inform interested researchers on the current scope and maturity of GORE-for-BP methods and identify opportunities for research aimed at generalization, formalization and validation of these methods. The results can also be used to devise design criteria for newly developed methods. While some of the criteria can be evaluated directly from our reading of the papers, others require interpretation and judgement. To apply these analysis criteria in a consistent and objective manner, we developed an assessment procedure (see third sub-section).

Method Meta-Modelling

Meta-modelling is mostly used to describe or specify the syntax of conceptual modelling languages (Guizzardi, 2007). Rolland et al. (1995), Rolland, Nurcan, and Grosz (1999a) and Rolland, Prakash, and Benjamen (1999b) have applied meta-modelling principles to systems development methods. Since then, method meta-modelling has become a core research technique in the Method Engineering field, see e.g., Karlsson and Agerfalk (2009) and Bucher and Dinter (2012). The idea is that by modelling how methods work, they can be better understood and analysed.

A *method meta-model* provides a set of generic concepts to describe any method model. For instance, a simple method meta-model could define the concepts Source State, Target State and Strategy and an association relationship between them, such that Strategy is associated both to a Source State and to a Target State (Figure 2 – Method Meta-model).

Next, a *method model* is used to prescribe how things must/should/could be done according to a particular method and is therefore also referred to as a *way-of-working* (Rolland et al., 1995). For instance, a specific method could have a way-of-working to elicit requirements via interviewing techniques, which could be represented in the method model by moving from Source State 'Null' (signifying a start state where there is a recognized lack of knowledge about business processes and their requirements) to Target State 'Elicited Requirements' via Strategy 'Interviewing techniques' (Figure 2 – Method Model).

Finally, the term *method* is used in a specific sense in Method Meta-Modelling as it refers to the actual execution of the activities that were recommended by a way-of-working, done in the context of a specific project. For instance, to elicit process requirements during a business process modelling project at company X, people could use the interviewing techniques as prescribed by the way-of-working (Figure 2 – Method).

Figure 2: Method meta-modelling (Adapted from (Rolland, Souveyet, and Moreno, 1995; Rolland, Nurcan, and Grosz, 1999a; Rolland, Prakash, and Benjamen, 1999b;))

GORE-for-BP methods describe one or more particular routes through the REBPM framework that can be followed in order to reach the seven knowledge states. These routes describe the GORE-for-BP methods at the way-of-working abstraction level as these descriptions are project-independent, so abstract from project-specific interpretations of the method prescriptions. Each step in a route prescribed by a method constitutes a *method fragment* and expresses the intention to reach Target State S_j starting from a Source State S_i using a Strategy Str_{ij}. A GORE-for-BP method then consists of a number of method fragments, each of which is a triplet $<S_i, S_j, Str_{ij}>$ whereby S_i and S_j are knowledge states in the REBPM framework and Str_{ij} is a strategy for reaching S_j from S_i.

Figure 3 shows an example method model (in the form of a Petri Net) indicating a route through the REBPM framework. The method modelled is the Soffer and Rolland GORE-for-BP method (Soffer and Rolland, 2005), which was one of the methods identified in the SLR (see the fourth section). Each method fragment consists of a strategy that is represented as a Petri Net transition between source and target Petri Net states. Non-deterministic choices in the Petri Net representation indicate the existence of alternative strategies when source and target states are the same (e.g., a linguistic or template driven strategy to elicit requirements) or alternative routes through the REBPM framework when only the source state is the same. By using Hierarchical Petri Nets, transitions can be elaborated as subnets, which allow distinguishing sub-steps of activities and intermediate states. For instance, the process design strategy of the Soffer and Rolland method starts from specified requirements (an RE knowledge state) and leads to designed processes (a BPM knowledge state) and consists of three tasks, which gradually allow moving from source to target state. The intermediate states and transitions shown in the subnet are too concrete for the abstraction level used in the REBPM framework, hence will not be used to compare methods and analyse them according to our first analysis criterion. Note further the additional states 'Null' and 'Signed Off', indicating respectively a start state with a recognized lack of knowledge leading to the initiation of the (execution of the) method and an end state where the state of knowledge is recognized as being sufficiently complete to stop the method. As GORE-for-BP methods can take any route through the framework, the start state can also be any REBPM knowledge state, which means that methods may assume a specific knowledge state to start from. The 'Signed Off' end state may require that different REBPM states have been reached simultaneously or alternatively, so therefore one or more additional 'Sign Off' transitions are added to the model. The Soffer and Rolland method considers 'Validated Requirements' as the final knowledge state, so there is only one transition to the 'Signed Off' end state.

Figure 3: The Soffer and Rolland way-of-working

The meta-modelling technique described in this sub-section offers a systematic way to understand the way of working of GORE-for-BP methods. The resulting method models allow analysing the completeness of the methods in terms of coverage of the REBPM framework. However, to apply the technique, GORE-for-BP methods need to be interpreted in terms of this framework. To increase the objectivity of this research activity, three researchers, all with a PhD in Information Systems, first independently modelled the selected methods. Next, these different models were compared and if there were differences in interpretation then these were discussed, analyzed and reconciled. The final models obtained represent the consensus of the three researchers. Researcher A is a software engineering professor with twenty-one years of experience with academic research at the time of the study. She has research expertise in software modelling, requirements specification, and business process modelling. Researcher B is a management information systems professor with fifteen years of research experience and expertise in conceptual modelling and business process management. Researcher C is a postdoctoral researcher in information systems with three years of relevant research experience in requirements engineering and business process modelling. Collectively, the research expertise covers the entire RE and BPM lifecycles. However, it is important to note that none of the researchers were involved in the development of the GORE-for-BP methods that were modelled, which further helps ensuring objectivity and avoiding bias.

Systematic Literature Review

A Systematic Literature Review (SLR) is a literature search and study technique for evaluating and interpreting all available research relevant to a particular research question, topic area, or phenomenon of interest (Kitchenham, 2004; Kitchenham, Dyba, and Jorgensen, 2004; Brereton et al., 2007; Kitchenham et al., 2009; Genero et al., 2012). SLRs are based on a research protocol that includes a search strategy and procedure, selection criteria and a quality assessment and selection procedure. A pre-defined protocol is necessary to systematically carry out the literature review and to reduce the possibility of researcher bias. The search strategy includes the definition of search terms and the sources to be searched. The search terms were derived from the terms contained within our first research question (*What GORE-for-BP methods can be identified?*), which lead to three main keywords: goal (contained in GORE), business process (contained in BP(M)) and method. We also identified synonyms for these keywords. The search string was constructed using the Boolean "AND" to join the main terms and "OR" to include synonyms.

(1) Goal OR Objective OR Intention OR Purpose
AND
(2) Process OR workflow
AND
(3) method OR technique OR approach OR grammar OR metamodel

We limited the search scope to five e-libraries that include the main journals and conference proceedings in the domains of RE and BPM. These e-libraries were Springer (including the Requirements Engineering Journal and the Lecture Notes in Computer Science series which publishes proceedings of major relevant conferences and workshops like CAiSE, BPMDS, EMMSAD, ER and BPM), ACM (including ACM SAC proceedings), Elsevier (including journals relevant to the target domains such as Information Systems, Data & Knowledge Engineering, and Information and Software Technology), IEEE (including the proceedings of the RE, COMPSAC and EDOC conferences) and Emerald (including the Business Process Management Journal). The search string was applied to the fields 'title', 'abstract' and 'keywords' of the papers included in the searched e-libraries and published from 1980 up until the 1st of August 2009 (as the search was performed in late summer 2009).

The search string was pilot tested on a small selection of e-sources. The main outcome was that the proposed search string was too specific (few search results) and that our search left methods uncovered that were intuitively good candidates. For instance, authors used unforeseen synonyms (e.g., 'framework' (Koubarakis and Plexousakis, 2002) instead of method or technique) or general keywords, titles and abstracts without our specific set of search terms (e.g., a paper titled Model Driven Architectures for Enterprise Information Systems (Barrios and Nurcan, 2004)). In order to fix this problem, we decided to drop the third series of terms (i.e., method, technique, etc.) in the conjunction. As a result of this change, we expected a larger number of results, but also more irrelevant results, which have to be manually eliminated, based on the selection criteria.

Our search procedure consisted in all three researchers executing the search individually, which resulted in three lists of papers of which title, abstract and keywords were carefully screened in order to determine whether the paper described a GORE-for-BP method (based on our understanding of the area as described in the second section). A united list of papers was obtained by reaching a consensus on the individual searches done by the researchers. As authors may publish different papers about their method, each focusing on different aspects related to the development or evaluation of (parts of) the method, the papers describing a same method were grouped. In order to cover missing information about the methods identified this way, we added previous work of the authors or external work that the authors build upon to the initial list of discovered papers. We browsed the World Wide Web for previous work of the authors, and more specifically, the authors' personal publication pages and publication repositories such as DBLP Computer Science Bibliography and Scientific Commons.

Study selection criteria are criteria for including a paper in, or excluding it from, the analyses that are performed. In order to apply the meta-modelling technique described in the previous sub-section and to reduce the subjective interpretation of the identified methods as much as possible, we defined quality criteria in terms of completeness of documentation. To assess these criteria, the entire collection of found papers describing a method is taken into account. Three quality categories (low, medium and high) were defined beforehand and the list of necessary conditions for categorizing methods is shown in Table 1. Methods that are considered 'low' in terms of completeness of documentation, have at least to explicitly identify goal modelling constructs (e.g., 'goal', 'objective', 'strategy') as well as business process modelling constructs (e.g., 'activity', 'sub-process', 'gateways', 'events'). Furthermore, at least one relationship should be described between the two kinds of constructs, e.g., business process activity X 'realizes' business objective Y.

Methods that are considered 'medium' in terms of completeness, satisfy the conditions for 'low' completeness and have an implicit description of how to link or integrate goal models and business process models, but lack explicitly distinguished method steps. So relative to 'low' methods, 'medium' methods not only mention a relationship between goal modelling constructs and business process modelling constructs, but also provide hints on how to transform or integrate goal modelling artefacts into business process modelling artefacts (or vice-versa). These 'medium' methods should also employ at least an example to illustrate the general ideas behind the method. However, the information provided is generally not sufficient to allow other researchers to replicate the example application.

In contrast, methods that are considered 'high' in terms of completeness satisfy the conditions for 'medium' completeness, and offer explicitly described distinguishable steps to execute the method. Also, a description is given of the type of artefact produced by executing each method step. So relative to 'medium' methods, 'high' methods do not only provide hints for the transformation, but offer repeatable method descriptions that describe which transformation steps are done and what the expected deliverables are. As the meta-modelling technique we wished to apply to analyse the identified GORE-for-BP methods requires the identification of method fragments (confer previous sub-section), it is necessary to have a good description of the individual steps to be executed. Hence, only 'high' methods are suitable for further analysis and this was used as our decisive selection criterion.

As part of the selection procedure, full copies of the papers were reviewed by all three reviewers. The actual selection was done jointly in a number of consecutive sessions. We started by selecting the methods that obviously scored ‘low’ in terms of documentation, and then identified ‘high’ methods. The remaining methods were expected to score ‘medium’ in terms of completeness, but could well be overestimated ‘low’ or underestimated ‘high’ methods. After discussing these remaining methods and finding a consensus on their quality assessment, we obtained the final list of papers, clustered by method. The results of the SRL are presented in the next section.

Category	Necessary Conditions
Low	- Separate goal and business process modelling constructs - At least one relationship between them is described
Medium	- Satisfy conditions of ‘low’ - An implicit description of how to link goals and business processes (but no explicitly distinguishable method steps) - An example that illustrates the method
High	- Satisfy conditions of ‘medium’ - An explicitly described method that contains distinguishable steps to execute the transformation - Description of the type of artefact produced by each method step

Table 1: Quality Metrics in terms of completeness of documentation

Assessment Procedure

After identifying and modelling GORE-for-BP methods, we could start analysing them using the criteria mentioned at the beginning of this section. The ways-of-working already provide the analysis of the selected methods according to the first criterion (*completeness in terms of the REBPM framework*) as they show which of the possible routes through the REBPM framework are taken by a method. Also the second (*conceptual modelling languages used*), third (*applicability restrictions*) and sixth (*validation in practical context*) criterion can be unambiguously assessed as this information is literally present in the papers. However, a protocol was required to assess the fourth and fifth criteria (*maturity of the transformation activity, practical guidelines offered to modeller*) as they require interpretation and judgement on behalf of the evaluators (i.e., the three researchers involved in the study).
We decided to assign scores to two variables (i.e., one for each of the remaining criteria) by looking at the performance of each method for the variable considered. When the aspect addressed by the variable is clearly missing (e.g., complete lack of practical guidelines), a

score of 0% is given. Note that a 0% score for *maturity of the transformation activity* would contradict the classification of a method as 'high' with respect to completeness of documentation. On the other hand, when the aspect considered is described in a detailed and comprehensive manner that is deemed sufficient by the evaluator (e.g., a well-documented catalogue of practical guidelines, a formally described precise algorithm for the transformation), a score of 100% is given. The score of 50% is given to aspects that are discussed in the papers, but lack completeness according to the evaluator (e.g., mentioning practical guidelines for some method steps but not for others, describing the transformation in detail but by means of an illustration only).

All three researchers first independently assign the 0%, 50% and 100% values to the two variables considered for each method in the selection. Next, the results are discussed in a group session and nuances of 25% and 75% were added to the range of possible values to reflect the joint opinion of all three researchers (e.g., when two researchers assigned a 50% score and one researcher a 100% score, the group discussion could settle at a 75% score rather than being forced to choose between 50 and 100%).

IDENTIFICATION AND SELECTION OF GORE-FOR-BP METHODS

The application of the search strategy resulted in an initial list of 38 papers, both journal and conference papers, where authors describe the development or evaluation of (parts of) GORE-for-BP methods. However, the papers often only highlight specific research issues instead of covering the entire method. The additional search in authors' personal publication pages and the DBLP Computer Science Bibliography and Scientific Commons publication repositories extended this list to 66 papers. After grouping related papers, a total of 19 GORE-for-BP methods were discovered (Table 2). The key idea of each method is briefly discussed in the Appendix.

Method	**References**	**Completeness Category**
Aburub et al. Method	Aburub, Odeh, and Beeson (2007) Cysneiros, do Prado Leite, and de Melo Sabat Neto (2001)	High
Bleistein et al. Method	Bleistein, Aurum, Cox, and Ray (2004a) Bleistein, Cox, and Verner (2004b, 2004c, 2004d, 2005, 2006a) Bleistein, Cox, Verner, and Phalp (2006b, 2006c) Cox and Phalp (2003)	High

	Cox, Phalp, Bleistein, and Verner (2005)	
Frankova et al. Method	Frankova, Massacci, and Séguran (2007a, 2007b) Frankova, Yautsiukhin, and Séguran (2007c) Séguran, Hébert, and Frankova (2008) Giorgini, Massacci, Mylopoulos, and Zannone (2006) Massacci, Mylopoulos, and Zannone (2008)	High
Grau et al. Method	Grau, Franch, and Maiden (2005, 2008) Grau, Franch, and Avila (2006) Jones and Maiden (2004)	High
Koliadis et al. Method	Koliadis, Vranesevic, Bhuiyan, Krishna, and Ghose (2006a, 2006b) Fuxman et al. (2004)	High
Lapouchnian et al. Method	Lapouchnian and Lespérance (2006) Lapouchnian, Yu, and Mylopoulos (2007) Sebastiani, Giorgini, and Mylopoulos (2004)	High
Soffer and Rolland Method	Soffer and Rolland (2005) Rolland, Prakash, and Benjamen (1999b)	High
de la Vara et al. Method	de la Vara and Sánchez (2007, 2008) de la Vara, Sánchez, and Pastor (2008)	Medium
Kavakli and Loucopoulos Method	Kavlaki and Loucopoulos (1999b) Locopoulos and Kavlaki (1995) Kavlaki (2004) Bubenko, Persson, and Stirna (2001)	Medium
Kazhamiakin et al. Method	Kazhamiakin, Pistore, and Roveri (2004a, 2004b) Pistore, Roveri, and Busetta (2004) Traverso et al. (2004)	Medium
Koubarakis and Plexousakis Method	Koubarakis and Plexousakis (1999a, 1999b, 2000, 2002) Bubenko, Persson, and Stirna (2001)	Medium
Neiger and Churilov Method	Neiger and Churilov (2003, 2004a, 2004b, 2006)	Medium
Nurcan et al. Method	Nurcan (2004a, 2004b) Barrios and Nurcan (2004) Nurcan and Edme (2005) Nurcan, Etien, Kaabi, Zoukar, and Rolland (2005)	Medium
Soffer and Wand Method	Soffer and Wand (2005, 2007)	Medium
Vasconcelos et al. Method	Vasconcelos et al. (2001) Tribolet, Winter, and Caetano (2005)	Medium
Greenwood et al. Method	Greenwood and Rimassa (2007) Greenwood (2008) Calisti and Greenwood (2008)	Low
List and Korherr Method	List and Korherr (2005) Korherr and List (2006, 2007)	Low
Lo and Yu Method	Lo and Yu (2008)	Low
Markovic and Kowalkiewicz Method	Markovic and Kowalkiewicz (2008)	Low

Table 2: GORE-for-BP methods identified in the SLR and assessment of their completeness of documentation

The answer to our first research question (*what GORE-for-BP methods can be identified?*) is thus contained in Table 2. *Construct validity* (i.e., whether the methods can really be characterized as GORE-for-BP methods) was guaranteed by deriving the search terms used in the search string from the formulation of the research question. Further, our search was guided by prior understanding of the GORE-for-BP concept as defined in the study of Decreus, El Kharbili, Poels, and Pulvermueller (2009a). *Internal validity* (i.e., whether all methods within our research scope were found) was ensured by strictly following the guidelines for SLR as in (Kitchenham, 2004; Kitchenham, Dyba, and Jorgensen, 2004; Brereton et al., 2007; Kitchenham et al., 2009), in particular making use of a research protocol that searched the main e-libraries with publications related to RE and BPM research, a pilot run to test (and correct) the initial search strategy, and a pre-defined search procedure involving three researchers with expertise in RE and BPM. The *external validity* (i.e., whether all relevant methods were found) is limited to our research scope which was deliberately confined to academic publications (as the goal of the SLR was to conduct a research review) in the period 1980 – mid 2009. Given the appearance of BPM in the nineties (although its BPR predecessor existed in the eighties), it is unlikely that older GORE-for-BP methods exist. However, methods described in papers published after our search period, are not included. Further, methods might exist that have not (yet) lead to academic publications. Nevertheless, given the precautions taken, we believe to have found a sample of GORE-for-BP methods that is sufficiently complete in order to perform the research review of the GORE-for-BP area.
The results of the quality assessment in terms of the completeness of documentation are shown in the third column of Table 2. All papers related to a same method were jointly assessed. Only seven methods were assessed as ‘high’ and these GORE-for-BP methods were finally selected to be further analysed (see next section) using the six criteria discussed in the previous section.

ANALYSIS OF GORE-FOR-BP METHODS

A first sub-section presents the method models of the seven methods that were selected for the analysis. The way-of-working of these methods was investigated by applying the method meta-modelling technique as described in the third section. The assessment of the six analysis criteria for each method is presented in a second sub-section.

Way-of-working of the Selected GORE-for-BP Methods

The *Aburub et al.* method models the non-functional requirements for a business process by means of the NFR (Non-Functional Requirements) goal modelling formalism (Cysneiros, do Prado Leite, and de Melo Sabat Neto, 2001) and next links the NFR model to the RAD model that offers a functional view of the business process (Figure 4). The route starts by eliciting non-functional requirements of business processes using observation, interviews or by examining business documents. Next, the specification strategy (using the NFR approach) consists of three steps: (1) defining relationships between goals and sub-goals, (2) specifying actors who will achieve the elicited non-functional requirements (which are represented by the goals and sub-goals), and (3) further operationalizing the goals. After the 'Specified Requirements' state is reached, the positive and negative interactions between goals are analysed in order to discover the most beneficial goal operationalization with the least conflicts. The route terminates with a process design strategy, during which first certain non-functional requirements (modelled as (sub-)goals in the NFR model) are selected for achieving process improvement. Next, these selected goals are mapped to appropriate elements (i.e., activities and interactions) in the RAD model of the business process. This mapping is based on the (lack of) correspondence between actors responsible for goal fulfilment and the roles in the RAD model of the business process. If there is, for instance, an actor in the NFR model that does not correspond to a role in the RAD model, then a new role can be added with activities or interactions directed at the fulfilment of the non-functional requirements for which this actor is responsible.

Figure 4: The Aburub et al. way-of-working

The *Bleistein et al.* method is a top-down approach that combines Jackson problem frames, i* goal modelling, and RAD process models for strategically aligning organisational IT considering business strategy, domain context and business processes (Figure 5). The elicitation strategy consists of identifying business model participants and their relationships and employs the VMOST (Vision, Mission, Objectives, Strategies, and Tactics) analysis (Sondhi, 1999), which is a technique for deconstructing business strategy into core components. Next, these strategic components are related to each other according to the rules of the BMM meta-model (OMG, 2010) for goal modelling constructs. Both i* goal modelling and Jackson problem frame modelling are used to visualize the related strategic components. Further refinement of the strategy and its context is needed to reach the 'Specified Requirements' state. The validation of the strategic alignment is done by tracing the lowest-level system requirements to the highest-level strategic business objectives. Finally, the process design strategy consist of cross-referencing process models against both goal models and context diagrams as a means of better understanding the processes supporting the business strategy.

Figure 5: The Bleistein et al. way-of-working

The *Frankova et al.* method translates Secure Tropos (Giorgini, Massacci, Mylopoulos, and Zannone, 2006; Massacci, Mylopoulos, and Zannone, 2008) goal models into business process models using a proprietary business process language, which focuses on security requirements (Figure 6). Based on existing elicited requirements, the Secure Tropos modelling language, a variant of i*, is used to write four parts of the requirements specification: (1) the actor model that specifies the principal actors and their goals, (2) the functional dependency model that specifies which actors depend on other actors for obtaining services, (3) the permission delegation model that specifies which actors delegate to other actors the permission to use provided services, and (4) the trust model that specifies which actors trust other actors for providing services. Next, the process design strategy refines the Secure Tropos models into intermediate structures (called business process hypergraphs and business process hierarchies) to reason about the business processes and their security constraints. The designed processes are then configured by means of the Secure BPEL language, which is an extension of the Web Service Business Process Execution Language (WS-BPEL) (OASIS, 2007). Finally, the resulting Secure BPEL models are enacted by means of a WS-BPEL process engine.

Figure 6: The Frankova et al. way-of-working

The *Grau et al.* method is an i*-based business process reengineering method that models business processes and generates operational and strategic goal models from these business process models. The way-of-working can be seen in Figure 7. The route starts by using the RESCUE method (Jones and Maiden, 2004) for requirements elicitation, which includes data gathering techniques such as observation of the current process, analysis of software system use reports, informal scenario walkthroughs and interviews with stakeholders. Next, the process design strategy consists of Detailed Interaction Script (DIS) modelling, which entails a simplified notation for process scenarios that includes goals, actors, preconditions, triggering events and post-conditions. Based on these process scenarios, the requirements specification is obtained by following a number of steps: (1) actor specification and modelling their main goals using the i* goal language, (2) building the operational i* model that deals with descriptive goals, and (3) building the intentional i* model that handles prescriptive goals. Finally, the requirements are validated by cross-checking the process scenarios and the resulting requirement specifications (i* models).

Figure 7: The Grau et al. way-of-working

The *Koliadis et al.* method has two different ways-of-working: one that transforms requirements into process designs (Figure 8 (a)) and another that transforms process designs into requirements (Figure 8 (b)). In both ways-of-working, the requirements are already elicited and readily available to be specified. When transforming requirements into process designs (Figure 8 (a)), the elicited requirements are specified by means of the Formal Tropos (a variant of i*) goal modelling language. Next, the process design strategy consists of the following steps: (1) specify whether the actors are internal or external to the organisation in scope, (2) map i* concepts to BPMN concepts, (3) sequence the required tasks / sub-processes and introduce control flow links, and (4) elaborate on the resulting sub-processes. When considering the other direction (Figure 8 (b)), a BPMN model is provided and a systematic approach is followed to convert the BPMN model into an i* goal model: (1) map BPMN concepts to i* concepts, (2) apply intentional reasoning by querying the intention of tasks and control flow links, and (3) specifying i* soft goals including the dependencies between these i* soft goals.

Figure 8: The Koliadis et al. way-of-working

The *Lapouchnian et al.* method aims to configure ‘high-variability’ business processes in terms of business priorities, and the way-of-working is given by Figure 9. To start with, requirements are modelled via high-variability goal modelling, and these goals are enriched by means of control flow and input/output annotations. Next, the requirement specification is validated by analysing the alternative paths in the goal model and the infeasible ones are removed. Based on the validated high-variability goal model, an initial version of the high-variability BPEL model is semi-automatically generated. After this initial process design, the configuration strategy consists of the following steps: (1) completing and deploying the high-variability BPEL process, (2) selecting the process preferences in terms of quality criteria, and (3) picking the business process configuration that matches best with the process preferences. Finally, the resulting configured BPEL process is executed on a BPEL run-time engine.

Figure 9: The Lapouchnian et al. way-of-working

Finally, the *Soffer and Rolland* method combines intention-oriented and state-based process modelling. The way-of-working was shown in Figure 3 (in the third section). It recommends two alternative strategies for requirements elicitation, i.e., linguistic strategy (defining a goal as a verb with associated semantic functions) and template-driven strategy (asking users to fill in a goal template). Next, the Map modelling formalism is used to specify the requirements, which are transformed into a GPM (Generic Process Model) process design by following a specific procedure: (1) define the intentions and the related conditions, and (2) define sections as the law and describe the related conditions, and (3) refine the sections where needed. Finally, the process design is formally analysed to discover anomalies and deficiencies, in order to validate the initial set of requirements (specified by the Map model), after which the method can be signed off.

Assessment of Analysis Criteria

The results of the assessment procedure are summarized in Table 3, which will be further discussed in this sub-section.

- **Completeness in terms of REBPM framework**

The method models show that the RE ‘Specified Requirements’ and BPM ‘Process Designed’ states are reached in all ways-of-working, which implies either a direct transformation of one state into the other or an indirect transformation from the ‘Specified Requirements’ state to the ‘Designed Process’ state via the ‘Validated Requirements’ state (for the *Aburub et al., Bleistein et al.,* and *Lapouchnian et al.* methods). The direct transformation, offered in both directions (RE to BPM and BPM to RE), is the essence of the *Koliadis et al.* method, which further only covers the ‘Elicited Requirements’ state and considers it as the start state to initiate a requirements specification activity (RE to BPM direction) or a process design activity (BPM to RE direction). Apart from the *Koliadis et al.* method, the *Grau et al.* method is the only method that transforms the 'Process Designed' state into the 'Specified Requirements' state. All the other methods offer the transformation only in the RE to BPM direction. Although some methods contain other transformations between RE and BPM states (i.e., from 'Elicited Requirements' to 'Process Designed' in the *Grau et al.* and *Koliadis et al.* methods, and from 'Process Designed' to 'Validated Requirements' in the *Soffer and Rolland* method), it is clear that the focus of the analysed GORE-for-BP methods (except the *Grau et al.* method) is the derivation of business process models from goal models.

Apart from this core transformation activity, four methods provide support for the full RE lifecycle (the *Soffer and Rolland, Aburub et al., Bleistein et al.,* and *Grau et al.* methods). The *Lapouchnian et al., Koliadis et al.,* and *Frankova et al.* methods assume elicited requirements to start from, so their ways-of-working do not contain a method fragment that leads to the 'Elicited Requirements' state. The latter two methods do not address requirements validation either. Methods that support requirements validation do so by means of a specific strategy that starts from the goal model (using techniques like conflict resolution, strategic alignment via traceability links, analysing and evaluating alternative goals, checks related to a common meta-model) or from the business process model as in case of the *Soffer and Rolland* method (using a process analysis technique). Methods that support requirements elicitation use different strategies like observation, interviewing, examining documents, scenario walkthroughs, VMOST analyses, linguistic strategy, and template-driven strategy.

Only the *Frankova et al.* and *Lapouchnian et al.* methods cover the 'System Configured' and 'Process Enacted' states of the REBPM framework, hence offer support for the system configuration and process enactment BPM activities. These two methods were found incomplete with respect to the activities of the RE lifecycle, missing requirements elicitation and in case of the *Frankova et al.* method also requirements validation.

Finally, none of the seven GORE-for-BP methods that were analysed include process diagnosis activities, so they are incomplete with respect to the BPM lifecycle activities. The four methods that are complete with respect to the RE lifecycle activities only cover the process design BPM activity.

	Completeness in terms of REBPM framework	Conceptual modelling languages used	Validation in practical context	Applicability restrictions	Practical guidelines offered to modeller	Maturity of the transformation activity
Aburub et al.	- Requirements Elicitation - Requirements Specification - Requirements Validation - Process Design	- RAD - NFR	- Illustration	- Only non-functional requirements	◔	◔
Bleistein et al.	- Requirements Elicitation - Requirements Specification - Requirements Validation - Process Design	- RAD - i* - Jackson Diagrams	- Illustration - Pilot Study		◕	◑
Frankova et al.	- Requirements Specification - Process Design - System Configuration - Process Enactment	- Secure Tropos (i*) - Secure BPEL	- Illustration	- Focus on security requirements related to business process execution	◔	◑
Grau et al.	- Requirements Elicitation - Requirements Specification - Requirements Validation - Process Design	- DIS - i*	- Illustration - Case Study		●	◕
Koliadis et al.	- Requirements Specification - Process Design	- Formal Tropos (i*) - BPMN -	- Illustration		◑	◕
Lapouchnian et al.	- Requirements Specification - Requirements Validation - Process Design - System Configuration - Process Enactment	- i* - BPEL	- Illustration	- Focus on high-variability business processes	◑	◑
Soffer and Rolland	- Requirements Elicitation - Requirements Specification - Requirements Validation - Process Design	- Map - GPM	- Illustration		◔	◑

● 100% ◕ 75% ◑ 50% ◔ 25% ○ 0%

Table 3: Analysis of the selected GORE-for-BP methods

- **Conceptual modelling languages used**

In total, three different goal modelling languages (five including i* variants) (i*, Formal Tropos (i*), Secure Tropos (i*), NFR, Map) and six different process modelling languages (RAD, Secure BPEL, DIS, BPMN, BPEL, GPM) are employed. Few other modelling languages are used, the exception being the use of a frame-based RE technique for modelling domain context (Jackson context and problem diagrams) in the *Bleistein et al.* method.
The ways-of-working of the selected GORE-for-BP methods show that to reach the 'Specified Requirements' state, either elicited requirements are specified using a goal modelling formalism (NFR, i*, Map) or process designs are transformed into goal models (DIS to i*, BPMN to i*). The method models further show that to reach the 'Process Designed' state, process models are either directly constructed from elicited requirements using a business process modelling language (DIS, BPMN) or are generated using a transformation technique that starts from non-validated requirement models (Secure Tropos to Secure BPEL, i* to BPMN, Map to GPM) or validated requirement models (NFR to RAD, i* to RAD, i* to BPEL).

- **Applicability restrictions**

Only the *Aburub et al.* method is restricted in its application. This method was specifically developed to design business processes such that they also realize non-functional process requirements, in particular related to quality of service attributes. Therefore, the RE activities prescribed by the method only deal with non-functional requirements for business processes. The other GORE-for-BP methods can be generally applied in situations where the strategic context of (any kind of) business processes needs to be considered. Two methods, however, pay specific attention to a particular kind of business process requirements (i.e., security of business process execution in the *Frankova et al.* method) or a particular kind of business processes (i.e., high-variability processes in the *Lapouchnian et al.* method). These are also the only two methods that address system configuration and process enactment, so they emphasize the impact of specific characteristics (i.e., security constraints and high-variability) on business process execution and explain how process design and system configuration should incorporate these characteristics.

- **Maturity of the transformation activity**

The method models show for each method the presence of an activity that transforms the RE 'Specified Requirements' state into the BPM 'Process Designed' state (or vice-versa or even

in both directions). Hence, each method provides a mapping between goal modelling and business process modelling constructs. The analysis of the conceptual modelling languages used by the methods already identified the languages of which the constructs are mapped onto each other. The transformation activity uses these mappings to transform one kind of model into another kind of model (e.g., i* goal model into BPMN business process diagram or BPMN business process diagram into i* goal model in the *Koliadis et al.* method).
The scores for this criterion are shown in Table 3. They reflect the joint and motivated opinion of the three evaluators on the extent to which the transformation is described by a formal algorithm such that it becomes executable with repeatable results. There was agreement that the *Grau et al.* and *Koliadis et al.* methods offer a good description of the transformation, however, it was felt that some details were missing that would enable an exact replication of the example transformation that was given in the papers (score = 75%). Four other methods (*Bleistein et al.*, *Lapouchnian et al.*, *Soffer and Rolland*, *Frankova et al.*) explain the transformation by means of an illustration rather than formally describing it with an algorithm (score = 50%). Finally, the *Aburub et al.* method describes the transformation only superficially and the illustration provided in the paper does not really explain how the transformation works (score = 25%).

- **Practical guidelines offered to modeller**

In terms of supporting the modeller with practical guidelines, the *Grau et al.* method received a maximum score of 100%. More specifically, this method offers the modeller seven rules to build the operational i* model, four guidelines to build the intentional i* model, and thirteen checks to verify the resulting i* models. The *Bleistein et al.* method also offers practical guidelines to modellers (score = 75%), but these guidelines relate more to the elicitation of the strategic information (by means of the VMOST guidelines and the guidelines of Weill and Vitale (2001)), and less to the practical modelling of requirements and processes. Next, the *Koliadis et al.* and *Lapouchnian et al.* methods discuss modelling guidelines, but do not provide sufficient details on how to use these modelling guidelines in a practical context (score = 50%). Finally, the remaining methods (*Aburub et al.*, *Frankova et al.*, *Soffer and Rolland*) focus on presenting their method by means of an example, but pay less attention to the guidelines for modellers to employ their method in a practical context (score = 25%).

- **Validation in practical context**

For all seven GORE-for-BP methods, the papers found in the SLR mentioned the use of a lightweight validation technique, i.e., a proof of concept application of the method by means of an example. Only two out of seven methods complemented these feasibility demonstrations with an additional validation. The *Grau et al.* method was tested in a number of case studies that leveraged earlier case study insights of the RESCUE method reported by Maiden, Jones, Manning, Greenwood, and Renou (2004). For the *Bleistein et al.* method, a pilot (field) study at a major Australian financial institution is reported (Cox, Bleistein, Reynolds, and Thorogood, 2006). No evidence of other validation studies (e.g., field experiments comparing the use of the methods with alternatives, longitudinal studies investigating the impact of applying the methods on organisational performance) was found in the papers.

The results of the analysis of the selected GORE-for-BP methods allow formulating answers to our second, third and fourth research questions (see second section). The mapping of the ways-of-working of the seven selected methods onto the REBPM framework clearly shows the *focus of the identified methods* (second research question). With few exceptions, this focus is the transformation of goal models, capturing the strategic context for the business processes and the process requirements that are derived from this context, into business process models that represent the design of these processes. The purpose of the majority of the identified methods is thus to support the systematic (re)design of business processes based on the identification of organizational goals and the operationalization of these goals into strategic objectives that the business processes help achieving. Despite a common purpose, the mapping also shows a wide variety in routes through the REBPM framework taken by the methods, indicating differences in understanding of how to achieve this purpose. Hence, based on the research review, we cannot establish the REBPM framework as a shared conceptualization of GORE-for-BP.

Further, two categories of methods can be distinguished. A first category of methods are (nearly) complete with respect to their coverage of the RE lifecycle, but only address the BPM process design activity. These methods aim at integrating RE activities into business process modelling. There is also a smaller category (only two instances were identified) of methods that are less complete in terms of the RE lifecycle, but that move further in the BPM lifecycle. These methods go all the way from goal-oriented requirements modelling over business process design to the configuration of systems that execute the designed business processes.

The *scope of the identified methods* (third research question), other than what knowledge states and state transformations of the REBPM lifecycle are covered, is also determined by the modelling languages that are used. The employed languages primarily model the business requirements related to strategic context (e.g., organisational goals, strategic objectives) and functional process requirements (e.g., process activities, sequencing of process activities). The incorporation of non-functional process requirements into process designs and the further derivation of system or process execution requirements are outside scope of most of the identified methods, although our analysis also shows that GORE-for-BP methods exist that explicitly take security and quality requirements for business processes into account.
The *maturity of the identified methods* (fourth research question) can be assessed as follows. Except for the *Grau et al.* method, none of the investigated methods can really be called mature. The description of the transformation activity, which is the essence of the methods (see our answer to the 'focus' question), and other methodical guidelines offered are generally not sufficient to allow users to apply the methods in practice without encountering interpretation problems. Another indication of a lack of maturity is the validation of methods by means of only a proof of concept application.

We end this sub-section by reflecting on the validity of the answers to the research questions distilled from our analysis results. For ensuring *internal validity* (i.e., truthful answers were provided) several research design controls were taken. First, to reduce error in the interpretation of methods, only those GORE-for-BP methods were analysed for which sufficient information was available, i.e., methods that scored 'high' with respect to completeness of documentation (for which the necessary conditions were listed in Table 1). Second, all selected methods were first modelled using the method meta-modelling technique presented in the third section, which helps increasing the objectivity of the analysis as the REBPM framework (that conceptualizes the GORE-for-BP concept) could now be used as a comparative framework for identifying similarities and differences between the methods. Third, to reduce subjectivity in the interpretation, three experienced researchers with research expertise in the domain performed the analysis. The analysis results presented in Table 3 reflect the consensus of the three researchers. The ways-of-working were first independently modelled by the researchers. Afterwards the method models were united based on a discussion of interpretation differences. Fourth, a protocol was predefined for assessing the criteria that require judgement on behalf of the evaluators. Again, scores were first given independently and next compared and discussed. Overall, there was little difference in opinion. It is, however, difficult to provide evidence of this agreement as formal inter-rater reliability statistics (e.g., Fleiss' kappa) provide little information when applied on a very small sample (i.e., only seven methods) using only three categories (i.e., initial scores of 0%, 50% and 100%).

With respect to *external validity* (i.e., can the answers be generalized to the entire population of GORE-for-BP methods?), we acknowledge the limitation of not being able to generalize outside our research scope. The research questions were formulated in terms of 'identified' methods and not 'all' methods, so the answers provided relate only to the sample of methods investigated. Nevertheless, as argued before, to be able to answer the questions, sufficient information on the methods had to be available. By extending the sample with other methods, the depth of the analysis would be less profound and more interpretation problems would surface, which would reduce the credibility of the research review findings.

DISCUSSION

An interesting perspective on our research review is to reflect on possible answers to the research questions that cannot be substantiated by the obtained analysis results. As none of the reviewed methods fully covers the REBPM framework and most methods typically cover not more than four of the possible knowledge states (see Table 3), there are ample opportunities for improving existing methods or developing new methods. For instance, although backward traceability (i.e., from process requirements to business requirements) and change impact analysis (i.e., how do changes in business process design affect the realization of strategic objectives?) were stated as reasons for integrating goal modelling and business process modelling (see second section), only few methods support these features. Furthermore, we observe that no ways-of-working feed back into the RE states once the BPM cycle moves beyond the 'Process Designed' state. Moreover, none of the methods reviewed covers the full BPM lifecycle, meaning that the analysis of process execution data to identify problems and opportunities for improvement is not supported. Some methods do support the strategic analysis of model-based business process improvements, but not for redesign that is driven by the analysis of real process execution data (i.e., starting from the 'Process Diagnosed' knowledge state). We think that our analysis reveals *round-trip engineering* (Grau et al., 2005) as a real research gap in the GORE-for-BP area and we suggest that future research investigates how the explicit linkage with RE activities and their outcomes can be exploited in other BPM activities than just process modelling.

Likewise, the RE activities of elicitation and validation could be covered better, as requirements elicitation and validation are crucial for any development effort (i.e., doing the right things is as important as doing things right). Again, research should investigate how the explicit linkage with BPM activities and their resulting artefacts and data (e.g., process monitoring and measurement results) can be exploited throughout the entire RE lifecycle, including the support or feedback given to requirements elicitation and validation activities.

The analysis of the scope and maturity of GORE-for-BP methods also discloses interesting research opportunities for further generalizing, formalizing and validating methods. When we compare the investigated methods, we see little common ground in the goal modeling and business process modeling languages used. A possible exception is the i* goal modeling language and its variants like Secure Tropos and Formal Tropos (used by several methods reviewed), which are at least comparable in terms of visual syntax, but still differ in terms of semantics. We recommend that researchers developing GORE-for-BP methods, abstract their work from the individual goal and business process modelling languages, such that the methodological aspects of their work get separated from syntax aspects and a common methodological ground for GORE-for-BP approaches can emerge. Future research could also focus on the integration of other RE techniques and models into GORE-for-BP methods. Only one of the reviewed methods allows modelling domain context (using a frame-based RE approach), while the incorporation of non-functional requirements in process designs via the use of goal modelling techniques (which was one of the major reasons for GORE-for-BP; see second section) is currently often considered out of scope.

Our research review further shows that few of the reviewed methods can be considered mature. The researchers involved in the research review experienced considerable difficulties in replicating the examples provided in the papers, which indicates that further formalization of the methods is desired. This lack of maturity, already demonstrated by the prior study of Decreus, Snoeck, and Poels (2009b), relates to the methodical guidance offered by the methods in general and to the RE-to-BPM (or vice versa or in both directions) transformation activity in particular as it constitutes the essence of this kind of methods. We acknowledge that academic papers may target fellow researchers rather than practitioners, so in a way it is understandable that precise step-by-step prescriptions of applying the methods in practice may be absent in those papers. Also in other domains it is observed that examples are preferred to present novel approaches rather than providing complete and formal definitions, as demonstrated for instance for process modelling languages in (Bi and Nolt, 2012). Nevertheless, given that our research review also demonstrated a lack of validation, sufficient details should be provided to allow for replication and falsification by other researchers. This brings us to another eminent GORE-for-BP research opportunity, i.e., validation and evaluation of proposed methods, preferably in realistic usage contexts.

Summarizing, we see a research agenda for the GORE-for-BP area emerging where research may develop in four directions:

1. *Extending GORE-for-BP methods*: developing new methods or extending existing methods to fully cover the REBPM framework, providing transformations between multiple BPM and RE states in both directions (i.e., round-trip engineering). This research may also be directed at a further *conceptualisation of GORE-for-BP* to motivate opportunities for exploring the benefits of applying RE techniques in BPM lifecycle stages beyond business process modelling and the benefits of feeding back the results of a full execution of the BPM lifecycle into RE activities.
2. *Generalizing GORE-for-BP methods*: abstracting from the particular modelling languages used, incorporating other than goal-oriented RE techniques and including a wider array of requirements, e.g., domain requirements, non-functional process requirements, system requirements for specific BPMS application support with respect to process execution, monitoring, analysis, and diagnosis.
3. *Formalizing GORE-for-BP methods*: further developing and formally describing the transformations that allow moving between RE and BPM states. Research on new methods should also pay sufficient attention to the elaboration of methodical prescriptions for method application.
4. *Validating GORE-for-BP methods*: validating existing and newly proposed methods using a variety of validation techniques (e.g., laboratory experiments aimed at comparing alternative methods, field studies investigating usability and utility). Such research may also be aimed at *evaluating the GORE-for-BP concept* itself, trying to demonstrate its claimed benefits and contrasting it with other approaches (e.g., Value-Based Requirements Engineering (Gordijn and Akkermans, 2001)).

LIMITATIONS

The limitations of our research review need to be acknowledged and discussed to properly assess its contributions. Our study reviewed the academic literature to identify GORE-for-BP methods and evaluate them in terms of completeness of documentation, focus, scope, and maturity. The evaluation was based purely on the information found in the reviewed publications. This information was largely confined to descriptions of the methods and proofs of concept to illustrate their application. With the exception of two methods, no information was found on the application of the methods in a real setting. Hence, a first limitation of the study is that *no assessment is made of the extent of adoption of GORE-for-BP methods*. As a consequence, questions related to the perception in practice of the quality, utility, and usability of GORE-for-BP methods cannot be answered and would require different research methods to investigate (e.g., survey research). Also, due to the absence of studies investigating the application of the methods, no advanced research review techniques, like statistical meta-analysis, were used.

Further, the study was not designed to generate data on the process and outcome of applying the reviewed methods, which could have been done, in principle, by means of a demonstration experiment. The analysis showed, however, that the description and illustration of the methods in the reviewed publications was insufficient to be able to apply them without interpretation problems. Given the difference in level of maturity of the methods considered, an objective comparison of their effectiveness and efficiency would have been doubtful. While individual methods can be applied to assess their success, this was not done as part of the study. Neither did we compare with other approaches that take into account the organizational context of business processes. Thus, a second limitation is that *no evaluation is made of the extent, to which GORE-for-BP methods actually reach their ultimate intended purpose, i.e., achieving a better strategic fit of business processes, and whether they do this better than alternative approaches*. Nevertheless, the problems identified by our analysis indicate that it is unlikely that the currently proposed GORE-for-BP methods are effective.

Other limitations are also consequences of the choice of research approach and limited information on the subject that was available. Only methods of searching and analysis that were appropriate to the research questions were applied: SLR for the identification of GORE-for-BP methods, method meta-modelling for the analysis of their focus in terms of coverage of the REBPM framework, and independent reading of the publications employing a predefined assessment procedure by three researchers for the analysis of completeness of documentation, scope, and maturity of the methods. It was noted before that *the research review results cannot be generalized outside the research scope determined by the set of methods investigated*, which was dependent on different factors (i.e., only academic publications were searched, SLR restricted to publications from 1980 till mid 2009, only well-documented methods analysed). Further, applying the chosen research methods necessarily results in an *inter-subjective interpretation of the investigated methods*, although, as discussed before, different precautions were taken to increase the objectivity of the analysis and the internal validity of the analysis results.

A final limitation that needs to be considered to assess the extent of the contribution made is that the *research area of GORE-for-BP is rather narrow*. Our study is not a comprehensive review of the broad areas of Requirements Engineering (RE) and Business Process Management (BPM), so does not inform a research agenda for developing RE or BPM methods in general. Instead, it focuses on a specific stream of research that aims at crossing the disciplinary boundary between RE and BPM. Though we investigate what could be called a 'niche' topic, the development of GORE-for-BP methods is relevant given the potential benefits of integrating goal modeling and business process modeling. Further, the SLR identified the existence of 19 different approaches, which is a sign of an active research area.

CONCLUSION

To end we state the two research contributions of our research review. First, we identified 19 different GORE-for-BP methods. We also evaluated these methods in terms of completeness of documentation: 7 methods scored ‘high’, 8 methods ‘medium’, and 4 methods ‘low’. All 6 methods found in a previous study by Decreus et al. (2009b), which was limited to top-down approaches (i.e., from RE to BPM) employing i* (or variants) as goal modelling language, were included in our search result. The strict adherence to SLR procedures provides credibility to our search results and allows us to conclude that within our research scope (i.e., academic literature from 1980 till mid 2009) we have provided a comprehensive account of published GORE-for-BP methods, which extends the knowledge gained from the previous study by Decreus et al. (2009b).

The number of methods found, all from different research teams, indicates that GORE-for-BP is an active research area. To further assess the state of research in GORE-for-BP, we analysed the seven most documented methods using the REBPM framework of (Decreus et al., 2009a) that conceptualizes the research area, a method meta-modelling approach to identify the way-of-working of the methods, six analysis criteria derived from our research review questions, and a predefined assessment procedure for those criteria that require interpretation and judgement. As four of the six methods found in (Decreus et al., 2009b) were included in this set, we believe that it can be considered a representative sample of GORE-for-BP methods, although we acknowledge that the generalization of conclusions drawn from this analysis must be handled with care. Nevertheless, the analysis results provide interesting insights into the GORE-for-BP research area with respect to the focus, scope and maturity of GORE-for-BP methods. These insights go further than the study of Decreus et al. (2009b), which focused primarily on the maturity of the methods. Because of the specific analysis method employed (i.e., method meta-modeling to map the ways-of-working of the reviewed GORE-for-BP methods onto the REBPM framework), we could not only demonstrate a lack of common underlying conceptualization of GORE-for-BP, but also pinpoint specific future research opportunities (e.g., round-trip engineering, better coverage of RE and BPM life cycles) aimed at better exploiting the advantages of integrating goal models and business process models. Our new insights and the research agenda that is derived from them constitute the second research contribution.

REFERENCES

Aburub, F., Odeh, & M., Beeson, I. (2007). Modelling non-functional requirements of business processes. *Information and Software Technology, 49*(11-12), 1162-1171.

Araujo , J., Whittle, J., & Kim, D-K (2004). Modeling and Composing Scenario-Based Requirements with Aspects. In: *Proceedings of the 12th IEEE International Requirements Engineering Conference (RE'04)* (pp. 58-67).

Barrios, J. & Nurcan, S. (2004). Model Driven Architectures for Enterprise Information Systems. In: *Advanced Information Systems Engineering LNCS 3084* (pp. 3-19).

Bi, H. H. & Nolt, J. (2012). Towards a formal semantics for control-flow process models. *Journal of Database Management, 23*(2), 72-97.

Bleistein, S., Aurum, A., Cox, K., & Ray, P. (2004a). Strategy-oriented alignment in requirements engineering: linking business strategy to requirements of e-business systems using the SOARE approach. *Journal of Research and Practice in Information Technology, 36*(4), 259-276.

Bleistein, S., Cox, K., & Verner, J. (2004b). Modeling Business Strategy in E-Business Systems Requirements Engineering. In: *Conceptual Modeling for Advanced Application Domains LNCS 3289* (pp. 617-628).

Bleistein, S., Cox, K., & Verner, J. (2004c). Problem frames approach for e-business systems. In: *Proceedings of the International Conference on Software Engineering (ICSE 04)* (pp. 7-15). Edinburgh, UK.

Bleistein, S., Cox, K., & Verner, J. (2004d). Requirements engineering for e-business systems: integrating Jackson problem diagrams with goal modeling and BPM. In: *Proceedings of the 11th Asia Pacific Software Engineering Conference* (pp. 410-417). Busan, Korea.

Bleistein, S., Cox, K. & Verner, J. (2005). Strategic alignment in requirements analysis for organizational IT: an integrated appproach. In: *Proceedings of the 2005 ACM symposium on Applied computing* (pp. 1300-1307). New York, USA.

Bleistein, S., Cox, K., & Verner, J. (2006a). Validating strategic alignment of organizational IT requirements using goal modeling and problem diagrams. *Journal of Systems and Software, 79*(3), 362-378.

Bleistein, S., Cox, K., Verner, J., & Phalp, K. (2006b). B-SCP: A requirements analysis framework for validating strategic alignment of organizational IT based on strategy, context, and process. *Information and Software Technology, 48*(9), 846-868.

Bleistein, S., Cox, K., Verner, J., & Phalp, K. (2006c). Requirements engineering for e-business advantage. *Requirements Engineering, 11*(1), 4-16.

Brereton, P., Kitchenham, B., Budgen, D., Turner, M., & Khalil, M. (2007). Lessons from applying the systematic literature review process within the software engineering domain. *Journal of Systems and Software, 80*(4), 571-583.

Bubenko, J., Persson, A., & Stirna, J. (2001). *HyperKnowledge Deliverable IST-2000-28401*. Appendix B - EKD User Guide.

Bucher, T. & Dinter, B. (2012). Situational method engineering to support process-oriented information logistics: identification of development situations. *Journal of Database Management*, *23*(1), 31-48.

Calisti, M. & Greenwood, D. (2008). Goal-Oriented Autonomic Process Modeling and Execution for Next Generation Networks. In: *Modelling Autonomic Communications Environments LNCS 5276* (pp. 38-49).

Cockburn, A. (2000). *Writing Effective Use Cases*. Boston: Addison-Wesley Longman Publishing Co., Inc.

Cox, K., Bleistein, S., Reynolds, P., & Thorogood, A. (2006). A contingency view of organizational infrastructure requirements engineering. In: *Proceedings of the 2006 ACM symposium on Applied computing* (pp. 1497-1504).

Cox, K. & Phalp, K. (2003). From process model to problem frame – a position paper. In: *Proceedings of the 9th international workshop on requirement engineering - REFSQ* (pp. 93–96).

Cox, K., Phalp, K., Bleistein, S., & Verner, J. (2005). Deriving requirements from process models via the problem frames approach. *Information and Software Technology, 47*(5), 319-337.

Cysneiros, L., do Prado Leite, J., & de Melo Sabat Neto, J. (2001). A framework for integrating non-functional requirements into conceptual models. *Requirements Engineering*, *6*(2), 97-115.

Dardenne, A., Van Lamsweerde, A., & Fickas, S. (1993). Goal-directed requirements acquisition. *Science of computer programming*, *20*(1-2), 3-50.

Davies, I. G., P., Rosemann, M., Indulska, M., & Gallo, S. (2006). How do practitioners use conceptual modeling in practice? *Data & Knowledge Engineering*, *58*(3), 358-380.

Davenport, T. H. (1993). Reengineering work through information technology. Boston, Harvard Business School.

de la Vara, J. & Sánchez, J. (2007). Business process-driven requirements engineering: a goal-based approach. In: *8th workshop on business process modeling, development, and support (BPMDS '07).* Trondheim, Norway.

de la Vara, J. & Sánchez, J. (2008). Improving Requirements Analysis through Business Process Modelling: A Participative Approach. In: *Business Information Systems LNBIP 7* (pp. 165-176).

de la Vara, J., Sánchez, J., & Pastor, O. (2008). Business Process Modelling and Purpose Analysis for Requirements Analysis of Information Systems. In: *Advanced Information Systems Engineering LNCS 5074* (pp. 213-227).

Decreus, K., El Kharbili, M., Poels, G., & Pulvermueller, E. (2009a). Bridging requirements engineering and business process management. In: *Lecture Notes in Informatics, GI-Edition Proceedings Workshop for Requirements Engineering and Business Process Management* (pp. 215-222).

Decreus, K., Snoeck, M., & Poels. G. (2009b). Practical challenges for methods transforming i* goal models into business process models. In: *Proceedings of the 17th IEEE International Requirements Engineering Conference* (pp. 15-23). Atlanta, USA.

Dijkman, R., Vanderfeesten, I., & Reijers, H.A. (2011). *The road to a business process architecture: an overview of approaches and their use*. BETA Working Paper Series WP 350. Eindhoven University of Technology.

Dumas, M., La Rosa, M., Mendling, J., & Reijers, H.A. (2013). *Fundamentals of Business Process Management*. Berlin Heidelberg: Springer.
Elzinga, D. J., Horak, T., Lee, C., & Bruner, C. (1995). Business process management: survey and methodology. *IEEE transactions on Engineering Management, 42*, 119-128.
Finkelstein, A., Kramer, J., Nuseibeh, B., Finkelstein, L., & Goedicke, M. (1992). Viewpoints: A Framework for Integrating Multiple Perspectives in System Development. *International Journal of Software Engineering and Knowledge Engineering, 2*(1), 31-58.
Frankova, G., Massacci, F., & Séguran, M. (2007a). From early requirements analysis towards secure workflows. *International Federation for Information Processing, 238*, 407-410.
Frankova, G., Massacci, F., & Séguran, M. (2007b). *From Early Requirements Analysis Towards Secure Workflows*. Technical Report #DIT-07-036. University of Trento.
Frankova, G., Yautsiukhin, A., & Séguran, M. (2007c). *From Early Requirements to Business Processes With Service Level Agreements*. Technical Report #DIT-07-037. University of Trento.
Fuxman, A., Liu, L., Mylopoulos, J., Pistore, M., Roveri, M., & Traverso, P. (2004). Specifying and analyzing early requirements in Tropos. *Requirements Engineering, 9*(2), 132-150.
Gagnon, Y. & Dragon, J. (1998). The impact of technology on organizational performance. *Optimum, The Journal of Public Sector Management, 28*(1), 19-31.
Genero, M., Fernandez-Saez A. M., Nelson, H. J., Poels, G., & Piattini, M. (2011). A systematic literature review on the quality of UML models. *Journal of Database Management, 22*(3), 46-70.
Giorgini, P., Massacci, F., Mylopoulos, J., & Zannone, N. (2006). Requirements engineering for trust management: model, methodology, and reasoning. *International Journal of Information Security, 5*(4), 257-274.
Gordijn, J. & Akkermans, H. (2001). Designing and evaluating E-business models. *IEEE Intelligent Systems, 16*(4), 11-17.
Grau, G., Franch, X. & Avila, S. (2006). J-PRiM: a Java tool for a process reengineering i* methodology. In: *Proceedings of the 14th IEEE International Requirements Engineering Conference* (pp. 352-353).
Grau, G., Franch, X., & Maiden, N. A. M. (2005). A goal based round-trip method for system development. In: *11th International Workshop on Requirements Engineering: Foundation For Software Quality (REFSQ)* (pp. 71–86).
Grau, G., Franch, X., & Maiden, N. A. M. (2008). PRiM: An i*-based process reengineering method for information systems specification. *Information and Software Technology, 50*(1-2), 76-100.
Greenwood, D. (2008). Goal-Oriented Autonomic Business Process Modeling and Execution: Engineering Change Management Demonstration. In: *Business Process Management LNCS 5240* (pp. 390-393).
Greenwood, D. & Rimassa, G. (2007). Autonomic goal-oriented business process management. In: *Proceedings of the Third International Conference on Autonomic and Autonomous Systems (ICAS '07)* (pp. 43-48). Athens, Greece.
Guizzardi, G. (2007). On ontology, ontologies, conceptualizations, modeling languages, and (meta) models. In: *Proceeding of the 2007 conference on Databases and Information Systems IV: Selected Papers from the Seventh International Baltic Conference DB&IS'2006* (pp. 18-39). IOS Press.
Hammer, M. & Champy, J. (1993). *Reengineering the corporation: A manifesto for business revolution*. New York: Harper Business.

Hung, R. Y.-Y. (2006). Business process management as competitive advantage: a review and empirical study. *Total Quality Management & Business Excellence, 17*(1), 21-40.
Jackson, M. (2001). *Problem Frames: Analysing and Structuring Software Development Problems*. New York: Addison-Wesley Longman Publishing Co., Inc.
Jeston, J. & Nelis, J. (2006). *Business process management: Practical guidelines to successful implementations*. Oxford: Butterworth-Heinemann, Elsevier.
Jones, S. & Maiden, N. A. M. (2004). RESCUE: An integrated method for specifying requirements for complex socio-technical systems. In: *Requirements Engineering for Sociotechnical Systems* (pp. 245-265). Idea Group Inc.
Karlsson, F. & Agerfalk, P. J. (2009). Towards structured flexibility in information system development: devising a method for method configuration. *Journal of Database Management, 20*(3), 51-75.
Kavakli, E. (2002). Goal-oriented requirements engineering: A unifying framework. *Requirements Engineering, 6*(4), 237-251.
Kavakli, E. (2004). Modeling organizational goals: Analysis of current methods. In: *Proceedings of the 2004 ACM symposium on Applied computing* (pp. 1339-1343).
Kavakli, E. & Loucopoulos, P. (1999a). Focus issue on legacy information systems and business process engineering: modelling of organisational change using the EKD framework. *Communications of the AIS, 2*(1), 1-29.
Kavakli, E. & Loucopoulos, P. (1999b). Goal-driven business process analysis application in electricity deregulation. *Information Systems, 24*(3), 187-207.
Kazhamiakin, R., Pistore, M., & Roveri, M. (2004a). A framework for integrating business processes and business requirements. In: *Proceedings of the Eighth IEEE International Enterprise Distributed Object Computing Conference (EDOC)* (pp. 9-20).
Kazhamiakin, R., Pistore, M., & Roveri, M. (2004b). Formal verification of requirements using spin: A case study on web services. In: *Proceedings of the 3rd IEEE International Conference on Software Engineering and Formal Methods (SEFM)* (pp. 406-415).
Kitchenham, B. (2004). *Procedures for Performing Systematic Reviews*. Technical Report TR/SE0401, Keele University, and Technical Report 0400011T.1, National ICT Australia.
Kitchenham, B., Brereton, P., Budgen, D., Turner, M., Bailey, J., & Linkman, S. (2009). Systematic literature reviews in software engineering - A systematic literature review. *Information and Software Technology, 51*(1), 7-15.
Kitchenham, B., Dyba, T., & Jorgensen, M. (2004). Evidence-based software engineering. In: *Proceedings of the 26th International Conference on Software Engineering* (pp. 273-281). Alexandria, Australia.
Koliadis, G. & Ghose, A. (2006). Relating business process models to goal-oriented requirements models in KAOS. In: *Advances in Knowledge Acquisition and Management* (pp. 25-39).
Koliadis, G., Vranesevic, A., Bhuiyan, M., Krishna, A., & Ghose, A. (2006a). A combined approach for supporting the business process model lifecycle. In: *Proceedings of the tenth Asia-Pacific Conference on Information Systems (PACIS 2006)* (pp. 1305-1319).
Koliadis, G., Vranesevic, A., Bhuiyan, M., Krishna, A., & Ghose, A. (2006b). Combining i* and BPMN for Business Process Model lifecycle management. In: *Business Process Management Workshops LNCS 4103* (pp. 416-427).
Korherr, B. & List, B. (2006). Extending the UML 2 Activity Diagram with Business Process Goals and Performance Measures and the Mapping to BPEL. In: *Advances in Conceptual Modeling - Theory and Practice LNCS 4231* (pp. 7-18).

Korherr, B. & List, B. (2007). Extending the EPC and the BPMN with Business Process Goals and Performance Measures. In: *Proceedings of the 9th International Conference on Enterprise Information Systems (ICEIS 2007)*. Funchal, Portugal.

Koubarakis, M. & Plexousakis, D. (1999a). Business Process Modelling and Design — A Formal Model and Methodology. *BT Technology Journal, 17*(4), 23-35.

Koubarakis, M. & Plesousakis, D. (1999b). Business Process Modeling and Design: AI Models and Methodology. In: *Proceedings of IJCAI-99 Workshop on Intelligent Workflow and Process Management: the New Frontier for AI in Business*.

Koubarakis, M. & Plexousakis, D. (2000). A Formal Model for Business Process Modeling and Design. In: *Advanced Information Systems Engineering LNCS 1789* (pp. 142-156).

Koubarakis, M. & Plexousakis, D. (2002). A formal framework for business process modelling and design. *Information Systems, 27*(5), 299-319.

Lapouchnian, A. & Lespérance, Y. (2006). Modeling Mental States in Agent-Oriented Requirements Engineering. In: *Advanced Information Systems Engineering LNCS 5074* (pp. 480-494).

Lapouchnian, A., Yu, Y., & Mylopoulos, J. (2007). Requirements-Driven Design and Configuration Management of Business Processes. In: *Business Process Management, LNCS 4714* (pp. 246-261).

Lee, R. G. & Dale, B. G. (1998). Business process management: a review and evaluation. *Business Process Management Journal, 4*(3), 214-225.

List, B. & Korherr, B. (2005). A UML 2 Profile for Business Process Modelling. In: *Perspectives in Conceptual Modeling LNCS 3770* (pp. 85-96).

List, B. & Korherr, B. (2006). An evaluation of conceptual business process modelling languages. In: *Proceedings of the 2006 ACM symposium on Applied computing* (pp. 1532-1539). Dijon, France.

Liu, R., Wu, F.Y., & Kumaran, S. (2010). Transforming Activity-Centric Business Process Models into Information-Centric Models for SOA Solutions. *Journal of Database Management, 21*(4), 14-34.

Lo, A. & Yu, E. (2007). From Business Models to Service-Oriented Design: A Reference Catalog Approach. In: *Conceptual Modeling - ER 2007 LNCS 4801* (pp. 87-101).

Loucopoulos, P. & Kavakli, E. (1995). Enterprise Modelling and the Teleological Approach to Requirements Engineering. *International Journal of Intelligent and Cooperative Information Systems, 4*(1), 45-79.

Lyytinen, K., Mathiassen, L., Ropponen, J., & Datta, A. (1998). Automating the Discovery of As-Is Business Process Models: Probabilistic and Algorithmic Approaches. *Information Systems Research, 9*, 275-301.

Maiden, N., Jones, S., Manning, S., Greenwood, J., & Renou, L. (2004). Model-Driven Requirements Engineering: Synchronising Models in an Air Traffic Management Case Study. In: *Advanced Information Systems Engineering LNCS 3084* (pp. 3-21).

Markovic, I. & Kowalkiewicz, M. (2008). Linking Business Goals to Process Models in Semantic Business Process Modeling. In: *Proceedings of the 12th International IEEE Enterprise Distributed Object Computing Conference (EDOC '08)* (pp. 332-338). Munich, Germany.

Massacci, F., Mylopoulos, J., & Zannone, N. (2007). An Ontology for Secure Socio-Technical Systems. In: *Handbook of Ontologies for Business Interaction* (pp. 188-206). Idea Group Inc.

Mylopoulos, J., Chung, L., & Yu, E. (1999). From object-oriented to goal-oriented requirements analysis. *Communications of the ACM, 42*(1), 31-37.

Nagayama, K. & Weill, P. (2004). *Seven Eleven Japan: Reinventing the Retail Business Model*. CISR Working Paper 338-MIT Sloan WP 4458-04, Massachusetts Institute of Technology.

Neiger, D. & Churilov, L. (2003). Structuring Business Objectives: A Business Process Modeling Perspective. In: *Business Process Management LNCS 2678* (pp. 1010-1020).

Neiger, D. & Churilov, L. (2004a). Goal-Oriented Business Process Engineering Revisited: a Unifying Perspective. In: *Proceeding of the First International Workshop on Computer Supported Activity Coordination (CSAC 2004)* (pp. 149-163).

Neiger, D. & Churilov, L. (2004b). Goal-Oriented Business Process Modeling with EPCs and Value-Focused Thinking. In: *Business Process Management LNCS 3080* (pp. 98-115).

Neiger, D. & Churilov, L. (2006). Intelligent Decision Support through Synchronized Decomposition of Process and Objectives Structures. In: *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06).*

Nurcan, S. (2004a). A Conceptual Framework for Intention Driven Flexible Workflow Modeling. In: *The fifth Workshop on Business Process Modelling, Development, and Support (BPMDS'04).* Riga, Latvia.

Nurcan, S. (2004b). Business Process Modelling for developing Process Oriented IT Systems. In: *Business Process Management Tools and Technologies Track of the 2004 Information Resources Management Association International Conference (IRMA).* New Orleans, USA.

Nurcan, S. & Edme, M.-H. (2005). Intention-driven modeling for flexible workflow applications. *Software Process: Improvement and Practice, 10*(4), 363-377.

Nurcan, S., Etien, A., Kaabi, R., Zoukar, I., & Rolland, C. (2005). A strategy driven business process modelling approach. *Business Process Management Journal, 11*(6), 628-649.

Nuseibeh, B. & Easterbrook, S. (2000). Requirements engineering: a roadmap. In: *Proceedings of the Conference on The Future of Software Engineering* (pp. 35-46). . Limerick, Ireland.

OASIS (2007). *Business Process Execution Language specification. Version 2.0.* Retrieved 01.10.2008, from http://docs.oasis-open.org/wsbpel/2.0/OS/wsbpel-v2.0-OS.html.

Object Management Group (2010). *The Business Motivation Model. Version 1.1.* OMG document formal/2010-05-01.

Pistore, M., Roveri, M., & Busetta, P. (2004). Requirements-Driven Verification of Web Services. *Electronic Notes in Theoretical Computer Science, 105,* 95-108.

Porter, M.E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York: Free Press.

Powell, T. C. & Dent-Micallef, A. (1997). Information technology as competitive advantage: the role of human, business, and technology resources. *Strategic Management Journal, 18*(5), 375-405.

Regev, G., Soffer, P., & Bider, I. (2005). Coordinated development of business processes and their support systems. *Requirements Engineering, 10*(3), 173-174.

Rolland, C., Nurcan, S., & Grosz, G. (1999a). Enterprise knowledge development: the process view. *Information & Management, 36*(3), 165-184.

Rolland, C., Prakash, N., & Benjamen, A. (1999b). A Multi-Model View of Process Modelling. *Requirements Engineering, 4*(4), 169-187.

Rolland, C., Souveyet, C., & Moreno, M. (1995). An approach for defining ways-of-working. *Information Systems, 20*(4), 337-359.

Rolland, C., (2005). Reasoning with Goals to Engineer Requirements. In: V. O. Camp, J. Filipe, S. Hammoudi, & M. Piattini (Eds.) *Enterprise Information Systems* (pp. 12-20). Springer.

Sebastiani, R., Giorgini, P., & Mylopoulos, J. (2004). Simple and Minimum-Cost Satisfiability for Goal Models. In: *Advanced Information Systems Engineering LNCS 3084* (pp. 675-693).
Seguran, M., Hebert, C., & Frankova, G. (2008). Secure Workflow Development from Early Requirements Analysis. In: *Proceedings of the IEEE Sixth European Conference on Web Services* (pp. 125-134).
Shaw, D. R., Holland, C. P., Kawalek, P., Snowdon, B., & Warboys, B. (2007). Elements of a business process management system: theory and practice. *Business Process Management Journal*, *13*(1), 91-107.
Smith, H. & Fingar, P. (2002). *Business process management (BPM): the third wave*. Meghan-Kiffer Press.
Soffer, P. & Rolland, C. (2005). Combining Intention-Oriented and State-Based Process Modeling. In: *Conceptual Modeling – ER 2005 LNCS 3716* (pp. 47-62).
Soffer, P. & Wand, Y. (2005). On the Notion of Soft-Goals in Business Process Modeling. *Business Process Management Journal, 11*(6), 663-679.
Soffer, P. & Wand, Y. (2007). Goal-driven multi-process analysis. *Journal of the Association for Information Systems, 8*(3), 175-203.
Soffer, P. & Kaner, M. (2011). Complementing Business Process Verification by Validity Analysis: A Theoretical and Empirical Evaluation. *Journal of Database Management, 22*(3), 1-23.
Sondhi, R. (1999). *Total Strategy*. Airworthy Publications International Ltd.
Sutcliffe, A., Maiden, N., Minocha, S., & Manuel, D. (1998). Supporting scenario-based requirements engineering. *IEEE Transactions on Software Engineering, 24*(12), 1072-1088.
Traverso, P., Pistore, M., Roveri, M., Marconi, A., Kazhamiakin, R., Lucchese, P. , Busetta, & P., Bertoli, P. (2004). Supporting the Negotiation between Global and Local Business Requirements in Service Oriented Development. In: *2nd International Conference on Service Oriented Computing (ICSOC).* New York, USA.
Tribolet, J., Winter, R., & Caetano A. (2005). Editorial message: special track on organizational engineering. In: *Proceedings of the 2005 ACM symposium on Applied computing* (pp. 1293-1294). Sante Fe, New Mexico.
van der Aalst, W. (2004). Business Process Management Demystified: A Tutorial on Models, Systems and Standards for Workflow Management. In: *Lectures on Concurrency and Petri Nets LNCS 3098* (pp. 21-58).
van der Aalst, W., ter Hofstede, A., & Weske, M. (2003). Business process management: A survey. In: *Business Process Management LNCS 2678* (pp. 1019-1030).
Vanderfeesten, I., Reijers, H.A., & van der Aalst, W. (2011). Product-based workflow support. *Information Systems, 36*(2), 517-535.
van Lamsweerde, A. (2000). Requirements engineering in the year 00: a research perspective. In: *Proceedings of the 22nd International Conference on Software Engineering* (pp. 5-19). New York, USA.
van Lamsweerde, A. (2001). Goal-Oriented Requirements Engineering: A Guided Tour. In: *Proceedings of the 5th IEEE international Symposium on Requirements Engineering* (pp. 249-263). Toronto, Canada.
Van Looy, A., De Backer, M., & Poels, G. (2011). Defining business process maturity. A journey towards excellence. *Total Quality Management & Business Excellence, 22*(11), 1119-1137.
Vasconcelos, A., Caetano, A., Neves, J., Sinogas, P., Mendes, R., & Tribolet, J. (2001). A framework for modeling strategy, business processes and information systems. In: *Proceedings of the 5th IEEE International Conference on Enterprise Distributed Object Computing* (pp. 69-80).

Vondrák. (2007). Business Process Modeling. *Information Modelling and Knowledge Bases, 18*, 223-235.
Weill, P. & Vitale, M. (2001). *Place to space: Migrating to eBusiness Models*. Boston: Harvard Business Press.
Weske, M., van der Aalst, W., & Verbeek, H. (2004). Advances in business process management. *Data & Knowledge Engineering, 50*, 1-8.
Woods, J. & Genovese, Y. (2006). *Delivery of Commodity Business Applications in a BPMS Does Not Mean You Should Customize the Applications*. Gartner Research vol. G 139084.
Yu, E. (1997). Towards modelling and reasoning support for early-phase requirements engineering. In: *Proceedings of the Third IEEE International Symposium* (pp. 226-235). Washington DC, USA.
Yu, E., Giorgini, P., Maiden, N. & Mylopoulos, J. (2011). *Social Modeling for Requirements Engineering*. Boston: MIT Press.
Zairi, M. (1997). Business process management: a boundaryless approach to modern competitiveness. *Business Process Management Journal, 3*(1), 64-80.

Geert Poels is full professor of Management Information Systems at the Department of Management Information Science and Operations Management of the Faculty of Economics and Business Administration, Ghent University (Belgium). He holds Bachelor and Master degrees in Business Engineering and Computer Science, and a PhD in Applied Economic Sciences. His research interests include conceptual modeling, business ontology, business processes, enterprise engineering, and Service Science. He has published over 30 refereed papers in Computer Science and Management Information Systems journals. He was chair of the 6th International Conference on Research and Practical Issues of Enterprise Information Systems (CONFENIS 2012).

<BIOGRAPHY KEN DECREUS/>

Ben Roelens is PhD student of Management Information Systems at the Department of Management Information Science and Operations Management of the Faculty of Economics and Business Administration at Ghent University. He holds a Master of Science degree in Business Engineering, with a specialization in Operations Management. His master thesis dealt with the application of business modeling languages to the theoretical principles of Service Science. His current research focuses on conceptual models, business ontology, business process management, and strategic management.

Monique Snoeck is senior full professor in the Information Management research group of the Faculty of Economics and Business of the KU Leuven and visiting professor at the Université de Namur. She holds a PhD in computer science from the KU Leuven. Her research focuses on conceptual modeling, requirements engineering, software architecture, model-driven engineering and business process management. Main guiding research themes are the quality of conceptual models, the automatic transformation of models to platform specific models or code and the integration of business process modeling & enactment with IS modeling and development.

APPENDIX

The Systematic Literature Review identified 19 GORE-for-BP methods. The key idea of each method is briefly described. For references we refer to Table 2 in the main text of the paper.

- *Aburub et al.* propose a method for modelling non-functional requirements of business processes in the form of goals and to link these goals to activities in the business process models. This method builds upon early work by Cysneiros et al.
- *Bleistein et al.* propose a requirements analysis framework for validating the strategic alignment of organisational IT based on strategy, context and process. The authors combine Jackson problem frames, i* goal modelling, and RAD process models.
- *de la Vara et al.* developed a method for a business process-driven GORE approach that transforms BPMN business process diagrams into Map and i* goal models.
- *Frankova et al.* introduce a method to translate Secure Tropos goal models into business process models using a propriety process language (Secure BPEL), with a focus on service-level agreements.
- *Grau et al.* suggest an i*-based business process reengineering method, that deals with modeling business processes and generating operational and strategic goal models from the business process models.
- *Greenwood et al.* introduce their own conceptual modelling language called Goal-Oriented Business Process Modelling Notation (GO-BPMN).
- *Kavakli and Loucopoulos* present a goal-driven business process analysis application within a larger enterprise knowledge modelling framework, known as the Enterprise Knowledge Development approach, by Bubenko et al.
- *Kazhamiakin et al.* propose mappings from Formal Tropos to BPEL.
- *Koliadis et al.* combine goal modelling languages i* and KAOS with the business process modelling language BPMN for lifecycle management of business process models.
- *Koubarakis and Plexousakis* present a formal framework for representing business process models and goal models, which was influenced by the Enterprise Knowledge Development approach of Bubenko et al.
- *Lapouchnian et al.* recognize the importance of requirements-driven design of business processes by suggesting a systematic approach to transform i* goal models into BPEL models.
- *List and Korherr* introduce several metamodels that span goals and business processes, such as extending the UML 2 Activity Diagram with business process goals.
- *Lo and Yu* go from business models to service-oriented design by means of a top-down method, using the i* goal language and proprietary business process diagrams.
- *Markovic and Kowalkiewic*z link business goals to business process models from the perspective of semantic business process modelling.

- *Neiger and Churilov* introduce goal-oriented business process modelling with EPCs and Value Focused Thinking as goal language.
- *Nurcan et al.* combine the Map goal language with business process chunks and demonstrate how Maps could be used for strategy-driven business process modelling.
- *Soffer and Rolland* combine intention-oriented process modelling (using the Map goal language) and state-based process modelling (using Generic Process Models).
- *Soffer and Wand* present a formal approach for goal-driven multi-process analysis and for analyzing the dependency of soft-goals on processes.
- *Vasconcelos et al*. propose a meta-model for modelling goals and business processes done within the context of the Organisational Engineering approach of Tribolet et al.

Figure 1

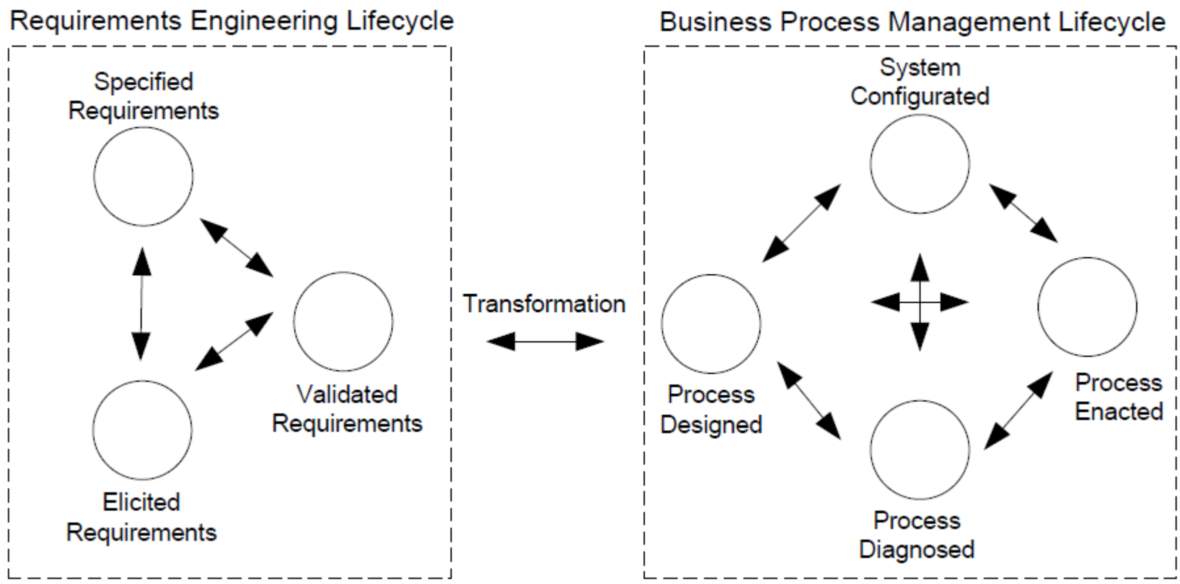

Requirements Engineering Lifecycle
Specified Requirements
Validated Requirements
Elicited Requirements
Transformation
Business Process Management Lifecycle
System Configurated
Process Designed
Process Enacted
Process Diagnosed

Figure 2

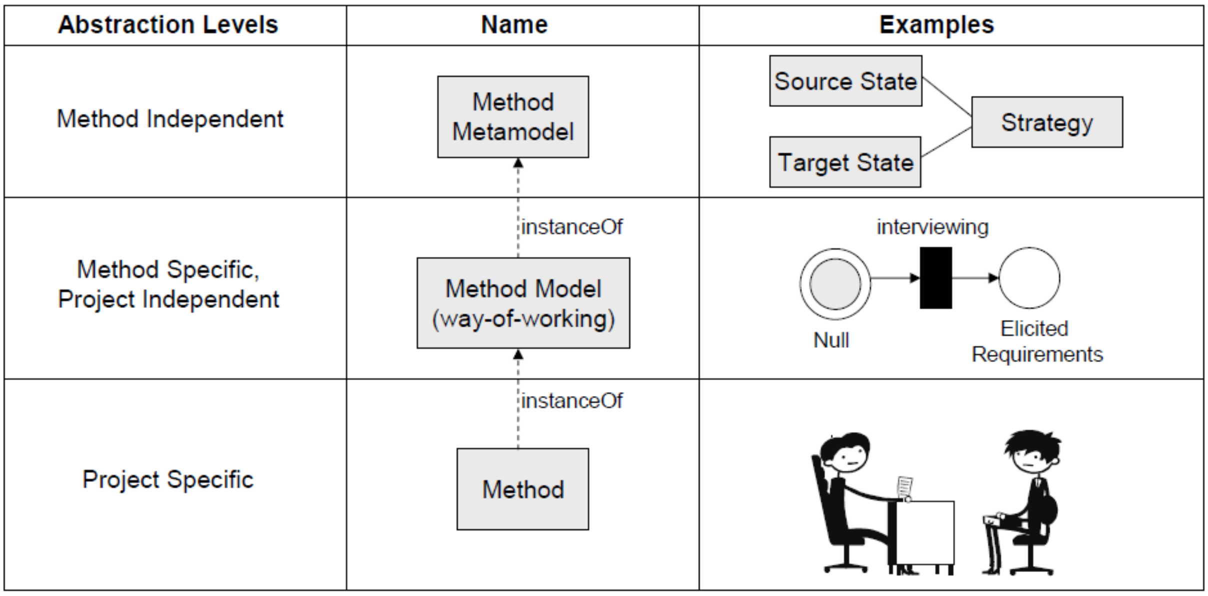
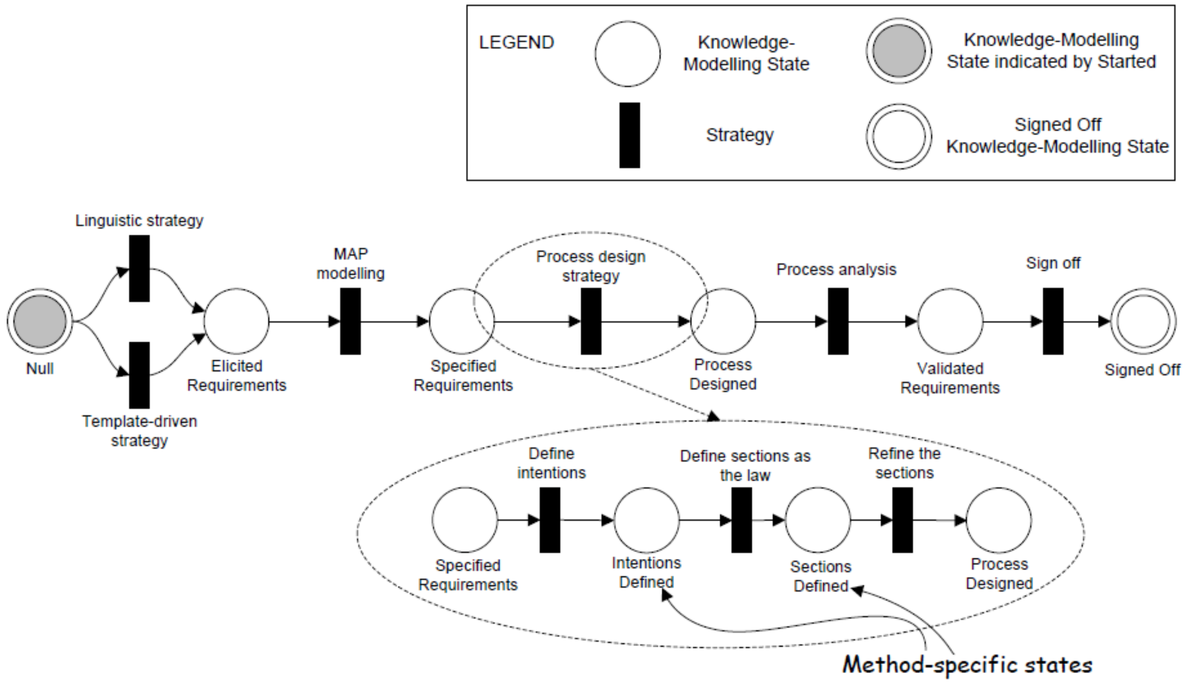
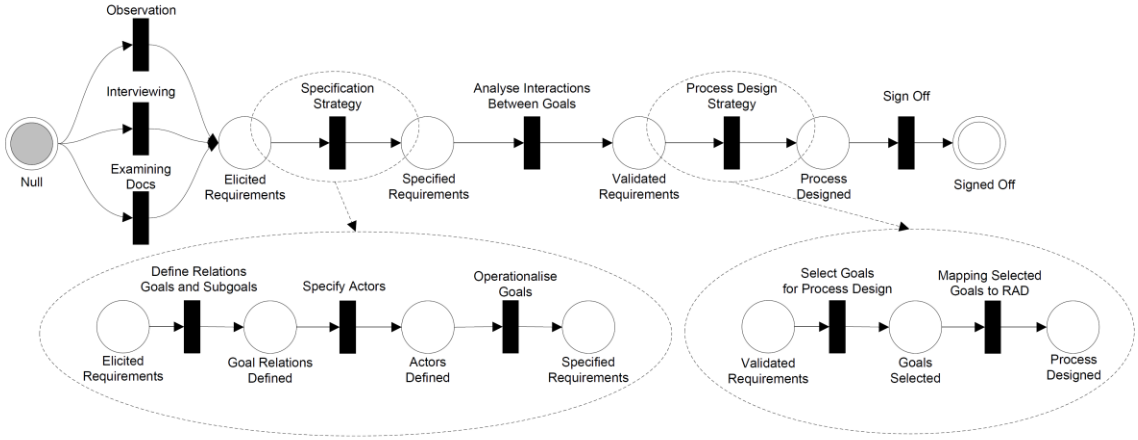

Abstraction Levels
Name
Examples
Method Independent
Method Metamodel
Source State
Strategy
Target State
instanceOf
Method Specific, Project Independent
Method Model (way-of-working)
interviewing
Null
Elicited Requirements
instanceOf
Project Specific
Method

Figure 3



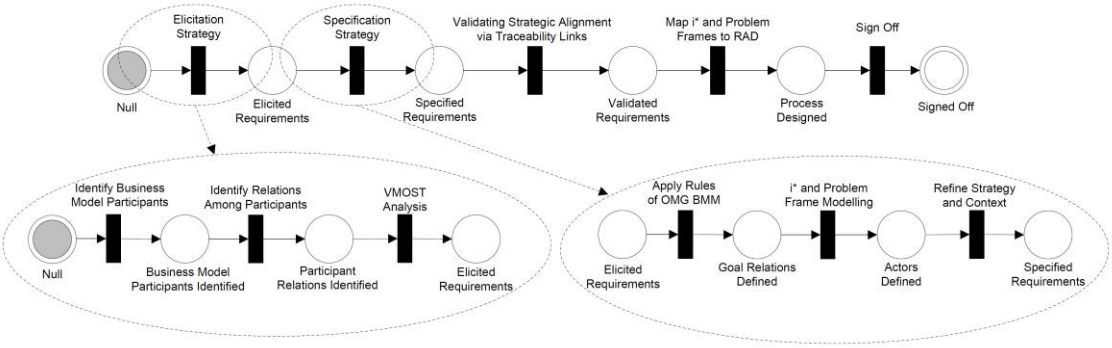
LEGEND
Knowledge-Modelling State
Knowledge-Modelling State indicated by Started
Strategy
Signed Off Knowledge-Modelling State
Linguistic strategy
Null
Template-driven strategy
Elicited Requirements
MAP modelling
Specified Requirements
Process design strategy
Process Designed
Process analysis
Validated Requirements
Sign off
Signed Off
Define intentions
Define sections as the law
Refine the sections
Specified Requirements
Intentions Defined
Sections Defined
Process Designed
Method-specific states

Figure 4



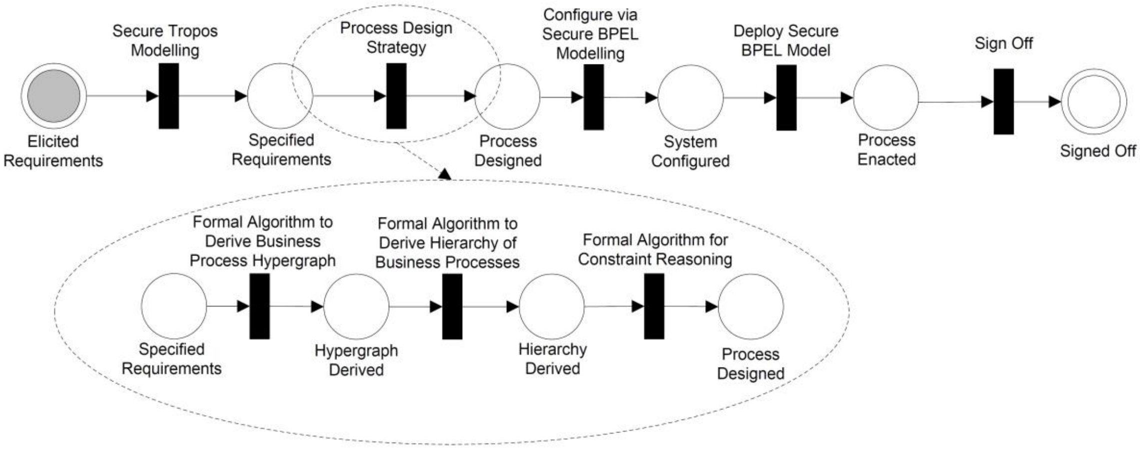
Observation
Interviewing
Examining Docs
Null
Elicited Requirements
Specification Strategy
Specified Requirements
Analyse Interactions Between Goals
Validated Requirements
Process Design Strategy
Process Designed
Sign Off
Signed Off
Define Relations Goals and Subgoals
Specify Actors
Operationalise Goals
Elicited Requirements
Goal Relations Defined
Actors Defined
Specified Requirements
Select Goals for Process Design
Mapping Selected Goals to RAD
Validated Requirements
Goals Selected
Process Designed

Figure 5



Elicitation Strategy
Specification Strategy
Validating Strategic Alignment via Traceability Links
Map i* and Problem Frames to RAD
Sign Off
Null
Elicited Requirements
Specified Requirements
Validated Requirements
Process Designed
Signed Off
Identify Business Model Participants
Identify Relations Among Participants
VMOST Analysis
Null
Business Model Participants Identified
Participant Relations Identified
Elicited Requirements
Apply Rules of OMG BMM
i* and Problem Frame Modelling
Refine Strategy and Context
Elicited Requirements
Goal Relations Defined
Actors Defined
Specified Requirements

Figure 6



Secure Tropos Modelling
Process Design Strategy
Configure via Secure BPEL Modelling
Deploy Secure BPEL Model
Sign Off
Elicited Requirements
Specified Requirements
Process Designed
System Configured
Process Enacted
Signed Off
Formal Algorithm to Derive Business Process Hypergraph
Formal Algorithm to Derive Hierarchy of Business Processes
Formal Algorithm for Constraint Reasoning
Specified Requirements
Hypergraph Derived
Hierarchy Derived
Process Designed

Figure 7

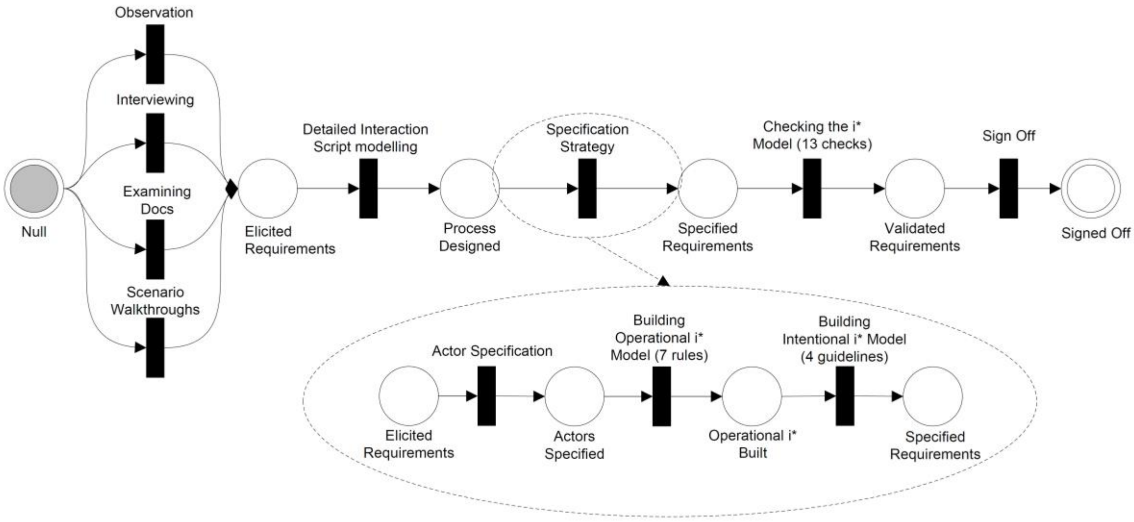
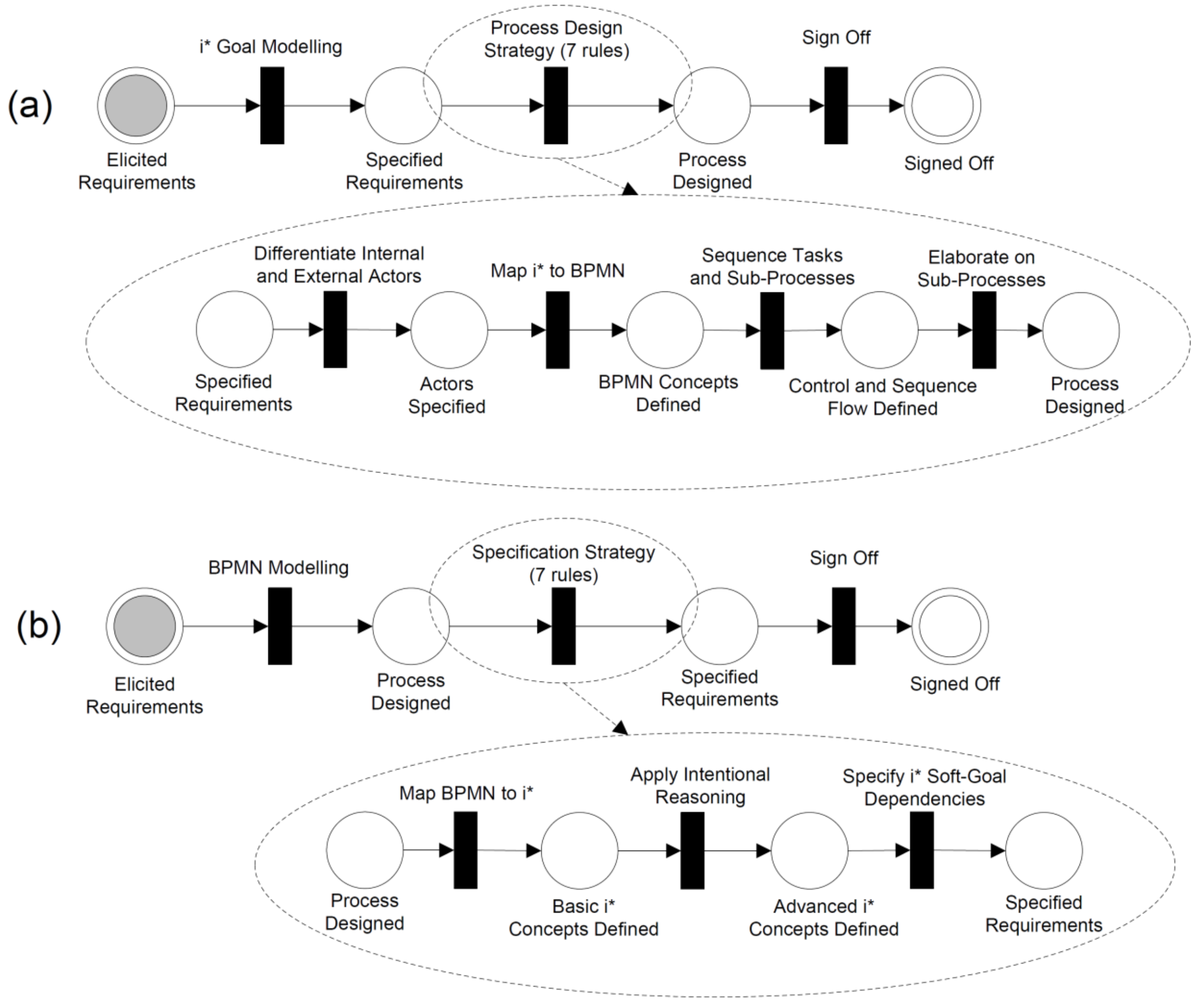
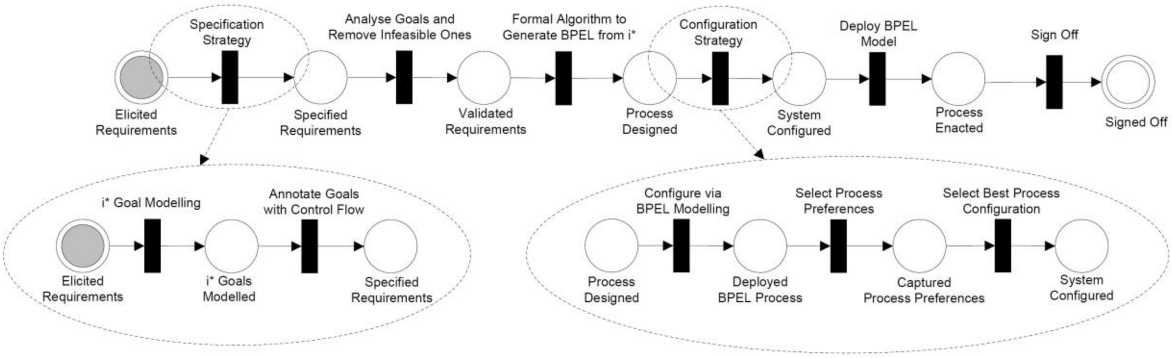

Observation
Interviewing
Examining Docs
Scenario Walkthroughs
Null
Elicited Requirements
Detailed Interaction Script modelling
Process Designed
Specification Strategy
Specified Requirements
Checking the i* Model (13 checks)
Validated Requirements
Sign Off
Signed Off
Actor Specification
Building Operational i* Model (7 rules)
Building Intentional i* Model (4 guidelines)
Elicited Requirements
Actors Specified
Operational i* Built
Specified Requirements

Figure 8



(a)
i* Goal Modelling
Process Design Strategy (7 rules)
Sign Off
Elicited Requirements
Specified Requirements
Process Designed
Signed Off
Differentiate Internal and External Actors
Map i* to BPMN
Sequence Tasks and Sub-Processes
Elaborate on Sub-Processes
Specified Requirements
Actors Specified
BPMN Concepts Defined
Control and Sequence Flow Defined
Process Designed
(b)
BPMN Modelling
Specification Strategy (7 rules)
Sign Off
Elicited Requirements
Process Designed
Specified Requirements
Signed Off
Map BPMN to i*
Apply Intentional Reasoning
Specify i* Soft-Goal Dependencies
Process Designed
Basic i* Concepts Defined
Advanced i* Concepts Defined
Specified Requirements

Figure 9



Specification Strategy
Analyse Goals and Remove Infeasible Ones
Formal Algorithm to Generate BPEL from i*
Configuration Strategy
Deploy BPEL Model
Sign Off
Elicited Requirements
Specified Requirements
Validated Requirements
Process Designed
System Configured
Process Enacted
Signed Off
i* Goal Modelling
Annotate Goals with Control Flow
Elicited Requirements
i* Goals Modelled
Specified Requirements
Configure via BPEL Modelling
Select Process Preferences
Select Best Process Configuration
Process Designed
Deployed BPEL Process
Captured Process Preferences
System Configured