

# An Analysis of Strategic Goals and Non-Functional Requirements in Business Process Management

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**Abstract:** Business processes' Non-Functional Requirements (NFR) can foster the strategic alignment in organizations. Our goal was to evaluate to what extent there are approaches that seek to support the modeling of business processes' NFR based on strategic goal-related information. To achieve this goal, we conducted a literature study based on systematic review concepts. As a result, we identified 19 works addressing strategic goals and business processes with NFRs. The most commonly used techniques are: i\* and Key Performance Indicators (KPI) for modeling strategic goals and Business Process Model and Notation (BPMN) for modeling business processes. According to our analysis, no approach fully addresses business processes' NFR based on strategic goals which was our primary question in conducting this study.

## 1 INTRODUCTION

Organizations need the support of Information Technology (IT) to quickly evolve their business processes and gain competitive edge (Lee et al., 2011). However, the strategic alignment between business and IT is required to achieve this dynamism (Tallon, 2008). Strategic alignment enables efficient communication among the strategic, tactical and operational levels of an organization (Sousa and Leite, 2014).

Business Process Management (BPM) can support strategic alignment (de Bruin and Rosemann, 2006). However, only addressing both functional requirements and Non-Functional Requirements (NFR), a complete strategic alignment between business and IT can be achieved. Nevertheless, while functional requirements have been well explored in BPM, NFRs have been neglected (Salles et al., 2013).

A good practice is to use strategic goals to identify business processes' NFRs since strategic goals represent the major organizational interests, which in turn need to be mapped to business processes. Strategic goals are fundamental to strategic alignment since they are the basis for organizing and planning activities at the tactical and operational levels.

This paper presents the results of a literature study

conducted to identify and evaluate approaches that propose using strategic goals as support for modeling business processes' NFRs. Although we could find some published literature studies exploring strategic goals and business processes, none of them was particularly concerned with business processes' NFRs.

This study is mainly an empirical and qualitative research with some quantitative aspects. We focused on the search for relevant and convenient data reported through scientific papers that represent prior experiences. Our goal was to reach new outcomes from the experimental maturity of the works evaluated. The selected works were evaluated in a predominantly qualitative way, based on the main information presented in each one. From the quantitative outlook, we do not produce strong statistical evidence since the number of selected works represents a small sample to allow in-depth quantitative analyzes. Some results could be measured in numbers and then classified and analyzed through basic descriptive statistics.

As main results, we identified 19 works addressing strategic goals, business processes and NFRs. The most commonly used techniques are: i\* and Key Performance Indicators (KPI), for modeling strategic goals; and Business Process Model and Notation (BPMN), for modeling business processes. Accord-

ing to our analysis, although partial solutions have been found, no approach fully addresses business processes' NFR based on strategic goals which was our primary research question in conducting this study.

This paper presents: necessary background and rationale; summary of related work; description of the applied research method; analysis of the selected works; and discussion of the obtained results.

## 2 STUDY BACKGROUND

We present here the main concepts related to this study, i.e., strategic goals, BPM and NFRs.

### 2.1 Strategic Alignment and Goals

Strategic alignment between business and IT refers to the synchronization between these two organization's sides to ensure that the services provided by IT are adherent to the strategic needs of the business areas (Henderson and Venkatraman, 1993). Business areas are those that represent the functions of an organization, such as: finance, human resources, manufacturing, marketing, logistics, accounting etc. Strategic alignment represents the dynamic adequacy of the IT structure and tasks so that it is always in tune with the organization's business areas, which represent the IT's customers (Henderson and Venkatraman, 1993).

Strategic goals are used to foster strategic alignment. Strategic goals are qualitative or quantitative values to be achieved at a predetermined future time. They represent business or organizational requirements (Janes and Faganel, 2013). Examples of strategic goals are: "increasing customer satisfaction to 99% by 2020" and "reducing project execution time by 25% over the next two years". Once modeled, strategic goals are used as the basis for setting expectations and aligning communication among different organization areas, including the business areas and IT. Each business area can model specific subgoals, which rely on IT services to be met.

IT solutions applied in line with strategic goals lead to business success (De Bruin and Rosemann, 2006). A strategic goal consists of: description, expected benefits, ways to achieve it, and ways to measure its achievement (Plösch et al., 2011). Most organizations represent strategic goals via KPI. KPIs can model quantitative indicators, which are measurable and useful for monitoring the progress and success of strategic goals (Parmenter, 2015).

Organizations can manage their business goals via KPIs (Parmenter, 2015). Business analysts interpret the combination of KPIs and their target values as

goals (e.g., "order approval time up to three days") (Wetzstein et al., 2009). Metrics varying during process execution can influence KPIs, and IT services can influence these metrics (e.g., "processing time", "results accuracy", "services availability" etc.). Thus, KPIs are specified based on business goals matched with expected values, which are transformed into targets, including delimitations of deviations below and above the expected value (Friedenstab et al., 2012).

Also related to this context, the *i\** framework is a goal-based technique, used to model organizational contexts based on dependencies among actors (Yu et al., 1996). The *i\** framework uses: actor, role, dependency, goal, softgoal, resource and task. It aims to model the involved actors (whose behavior is abstractly characterized by roles) and the dependencies among them, so that their goals are reached, resources are provided, tasks are performed and softgoals are minimally fulfilled (Yu et al., 1996). This technique is driven by a set of organizational goals to be achieved. A goal represents a condition or state that stakeholders want to achieve. Goals (also called rigid goals or concrete goals) are complemented by softgoals, which represent conditions or a state that the stakeholders wish to achieve, but without a clear definition of the expected values. Softgoals in *i\** share some concepts and aims with strategic goals in KPIs.

Other techniques to model strategic goals are: Tropos, Security *i\** (Si\*), Balanced Scorecard (BSC), Keep All Objectives Satisfied (KAOS), User Requirements Notation (URN) / Goal-oriented Requirements (GRL), Unified Modeling Language (UML) diagrams, Business Activity Monitoring (BAM), Business Motivation Model (BMM), among others. Although all these techniques are applicable to strategic goal modeling, they can target different purposes and work in different degrees of abstraction.

### 2.2 Business Process Management

BPM is an interdisciplinary area that involves aspects of business administration and information systems to manage business processes supported by automated systems. A business process consists of tasks performed by an organization, in a specific sequence, to achieve a specific goal (Weske, 2012). Examples of business processes are: "granting real estate credit by a financial organization" and "enrollment of new students by an educational organization".

BPM organizes work to ensure consistent results and take advantage of opportunities for improvement (Dumas et al., 2013). BPM includes concepts, techniques and tools to support technical and managerial aspects of business processes (van der Aalst et al.,

2003). The BPM lifecycle includes: modeling, implementation, execution, administration, monitoring, auditing, evaluation and improvement (Weske, 2012).

BPM contributes to achieve the strategic alignment between business and IT via management and improvement of technological solutions related to organizational value-added business processes (Fantinato et al., 2010). BPM enables one to transform the dialog between business and IT in an interactive and iterative approach. BPM combines top-down strategic vision with bottom-up continuous improvement.

Modeling business process means represent generically all actions and decisions that can be performed during process execution, considering that different actions can be performed for specific cases. The main notation currently used by organizations for this goal is BPMN (Kocbek et al., 2015). BPMN allows to model business processes assuming their execution through the integration of services offered by various information systems. Before the emergence of BPMN, many organizations adapted the UML activity diagrams for this goal (Mili et al., 2010), which are focused on software internal processes.

Other techniques to model business processes are: Event-driven Process Chains (EPC), Role Activity Diagrams (RAD), User Requirements Notation (URN) / Use Case Maps (UCM), Integrated DEFINITION's Process Description Capture (IDEF3), Yet Another Workflow Language (YAWL), Petri nets, Finite State Machines (FSM), among others.

### 2.3 Non-Functional Requirements

NFRs are used mainly in software engineering, although this concept is adaptable to other types of products (Chung et al., 2000; Pressman, 2009; Sommerville, 2010). A requirement is a condition, property or capability that a product must meet. A functional requirement defines a behavior (including inputs and outputs) that a product must perform. NFRs define constraints on how a function can or should be used, associated with minimum levels of quality.

NFRs typically relate to performance, usability, availability, security, technologies that should be used, and constraints on the development process (Pressman, 2009). NFRs should consider customer needs. Failure to meet certain NFRs may render the entire product ineffective (Sommerville, 2010).

The concept of requirements, both functional and non-functional, can be mapped from software engineering to BPM by considering business processes as the product being developed (Charfi and Zhi, 2015). In BPM, functional requirements represent what the business process must perform while NFRs represent

quality constraints which need to be met during the process execution. Typical examples of NFRs of software engineering may also be used in BPM such as those related to performance and usability. For example, "a sequence of activities in a business process must run within a maximum of 24 hours".

NFRs are commonly declared late and informally during product development, making it difficult their enforcement (Pressman, 2009; Sommerville, 2010). This weakness is evident in BPM by BPMN not supporting NFRs (Bocciarelli and D'Ambrogio, 2014). Moreover, some techniques that have been proposed to represent business processes' NFRs have not fully addressed the problem. Such techniques usually address only how to represent NFRs without addressing the source of information needed to model them (Salles and Fantinato, 2012).

Considering the need for strategic alignment, a business process should be implemented and executed in line with the strategic goals linked to the scope that encompasses this process. This alignment could be supported by NFRs specified in the business process model, which is used to guide the process implementation. Thus, a strategic goal would be represented in a process model via NFRs, which would in turn be used to support the process implementation.

## 3 RELATED STUDIES

We present here an analysis of other reviews – systematic or not – with a purpose similar to ours. We identified six BPM-related reviews that address some aspect of strategic goals. None of the identified reviews fully meets the purpose of our literature study that is "identifying and assessing approaches that use strategic goals as support for modeling business processes' NFRs". In addition, several of the identified reviews have been driven to specific contexts such as aspect-orientation (Pourshahid et al., 2012) and service choreography (Leite et al., 2013) while our study is intended to be context free.

Evidence that these previously published reviews have purposes other than our literature study is the low overlap of selected papers among them. One of the related reviews evaluated 19 papers, of which four are also the target of our study, which represents about only 20% of overlap. However, this existing review presents a broader purpose – "investigating goal-oriented requirements engineering for business processes" (Poels et al., 2013) in a generic way rather than focused on NFRs. The only other existing overlap refers to a single work also evaluated in another review whose main purpose is to evaluate "compliance

measurement based on goals and indicators” (Shamsaei et al., 2011). Its authors do not specifically address the representation of business processes’ NFRs; instead, they are concerned with a following step, i.e., measuring how much business processes comply to strategic goals. We do not identified any other overlap of our study with some other identified review.

Two additional related reviews were found, but also without addressing the same target of our study, and only tangentiating it. The first one presents a very wide proposal, which is “business process modeling challenges and solutions” (Alotaibi, 2014). Like other existing reviews, this one is not concerned with the representation of business processes’ NFRs. Finally, the latest identified review is concerned with “business process modeling quality” (de Oca et al., 2015), assuming that the quality of process modeling is key to achieving strategic goals. Its authors are focused on identifying approaches that analyze whether process models have quality and whether such quality influences strategic alignment.

## 4 RESEARCH METHOD

This literature study was based on systematic review concepts. A systematic review refers to the identification, evolution and interpretation of all available relevant research papers that address the issues defined in a research protocol (Kitchenham and Charters, 2007). Individual studies evaluated in a review are called primary studies, and a systematic review is a secondary study. A systematic review differs from traditional reviews and surveys because it is a transparent, scientific and replicable approach used to avoid bias (Biolchini et al., 2005). To conduct this literature study, the guidelines proposed by Kitchenham and Chartes were used (Kitchenham and Charters, 2007). The following subsections present the study planning and conduction.

### 4.1 Need for Literature Study

No previous literature study has been conducted with the specific goal presented here (cf. Section 3), with which our research group is interested. In addition, given the importance of research relating strategic goals, strategic alignment and BPM, this literature study may be of interest and utility to other researchers and the industry. We have empirically identified that strategic goals can be an important source of information for modeling business processes’ NFRs. We intend to work along this train of thought, and hence decided to carry out this study.

We aimed to investigate previous approaches in this context to be used as the basis by us and other researchers interested in such subject. The interested researchers should be able to know which techniques have been more widely applied in this context as well as know its features, benefits and drawbacks. With the outcomes obtained, next research works with the aim of improving the strategic alignment with the support of BPM can be developed more consciously.

### 4.2 Research Questions

The main research question guiding this study is: **“Are there approaches proposed to modeling business processes’ NFRs based on strategic goals?”**

In addition, in order to better characterize the found approaches, two subquestions were defined:

- **What Strategic Goal Modeling Techniques are used in the Found Approaches?** Per the rationale presented in Section 2, our empirically raised hypothesis was that KPIs should be the technique most often used to model strategic goals in BPM. Nevertheless, we also expected to find other techniques, including, for example, i\*.
- **What Business Process Modeling Techniques are Used in the Found Approaches?** Per the rationale presented in Section 2, our empirically raised hypothesis was that BPMN should be the technique most often used to model business processes in strategic goal-driven BPM. Nevertheless, we also expected to find other techniques, including, for example, UML activity diagrams.

### 4.3 Data Sources and Search Strategy

The selected data sources are Scopus ([www.scopus.com](http://www.scopus.com)) and Web of Science ([pcs.webofknowledge.com](http://pcs.webofknowledge.com)). Both databases together provide access to papers published and indexed by leading international publishers in the area of interest, including IEEE, ACM, Springer, among several others.

As for the search strategy, we created a search string that expresses the goals of this literature study and should filter papers that could answer our research questions. The following basic search string was created, without the syntax influences of each data source’s search engine: (“business process model” OR BPMN OR “activity diagram” OR “use case maps” OR UCM OR “event-driven process chain” OR EPC OR “integrated definition” OR “process description capture” OR IDEF3 OR “role activity diagram” OR RAD OR “yet another workflow language” OR YAWL OR “petri nets” OR “state machine” OR statecharts) AND (“strategic goal” OR

“business goal” OR “business requirement” OR “organizational requirement” OR “key performance indicator” OR KPI OR i\* OR Si\* OR “balanced scorecard” OR BSC OR “keep all objectives satisfied” OR KAOS OR “user requirements notation” OR URN OR “goal-oriented requirements” OR GRL OR “business activity monitoring” OR BAM).

Overall, we searched for papers addressing concepts related to both “business process modeling” and “strategic goals”. To increase the chance of finding all related papers, we also used different expressions identified as synonyms or related to business process modeling and to strategic goals, which are resulting of an exploratory study of the area. For “business process modeling”, we also used the names and acronyms for the most important process modeling notations and languages as introduced in Section 2.2. Moreover, for “strategic goals”, we used similar or related expressions as presented in Section 2.1 and 2.3. In order to create the string used, a series of iterative exploratory searches were conducted, testing different keyword combinations, in order to minimize the number of returned records while maximizing the likelihood of finding the most important works.

#### 4.4 Selection Strategy

We specified Inclusion Criteria (IC) and Exclusion Criteria (EC) aiming to ensure that only papers actually related to the investigated context were selected as primary studies for this literature study. Each result returned by the search engines, in order to be selected for this literature study, should satisfy both inclusion criteria and not be eliminated by any of the exclusion criteria. The defined criteria are presented below.

##### Inclusion Criteria:

- **IC-1:** the paper addresses strategic goals.
- **IC-2:** the paper addresses process modeling.
- **IC-3:** the paper addresses NFRs at some level.

##### Exclusion Criteria:

- **EC-1:** the paper is not available on the web.
- **EC-2:** the publication is not a peer-reviewed scientific paper such as: technical reports, books, book chapters, proceedings preface, journal editorials, master’s dissertations, doctoral theses.
- **EC-3:** the paper is not written in English.
- **EC-4:** the paper is not primarily related to information systems or business administration.
- **EC-5:** business processes are addressed in the scope of software engineering instead of BPM.

#### 4.5 Paper Selection

Paper selection was performed in three steps (cf. Figure 1) described as follows (Kitchenham and Charters, 2007). Table 1 presents the list of the works selected as primary studies for this literature study.

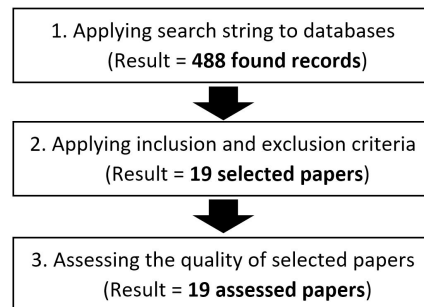


Figure 1: Identification and selection of primary studies.

##### Step 1. Applying Search String to Databases:

the search string was submitted to the chosen data sources. As a result, 465 records were obtained in Scopus and 215 in Web of Science. Disregarding those repeated, 488 initial records were obtained.

##### Step 2. Applying Inclusion and Exclusion Criteria:

each record resulting from the search described in the previous step was subjected to the inclusion and exclusion criteria. For this, we analyzed the following parts of each paper: title, abstract and keywords. For some cases, a more thorough reading of the content of the paper was required. Based on this analysis, papers that did not meet the criteria were removed. When two similar papers of the same authors were found, only the most up-to-date and complete one was chosen. As a result, 19 primary studies were selected.

##### Step 3. Assessing the Quality of Selected Papers:

the exclusion criteria EC-1, EC-2 and EC-3 were used as quality criteria. For the first case (EC-1), we assumed that the unavailability of a paper on the web is an indication of lack of quality of the publication vehicle, considering the current web readiness. For the second case (EC-2), we considered that papers peer-reviewed have a higher quality assurance than those papers that have not undergone this type of review process before publication such as invited book chapters. Finally, for the third case (EC-3), we assumed that papers not published in English also present an indication of lack of quality considering that the great majority of high-quality conferences use the English language as universal standard. No extra paper was removed since no new criterion was used for this step.

Table 1: Final list of the 19 works selected as primary studies.

<b>Id</b>	<b>Paper title</b>	<b>Paper reference</b>	<b>PT<sup>a</sup></b>
P01	A Framework for Integrating Business Processes and Business Requirements	(Kazhamiakin et al., 2004)	C
P02	B-SCP: A requirements analysis framework for validating strategic alignment of organizational IT based on strategy, context, and process	(Bleistein et al., 2006)	J
P03	A combined approach for supporting the business process model lifecycle	(Koliadis et al., 2006)	C
P04	Requirements-driven design and configuration management of business processes	(Lapouchnian et al., 2007)	C
P05	Business process management with the user requirements notation	(Pourshahid et al., 2009)	J
P06	Scenario-driven approach for business process modeling	(Ruokonen et al., 2009)	C
P07	Wiki-based requirements management for business process reengineering	(Abeti et al., 2009)	C
P08	Rule based business process optimization	(Aghdasi and Malihi, 2010)	C
P09	Towards a pattern-based framework for goal-driven business process modeling	(Behnam et al., 2010)	C
P10	Synthesizing enterprise strategic model and business processes in active-i*	(Xu et al., 2010)	C
P11	A method for eliciting goals for business process models based on non-functional requirements catalogues	(Cardoso et al., 2011)	J
P12	Extending BPMN for business activity monitoring	(Friedenstab et al., 2011)	C
P13	An integration framework for multi-perspective business process modeling	(Letsholo et al., 2012)	C
P14	Event-driven manufacturing process management approach	(Estruch and Álvaro, 2012)	J
P15	A bi-directional mapping between i and BPMN models in the context of business process management	(Alves et al., 2013)	C
P16	Making a link between strategy and process model collections: A multi-layered approach	(Dallilo et al., 2014)	C
P17	Modeling organizational alignment	(Sousa and Leite, 2014)	C
P18	Combining modelling and simulation approaches: How to measure performance of business processes	(Bisogno et al., 2016)	J
P19	A framework for systematic analysis and modeling of trustworthiness requirements using i* and BPMN	(Mohammadi and Heisel, 2016)	C

<sup>a</sup> Publication Type (PT): C – Conference / J – Journal

## 5 SELECTED WORKS ANALYSIS

We present here a discussion of the selected works, per Table 1, following their publication order. We focused on highlighting how the approaches deal with modeling of strategic goals and their mapping to business processes' NFRs. All acronyms and initialisms used in this section are defined in Section 2, except for those not yet presented in the text.

**[P01] “A Framework for Integrating Business Processes and Business Requirements” (Kazhamiakin et al., 2004):** this paper proposes a framework for representing strategic goals using Tropos and implementing related processes through web services orchestrated by Web Services Business Process Execution Language (WS-BPEL). This framework does not provide an intermediate step of process modeling prior to its implementation in WS-BPEL. Formal annotations are used at all levels to model constraints to business requirements and to processes. Tropos' softgoals are used to describe NFRs at the business requirements level, but no clear direction of how map them to the web services orchestrations is presented.

**[P02] “B-SCP: A requirements Analysis Framework for Validating Strategic Alignment of Organizational IT based on Strategy, Context, and Pro-**

**cess” (Bleistein et al., 2006):** this paper proposes cross-referencing processes with organizational goal models and context diagrams. Tasks, goals and softgoals are modeled in i\* models, which are integrated with context diagrams, and in turn are integrated with RADs to model the processes. In the end, activities and state descriptions in RADs are cross-referenced with i\*, i.e., processes in RADs are linked to goals in i\*. Softgoals representing NFRs in i\* are mapped to RAD in terms of specific types of actions, i.e., they are addressed as functional elements.

**[P03] “A Combined Approach for Supporting the Business Process Model Lifecycle” (Koliadis et al., 2006):** this approach addresses the management of process change throughout the BPM lifecycle supported by combined notations. i\* models are used for the organizational context, representing strategic goals, and BPMN for the operational context, representing the process model. The authors' intent is to provide a way of expressing changes, which arise in one model, effectively in the other model. With this purpose, they present constrained development methodologies capable of guiding an analyst when reflecting changes from an i\* model to a BPMN model and vice-versa. As BPMN does not support the modeling of NFRs, the softgoals specified using i\* for the

organizational context cannot be mapped to the process model. No clear direction is presented on the treatment of NFRs through this approach.

**[P04] “Requirements-driven Design and Configuration Management of Business Processes” (Lapouchnian et al., 2007):** this paper proposes to use goal models to address process configurations and tailor deployed process aiming to meet non-functional requirements, which represent business priorities or customer preferences. A technique similar to  $i^*$  is used to model strategic goals. NFRs are hence modeled as softgoals in the goal models. Processes are implemented through WS-BPEL and they are configured considering the goal models, including their softgoals. Like paper [P01], this approach does not provide for an intermediate step of process modeling prior to its implementation in WS-BPEL. The emphasis of this approach is on goal-driven process variability. NFRs are not directly addressed at the process level; instead, processes’ functional requirements are configured (i.e., chosen) based on the goal models’ NFRs represented as softgoals.

**[P05] “Business Process Management with the User Requirements Notation” (Pourshahid et al., 2009):** this approach is based on URN extended with KPI, including GRL for modeling goals and UCM for modeling processes. A URN-based framework provides process monitoring and performance management capabilities integrated across the BPM lifecycle. KPIs are used to model NFRs linked to processes models since they are not supported by UCM. In summary, GRL supports goals and softgoals, which are used for the functional modeling of processes, and in turn must be tied to KPIs representing its NFRs.

**[P06] “Scenario-driven Approach for Business Process Modeling” (Ruokonen et al., 2009):** this approach is formed by four steps: first, the essential business requirements, representing strategic goals, are modeled as scenarios using UML sequence diagrams; then, the modeled scenarios are synthesized by a UML state machine, which represents the process model; next, the process model is translated into a process skeleton using a UML activity diagram; and, finally, the process skeleton is implemented in WS-BPEL. Although NFRs is a concern which can be addressed by this approach, no clear direction is presented on their treatment through the approach steps. NFRs can be modeled as exception behavior in scenarios but cannot be directly mapped to process models and hence need to be recovered and addressed only during translation to process skeletons.

**[P07] “Wiki-based Requirements Management for Business Process Reengineering” (Abeti et al., 2009):** this paper presents an approach to manag-

ing both organizational and system requirements for process reengineering. The proposed method uses requirements acquired by a semantic wiki to partially automate the translation from business requirements description to processes and system artifacts. The semantic wiki is built by means of  $Si^*$  concepts which include the modeling of NFRs as softgoals. Processes are specified in terms of UML use case diagram (for the static aspects) and BPMN (for the dynamic interactions). In both UML use case diagram and BPMN, it is not possible to model the NFRs. Therefore, the  $Si^*$  softgoals should be mapped to functional requirements at the process level.

**[P08] “Rule based Business Process Optimization” (Aghdasi and Malihi, 2010):** these authors propose process optimization through changing process model with respect to business goals. KPI-based business rules represent strategic goals, which are mapped to rule-based processes. The authors are concerned with achieving and maintaining strategic alignment by a changing control. It breaks down business goals into subgoals so that the desired performance measures specified in KPIs are met in business rules. NFRs are inherently addressed by the approach since it is proposed as a single framework in which all the concepts involved are systematized in a metamodel.

**[P09] “Towards a Pattern-based Framework for Goal-driven Business Process Modeling” (Behnam et al., 2010):** related to paper [P05], this paper proposes a goal-driven, pattern-based framework to build processes from organization goals while maintaining traceability between them. Patterns are made up of goal templates and process templates as well as their relationships. As notations, URN/GRL and URN/UCM are respectively used for modeling goals and processes. Unlike paper [P05], KPIs are not used here to model NFRs tied to processes models since they are not supported by UCM. Thus, NFRs are explicitly addressed only as softgoals in GRL and not explicitly addressed at the process level.

**[P10] “Synthesizing Enterprise Strategic Model and Business Processes in Active- $i^*$ ” (Xu et al., 2010):** this paper proposes to combine goals and process modeling through  $i^*$  models and UML activity diagrams. Potential synergy points between the  $i^*$  framework and UML activity diagrams are found by matching and mapping the major concepts of their metamodels. This approach aims at: identifying processes out of business objectives, extracting business goals through process abstraction, and identifying mismatches between business goals and processes. A combined metamodel is proposed in which both goals elements (including softgoals) and process elements are addressed together. This metamodel is presented

at a higher level of abstraction without presenting a clear mapping between softgoals and processes.

**[P11] “A Method for Eliciting Goals for Business Process Models based on Non-functional Requirements Catalogues” (Cardoso et al., 2011):** these authors propose a systematic way of identifying organizational goals for “as-is” process models. They propose using NFR catalogs, defined by other authors, to tackle the difficulty in identifying business goals and softgoals to be later used in process modeling. The approach is based on *i\** and Tropos. No specific notation is used to model processes. Per these authors, their approach allows modeling processes aligned with the business goals identified with the support of the mentioned catalogs.

**[P12] “Extending BPMN for Business Activity Monitoring” (Friedenstab et al., 2011):** this paper proposes a BPMN extension that incorporates BAM concepts which aims to represent KPIs’ real-time scores for process activities. A metamodel was built to systematically describe the aspects of the extension as well as the symbols added to BPMN to represent KPIs. The authors recommend that KPIs should be identified during the modeling phase in parallel with the functional requirements elicitation.

**[P13] “An Integration Framework for Multi-perspective Business Process Modeling” (Letsholo et al., 2012):** a multi-perspective integration framework for process modeling is proposed to better align organizational goals and processes. The proposed framework is guided by the six models, proposed by other authors, which covers the following concerns: “what”, “how”, “where”, “who”, “when” and “why”). The authors suggest the following techniques for process modeling: (i) goal-oriented – *i\**, KAOS and Tropos; (ii) data-oriented – entity-relationship model, data flow diagrams and UML class diagram; and (iii) process-oriented – BPMN, IDEF3, UML activity diagrams, RAD and EPC. Each suggested technique can be appropriate at different levels for each concern presented. By this approach, NFRs are inherently addressed when combining the techniques useful for that although this is not explicitly addressed.

**[P14] “Event-driven Manufacturing Process Management Approach” (Estruch and Álvaro, 2012):** an approach is proposed to manage process through an event-driven architecture based on BAM concepts. The proposed approach is based on concepts such as BAM, KPI and CEP. The notation used to model processes is BPMN, which is extended to express logic for both: processing complex events and evaluating related KPIs. NFRs are addressed through CEP and KPIs which are embedded in BPMN representing both strategic goals and processes’ NFRs.

**[P15] “A Bi-directional Mapping between *i\** and BPMN Models in the Context of Business Process Management” (Alves et al., 2013):** this paper extends the paper [P03] by refining the proposed heuristics to obtain *i\** models from BPMN models beyond BPMN from *i\**. Similar to the paper [P03], the mapping from BPMN to *i\** also addresses NFRs only indirectly. As NFRs are not modeled in BPMN, they should be inferred by searching quality attributes related to the activities performed by the participants.

**[P16] “Making a Link between Strategy and Process Model Collections: A Multi-layered Approach” (Dallilo et al., 2014):** this paper proposes a multi-level approach, including a multi-layered metamodel, which extends BPMN and links strategic goals with an organization’s collection processes, based on the Business Motivation Model (BMM) and BPMN. KPIs link the BMM and BPMN levels. While BPM represents the strategic goals, BPMN represents the process modeled to address such goals. KPIs systematically models the indicators responsible for assessing if the process execution is meeting the strategic goals.

**[P17] “Modeling Organizational Alignment” (Sousa and Leite, 2014):** this paper proposes a conceptual model that merges *i\**, BPMN and KPI. The *i\** models are used to interconnect the other two. KPIs are linked only to the goals (including the softgoals that represent NFRs), detailing them by expressing what is necessary to satisfy them. Accordingly, NFRs are not directly addressed at the process level through BPMN. KPIs only insert an implicit link of traceability that helps identify crucial elements in the process.

**[P18] “Combining Modelling and Simulation Approaches: How to Measure Performance of Business Processes” (Bisogno et al., 2016):** a method is proposed to analyze and improve operational performance of processes. The proposed method employs BPMN and Business Processes Simulation (BPSim) to measure KPIs. Like paper [P09], this work uses an inverse approach comparing to other approaches, i.e., strategic goals (specified as KPIs) are obtained from process models (modeled in BPMN) rather than the other way around. Based on process models, operational performance can then be measured using BPSim. The method allows testing of process designs and quantified measurement of variations in operational performance through four predefined KPIs. The only mapping between NFR and BPMN is through the four KPIs which should be modeled based on the process model evaluation.

**[P19] “A Framework for Systematic Analysis and Modeling of Trustworthiness Requirements using**



**i\* and BPMN**” (Mohammadi and Heisel, 2016): this paper proposes a framework for analyzing and modeling user-centered trustworthiness requirements. These authors use goal models to capture users’ trust strategic goals, which should motivate design decisions with respect to trustworthiness. These authors use i\* for goal modeling and BPMN for process modeling. The framework supports the refinement of softgoals right up to the elicitation of corresponding trustworthiness requirements. Trustworthiness-related NFRs are firstly specified as softgoals in i\* and mapped to BPMN, which has been extended to allow annotations capable of representing such NFRs.

## 6 DISCUSSION OF THE RESULTS

This section presents a discussion of our study’s overall outcomes. First, Figure 2 shows the distribution of the 19 selected papers in relation to the publication year. One can see a low number of found papers, but steadily since 2009. Considering the importance of strategic alignment for organizations as well as the importance of the support provided by BPM in this context, one could expect a larger number of works related to this research topic. This low number is probably reflex of the negligence commonly associated to NFRs in this and similar contexts.

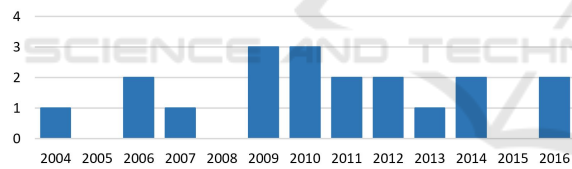


Figure 2: Distribution of papers by publication year.

Our main result is the absence of approaches that fully meet the research problem that motivated this literature review. Our primary goal was to find research papers proposing some approach to model business processes’ NFR based on organizational strategic goals. Per our analysis, no approach has been proposed specifically for this purpose. Aiming to support our findings, Table 2 presents the main characteristics of the works found and analyzed in Section 5.

As for “strategic goal modeling”, we found eight techniques used for this purpose in the 19 evaluated papers. Figure 3 summarizes the techniques used to model strategic goals. Two techniques stand out: i\* and KPI, respectively present in 47% and 37% of the papers. Tropos and URN/GRL (the third and fourth most used technique) as well as Si\* are associated with the i\* framework, which highlights the importance of i\* for this context. All three other techniques

are used in no more than one paper each. Per Table 2, one can verify that, for most of the approaches found, NFRs are modeled at the goal level through the *soft-goal* concept (cf. column “NFRs at goal level”). Softgoals are used in 13 papers (of the total of 19 papers), for which goal modeling is always performed with i\* or some i\*-related technique. We were expecting to find KPI as the most used technique instead of i\*, since KPI is highly known and used in both industry and academia. Either way, both technique are widely used and well distributed in time terms for the period considered. On the other hand, BSC did not occur in any of the 19 papers found, although it is also widely used in industry and in scientific research.

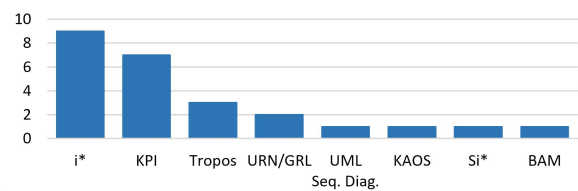


Figure 3: Techniques used to model strategic goals.

As for “business process modeling”, we found nine techniques used for this purpose in the 19 evaluated papers. Figure 4 summarizes the techniques used to model business processes. Corroborating to our initial expectation, BPMN is notably the most widely used technique used to model business processes in this context, present in 53% of the papers. The second most widely used technique is UML Activity Diagrams, present in 16% of the papers. BPMN is the most popular notation used to model business processes while UML Activity Diagrams is the most popular technique used to model internal software processes. All seven other techniques are used in no more than two papers each. There are also three papers that do not mention any particular modeling technique. Per Table 2, NFRs are not modeled at the process level for most of works (cf. column “NFRs at process level”). In five works, KPI are used to model NFRs at both goal and process levels. In fact, KPIs are used to model NFRs in an integrated way for both perspectives. Therefore, there is no direct way of modeling business processes’ NFRs even for these works.

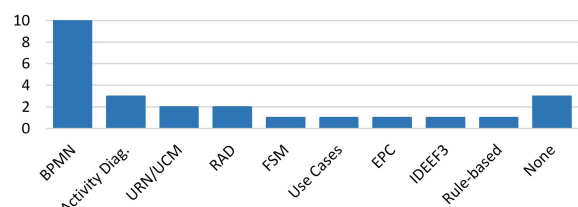


Figure 4: Techniques used to model business processes.

Table 2: Summary of the main characteristics of the 19 selected works.

<b>Id</b>	<b>Strategic goal modeling</b>	<b>Business process modeling</b>	<b>Goals' NFRs</b>	<b>Processes' NFRs</b>
P01	Tropos	[None]	Softgoals	[None]
P02	i*	RAD	Softgoals	[None]
P03	i*	BPMN	Softgoals	[None]
P04	i*	[None]	Softgoals	[None]
P05	KPI, URN/GRL	URN/UCM	Softgoals + KPI	[None]
P06	Sequence diagram	Activity diagram, FSM	Exception behavior	[None]
P07	Si*	BPMN, Use cases diagram	Softgoals	[None]
P08	KPI	Rule-based	KPI	KPI
P09	URN/GRL	URN/UCM	Softgoals	[None]
P10	i*	Activity diagram	Softgoals	[None]
P11	i*, Tropos	[None]	Softgoals	[None]
P12	KPI	BPMN	KPI	KPI
P13	i*, Tropos, KAOS	BPMN, Activity diag., RAD, EPC, IDEEF3	[Several]	[Several]
P14	KPI, BAM	BPMN	KPI	KPI
P15	i*	BPMN	Softgoals	[None]
P16	KPI	BPMN	KPI	KPI
P17	i*, KPI	BPMN	Softgoals + KPI	[None]
P18	KPI	BPMN	KPI	KPI
P19	i*	BPMN	Softgoals	Annotation

Figure 5 presents a cross-analysis between goal modeling and process modeling through overlapping Figures 3 and 4. We found 39 combinations between a technique to model strategic goals and a technique to model business processes for Figure 5. The number of occurrences for each combination is shown within each circle; larger circles represent a larger number of occurrences for the respective combination. For example, two occurrences were found for the combination of i\* and RAD. Aligned to Figures 3 and 4, the most widely combinations in this context are “i\* with BPMN” and “KPI with BPMN”, representing together 26% of found combinations. As for the other combinations, four are related to some other goal modeling technique used with BPMN whereas ten are related to i\* or KPI used with some other process modeling technique, which represents more 36% of found combinations. The other 38% refers to combinations not involving KPI, i\* or BPMN.

Although different techniques were found for both goal modeling and process modeling, Table 2 indicates the evolution of each one. In terms of goal modeling, i\* and KPI are undoubtedly the most used techniques since 2010. On the other hand, in terms of process modeling, BPMN is practically the only technique used in this context since 2011. Therefore, although we did not identify any approach that completely addresses the modeling of business processes' NFR based on strategic goals, one can infer that the way to reach this end, as indicated in the literature, would be to define an approach based on i\* or KPI for goal modeling and BPMN for process modeling.

## 7 CONCLUSION

This paper presented the results of a literature study conducted to identify and evaluate approaches that propose the use of strategic goals as support for modeling business processes' NFRs. To the best of our knowledge, no previous study has been carried out with this specific goal as presented here.

We identified 19 works addressing strategic goals, business processes, and NFRs at some level. The most commonly used techniques are: i\* and KPI for goal modeling and BPMN for process modeling. Although we found partial solutions, no approach fully addresses business processes' NFR based on strategic goals which was our primary research question. Nevertheless, considering the evolution of the techniques found, we concluded that the indicated way to reach this end is by defining an approach based on i\* or KPI for goal modeling and BPMN for process modeling.

Our conclusions were obtained from the experimental maturity of the 19 evaluated works. The evaluation was primarily qualitative, based on the main information presented in each paper. In quantitative terms, we did not produce any strong statistical evidence considering the small sample of found works which could not allow in-depth quantitative analyses.

In terms of future work, we plan to use the information obtained from this review to assist in the proposal of a new approach to address the strategic alignment between business and IT with BPM as support. Our proposal should fully address business processes' NFR based on strategic goals through a combination between KPI and BPMN, considering they are the techniques most widely used in this context.

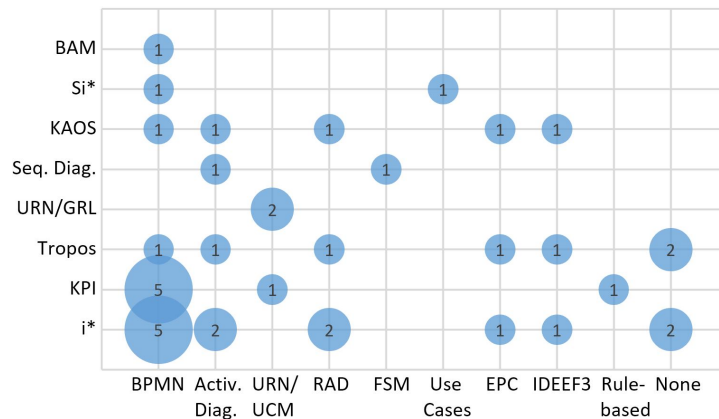


Figure 5: Cross-analysis between techniques to model strategic goals and techniques to model business processes.

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