ISSN 2395-8618

A Method Based on Patterns for Deriving Key Performance Indicators from Organizational Objectives

Carlos Mario Zapata Jaramillo and Luis Fernando Castro Rojas

Abstract—**Organizational strategic alignment implies consistency among the organizational elements. Organizational objectives act as essential elements for leading such alignment. In addition, key performance indicators (KPIs) have demonstrated usefulness for assisting the strategic alignment allowing for a holistic control of the organization. Some approaches emphasizing objective-KPI relationships have been proposed; however, they lack of a fully appropriate method for treating organizational objectives, KPIs, and objective-KPI relationships. They exhibit some drawbacks in terms of ambiguity, stakeholder understandability, and subjectivity. In this paper, we propose a method for overcoming such drawbacks, by using pre-conceptual-schema-based organizational patterns as a way to operationalize organizational objectives in terms of the KPIs. So, a systematic method for deriving a set of candidate KPIs from a specific organizational objective is provided. In addition, we present a lab study in order to illustrate the main aspects of this proposal.**

Index Terms—**Strategic alignment, organizational objective, key performance indicator, pattern.**

I. Introduction

STRATEGIC alignment for improving the performance of an organization has received a renewed attention among academics and practitioners since the 1990s [1]. Some authors conclude that means for establishing and assessing such alignment are underdeveloped [2]. Consequently, achieving this alignment will be one of the most important management priorities in the upcoming years [3].

Several studies agree that organizational objectives are essential for leading the strategic alignment [2–5]. According to Basili *et al*. [4], such objectives are not always explicitly nor clearly stated in the organizations. Thus, the verification of the achievement of those objectives is a difficult task.

Some other studies propose key performance indicators as vital factors for guaranteeing strategic alignment [2], [4], [5]. According to Cosenz [6], "what cannot be measured cannot be controlled." Consequently, strategies and assessment practices, such as the adoption of proper performance indicators, need to be implemented. In addition, according to Kronz [7], the holistic management can be achieved by collecting and analyzing performance in terms of key performance indicators (KPIs).

As a result, relationships among organizational objectives and key performance indicators are becoming more important. According to Basili *et al*. [5], an integrated vision of the company can be obtained by aligning and communicating all the goals, strategies, and measurement opportunities. So, all of the organizational elements can be directed to the same target. In most of the companies, performance measurement indicators have been developed; however, little effort to adequately establish links between objectives and performance indicators has been devoted [8].

Some approaches for exploring organizational objectives, KPIs, and objective-KPI relationships have been proposed. Some of them have metrics and models for measuring objective achievement. For example, Shamsaei *et al*. [9] propose an approach for modeling the context and measuring compliance levels based on certain rules. Pourshahid *et al*. [10] describe a method for decision making by including objectives, decision-making devices, and KPIs. Barone *et al*. [11] and Maté *et al*. [12] outline a method for modeling processes, objectives, indicators, and situations affecting the objectives. Strecker *et al*. [13] present a conceptual modeling proposal with the aim of satisfying essential requirements in the domain of organizational performance measurement. Frank *et al*. [14] outline a method for modeling indicator systems, based on a modeling language called SCORE-ML. Some proposals are mainly theoretical, and specifications for guiding any computational tractability are ignored, e.g., BSC (Balanced Scorecard) [15] and GQM (Goal Question Metrics)+ Strategies® [4], [17]. Thevenet [18] proposes the INSTAL method, which is aimed at aligning

Manuscript received on February 27, 2016, accepted for publication on May 13, 2016, published on June 25, 2016.

Carlos Mario Zapata Jaramillo is with the Facultad de Minas of the Universidad Nacional de Colombia, Colombia (e-mail: cmzapata@unal.edu.co).

Luis Fernando Castro Rojas is with the Facultad de Ingeniería of the Universidad del Quindío and the Facultad de Minas of the Universidad Nacional de Colombia, Colombia (e-mail: lufer@uniquindio.edu.co, lufcastroro@unal.edu.co).

ISSN 2395-8618

information systems to strategic business objectives in an organization. Doumi *et al*. [19] propose the modeling of strategic alignment among objectives and information systems by using indicators. Giannoulis *et al*. [2], [20] present the SMBSC (strategic maps and balanced scorecard) metamodel, which includes the concept of measure for supporting the evaluation of an objective performance. Finally Popova *et al*. [21] present a formal framework for modeling objectives, performance indicators and their relationships.

Unfortunately, the aforementioned contributions lack a wholly appropriate method for treating organizational objectives, KPIs, and objective-KPI relationships. They exhibit some drawbacks: i) some proposals are used for expressing objectives and KPIs by using informal natural language, causing ambiguity problems; ii) other proposals are used for expressing objectives and KPIs too formally inducing stakeholder understandability problems; and iii) in some cases the objective-KPI relationships are established by using personal criteria involving subjectivity problems. In the next Section we present a comparison of such contributions in order to evidence the aforesaid drawbacks.

In this paper we propose a novel method based on patterns for overcoming the previously identified drawbacks. Such a method allows us for deriving a set of candidate KPIs from organizational objectives. The method is based on pre-conceptual schemas [22], [23] for representing organizational objectives, key performance indicators, objective-KPI relationships, and the involved domain elements. Also, it uses a set of patterns for deriving candidate KPIs. As a result, a lab study is developed in order to demonstrate how the key performance indicators can be derived from organizational objectives by identifying and by applying certain patterns.

This paper is organized as follows: in Section II we show a review of the related work, and we present additional background information for facilitating a comparison among several approaches dealing with organizational objectives, KPIs, and objective-KPI relationships. In Section III we describe the proposal based on patterns for deriving key performance indicators from organizational objectives. In Section IV we provide a lab study for illustrating the main aspects of the proposal. Finally, in Section V we present some conclusions and future work.

II. Related Work

A. Objective-Oriented Proposals

Several approaches have been proposed for studying the strategic alignment in organizations. More specifically, such approaches have been focused on organizational objectives, KPIs, and objective-KPI relationships.

A first set of approaches based on GORE (goal-oriented requirements engineering) establishes the objectives as main components for contributing to the strategic alignment. Such proposals only emphasize on representing, defining, and analyzing the organizational objectives, but they disregard the inclusion of KPIs and objective-KPI relationships. Some of such proposals are presented by Kavakli [24], Engelsman *et al*. [25], Yu *et al*. [26], de la Vara *et al*. [27], Gröner *et al*. [28], and Giannoulis *et al*. [29]. The latter formalize the strategy maps [30] by using a metamodel. The MAP methodology [31] allows for the modeling of the high-level goals and strategies of an enterprise.

B. KPI Oriented Proposals

Another set of proposals is focused on representing, defining, and analyzing the KPIs, but they disregard the inclusion of organizational objectives and objective-KPI relationships. Some of such proposals are presented by Caputo *et al*. [32] using SBVR (semantics of business vocabulary and business rules) for developing a KPI Vocabulary; Del-Río-Ortega *et al*. [33] proposing an ontology for the definition of process performance indicators; and Wetzstein *et al*. [34] using WSML (web service modeling language) for defining a KPI ontology.

C. Objective-KPI Oriented Proposals

Since the aforementioned set of proposals provides crucial elements for supporting the method we propose in this paper, we are mainly centered on those approaches aimed at including both organizational objectives and KPIs, as well as the objective-KPI relationships. Therefore, in this section, we review such proposals; besides, we analyze them with the previously established drawbacks in mind.

BSC (balanced scorecard) [14] includes causal linkages among objectives and performance measurements. In this context, objectives are measurable and the measures support the assessment for fulfilling such objectives.

GQM+ Strategies [4], [17] is an approach for linking organizational operational objectives and strategies from the top management level to the project level and back. Also, this approach is intended to align the business at all levels of the organization in a seamless way. Finally, GQM+ provides a mechanism for monitoring the success and failure of objectives and strategies by using measurement.

Giannoulis *et al*. [2] introduce the SMBSC meta-model, which allows for the integration of strategy maps and BSC by using a metamodel. Then, Giannoulis and Zdravkovic [35] present a case scenario based on i* and SMBSC.

Strecker *et al*. [13] introduce a conceptual model for representing an indicator system by rationalizing the process of creating, using, and maintaining indicators. Such a proposal includes the indicator-objective relation, and benefits from the reuse of MEMO (multi-perspective enterprise modeling) modeling concepts. Another proposal integrated with MEMO is outlined by Frank *et al*. [14]. The authors propose a modeling method for designing business indicator systems related to the organizational objectives. The modeling

ISSN 2395-8618

concepts are defined by using the performance modeling language called SCORE-ML.

Doumi *et al*. [19] propose the modeling of strategic alignment among objectives and information systems by using indicators. Such indicators are associated with tasks and they are used for helping stakeholders to implement actions for achieving objectives. In addition, the indicators facilitate the verification of the accomplishment of the organizational objectives and the reorganization of the business processes.

The INSTAL method introduced by Thevenet [18] aims at aligning information systems with organizational objectives. Such a method involves metrics applied to strategic elements and measures applied to operational elements. However, in this method, performance indicators are lightly treated, and explicit objective-KPI relationships are not considered.

Two extensions of URN (user requirements notation) have been proposed. Shamsaei *et al*. [9] propose some rules for modeling the context and measuring the compliance level of their process. In addition, a regulation model, including policies, sub-policies, rules, and KPIs is provided. Pourshahid *et al*. [10] propose a method for making decisions, including objectives, decision-making devices, and KPIs into a single conceptual framework. In both URN extensions, a graphic tool is used for representing and analyzing KPIs. Basic notation of such a tool is illustrated in Figure 1. Unfortunately, KPIs are subjectively related to the objectives, and the specification of KPIs is carried out in an uncontrolled way by using natural language.

Barone *et al*. [11] and Maté *et al*. [12] use BIM (business intelligence model) for modeling the business strategy. This framework comprises the modeling of objectives, indicators, and potential situations affecting objectives. Also, some techniques and algorithms are provided for deriving values and composing indicators. Such proposals are supported by a visual editor prototype for drawing business schemas and reasoning about them. An example of this framework is illustrated in Figure 2.

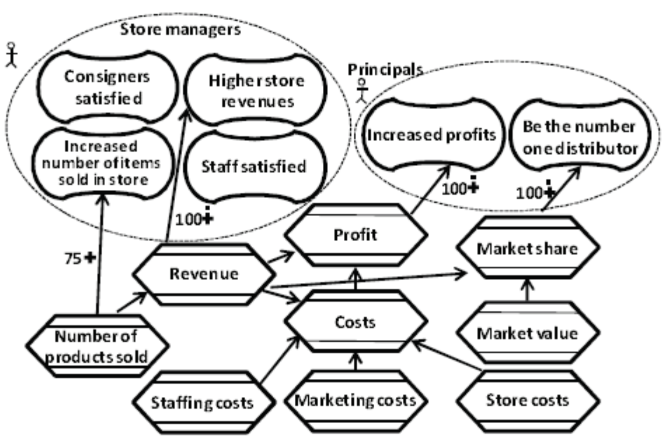

Fig. 1. Representation of KPIs and Objectives. Source: [9]

Popova *et al.* [21] present a framework for formally modeling predicate-logic-based performance indicators and their relationships by using a performance-oriented view. LEADSTO language and the LEADSTO property editor tool are used in the modeling process. LEADSTO language is a sublanguage of TTL (temporal trace language) which enables direct temporal—or causal—dependency modeling among state properties. Besides, the relationships are formally defined by using axioms expressed in TTL. The components of the framework and the considered modeling views—process, performance, organization, and agent—can be directly related to the components of the GERAM (the generalized enterprise reference architecture and methodology). This approach is illustrated in Figure 3.

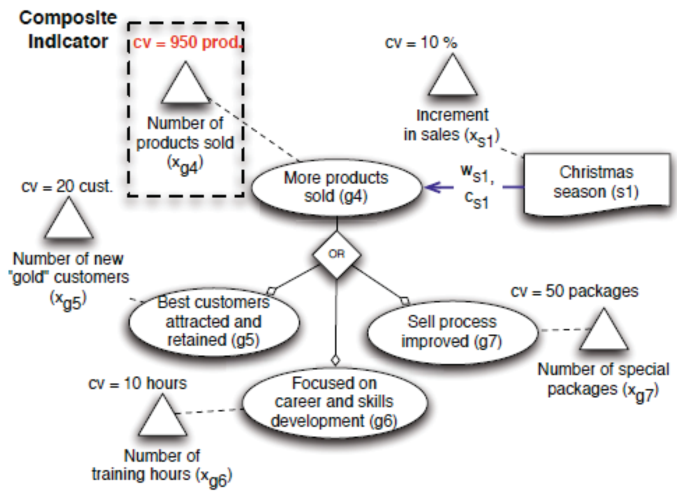

Fig. 2. Relationships among objectives and KPIs. Source: [10].

D. *Comparison of Proposals*

Table 1 shows a comparison of the aforementioned proposals. We use the following notation: "✓" means the proposal successfully addresses the issue; "p" indicates the proposal addresses it partially; and "✗" indicates the proposal does not contemplate the issue.

We see some proposals related to the objective-KPI relationships. However, none of the analyzed approaches provides an assisted method that would systematically guide an appropriate derivation of KPIs. Moreover, some of such proposals specify objectives and KPIs either informally in natural language or simply as labels within a specific diagram, leading to ambiguity problems. Other proposals express objectives and KPIs by using formal specifications that induce stakeholder understandability problems. Lastly, some proposals establish objective-KPI relationships by using only the personal criterion involving subjectivity problems. For these reasons, more research on this field is needed.

ISSN 2395-8618

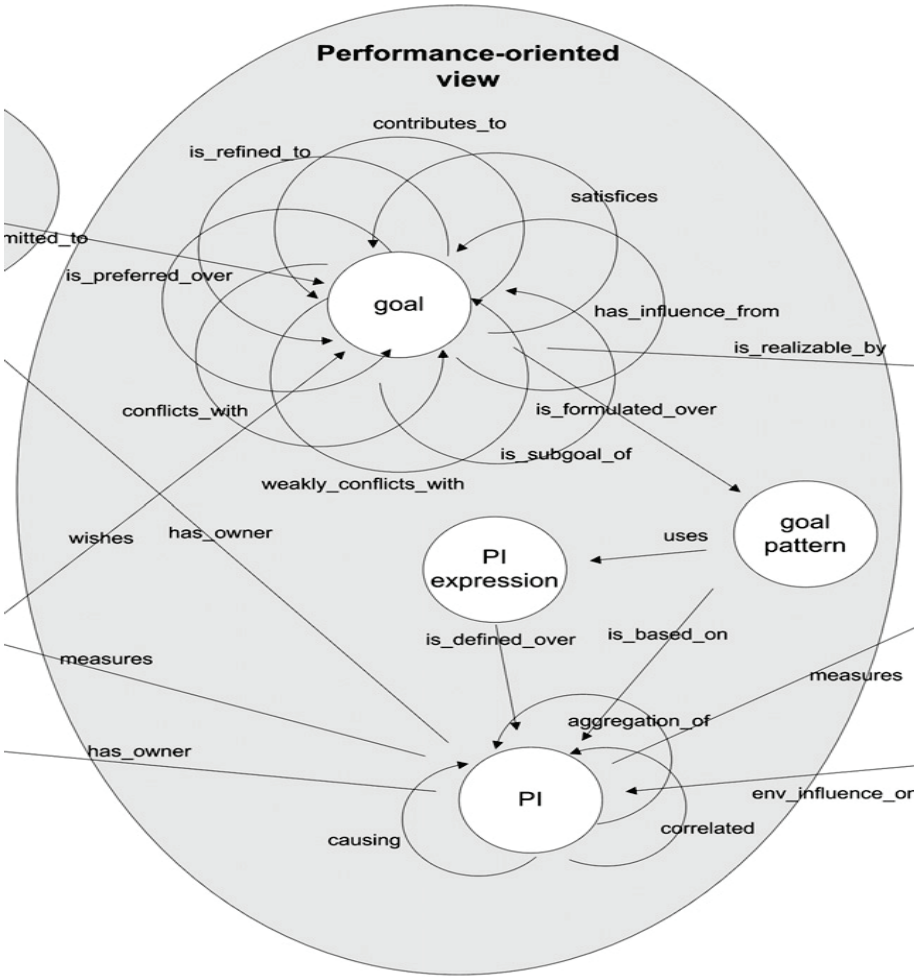

Fig. 3. Fragment of Meta-model for the performance-oriented view. Source: [21]

III. Our Proposal

The main weakness of the current research in this area is the lack of a systematic approach for deriving KPIs from the concepts involved in specific organizational objective domain. In this paper we propose a systematic method for deriving KPIs from organizational objectives. Thus, we can correctly map elements representing the organizational objective domain to elements representing the performance indicator domain. These indicators are useful for assessing the fulfillment of the organizational expectations. In addition, an appropriate traceability among the aforementioned elements can be established.

A method for systematically linking organizational objectives to KPIs should include the following features:

- The method should provide a clear understanding of the domain where the organizational objectives are defined.
- The method should support the analyst by providing techniques to perform the derivation process of KPIs in a systematic and precise way.

Accordingly, our proposal includes the following phases as a way to deal with the previously mentioned problems:

1) Defining a modeling process for describing the organizational objective and their domain.
2) Developing a methodological guideline for deriving KPIs from organizational objectives.

A. Phases

1) Modeling phase:

In this step, we represent the actual domain of the enterprise related to such organizational objective. We use the pre-conceptual schemas [22] for modeling the organizational objectives and their domain. Pre-conceptual schemas have several advantages: unambiguous syntax, integration of concepts, dynamic elements, and proximity to the stakeholder language. In addition, untrained stakeholders can understand pre-conceptual schemas [23].

ISSN 2395-8618

TABLE I
COMPARISON OF STUDIED PROPOSALS. SOURCE: THE AUTHORS

Proposal	Aspects of comparison				
	Objective modeling	KPI modeling	Objective-KPI relationship modeling	Assisted KPI derivation	Detected drawbacks
Shamsaei *et al*. [9]	✓	✓	✓	✗	Ambiguity, Subjectivity
Pourshahid *et al*. [10]	✓	✓	✓	✗	Ambiguity, Subjectivity
Barone *et al*. [11]	✓	✓	✓	✗	Ambiguity, Subjectivity
Maté *et al*. [12]	✓	✓	✓	✗	Ambiguity, Subjectivity
Doumi *et al*. [19]	✓	✓	✓	✗	Ambiguity, Subjectivity
Frank *et al*. [14]	✓	✓	✓	✗	Subjectivity
Strecker *et al*. [13]	✓	✓	✓	✗	Subjectivity
Popova *et al*. [21]	✓	✓	✓	✗	Stakeholder understandability
Thevenet [18]	✓	P	✗	✗	Ambiguity, The modeling of Objective-KPI relationships is not considered.
Del-Río *et al*. [33]	✗	✓	✗	✗	Objectives and Objective-KPI relationships are not considered in the model.
Wetzstein *et al*. [34]	✗	✓	✗	✗	Objectives and Objective-KPI relationships are not considered in the model.
Caputo *et al*. [32]	✗	✓	✗	✗	Objectives and Objective-KPI relationships are not considered in the model.

Basic Concepts and Notation

Nodes

Pre-conceptual Schemas include five kinds of nodes connected to two kinds of arcs for graphically representing a model [22, 23].

Every *concept* has an incident connection-type arc starting or ending in a relationship. The *concept* node can be of two kinds:

- *Class-Concept* is a concept that contains attributes and can be instantiable.
- *Attribute-Concept* is a leaf concept within a Pre-conceptual Schema, i.e., an attribute of a *Class-Concept*.
- A *dynamic relationship* represents actions and has exactly one incoming and one outgoing *connection* arcs. Such a relationship can be connected to concepts by using *connections arcs*. In addition, it can be connected to other dynamic relationships by using *implication* arcs.
- A *structural relationship* can be either is-a or part/whole type. It is incident to *concepts* and has exactly one incoming and one or more outgoing arcs of *connection* type.
- An *achievement relationship* can be connected to *structural* and *dynamic relationships* and *concepts*. In addition, *achievement relationships* can be connected among each other by using *implication* arcs.

Arcs

- A *connection arc* connects a *concept* to a *relationship* or vice versa.
- An *implication arc* connects a *dynamic relationship* to a *dynamic relationship*. *Implication arc* can be also used for connecting *achievement relationships* among each other.

The basic notation of the pre-conceptual schemas is illustrated in Figure 4.

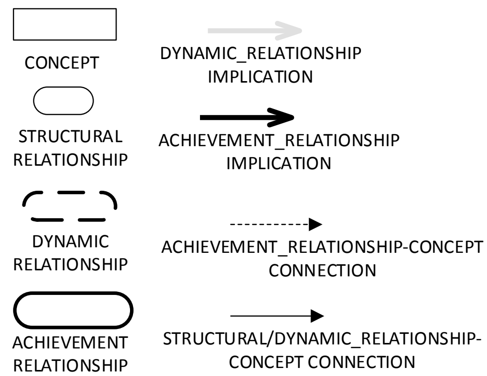

Fig. 4. Basic elements of Pre-conceptual Schemas. Source: [23]

2) Derivation Phase

In this phase, a set of candidate KPIs is derived from organizational objectives and their previously modeled domain. The derivation process comprises a set of patterns, which guides the analysis of the several possibilities for identifying key performance indicators. According to Martinez [36], a pattern reflects something to be used in a number of situations and, thus, has some generality. She establishes three features of the patterns: (1) the description of a pattern contains a context, which explains the intent of the pattern and suggests how it should be used; (2) patterns express solutions in a variety of ways, depending on the details of a circumstance; and (3) pattern descriptions can express architectural considerations, regardless of specific languages and design methodologies.

ISSN 2395-8618

Consequently, we define a set of patterns to be systematically processed and to guarantee recurrent solutions in every step of the process. Such patterns specify candidate KPIs from an organizational objective model.

B. Description of the Pattern

We use a template—based on the work developed by Martinez [36]—for describing the patterns defined in this paper. Hence, the basic elements we use are the following:

- *Name:* A sentence summarizing the pattern.
- *Context:* A situation characterizing a problem. It describes situations in which the problem occurs.
- *Problem*: The recurring problem arising in the context.
- *Structure*: A detailed specification of the structural aspects of the pattern.
- *Solution*: The strategy for solving the recurring problem.
- *Examples*: A model intended to illustrate the pattern.

C. Patterns in the organizational objective model

The patterns proposed in this paper are focused on identifying several structures belonging to an organizational objective model that can be useful for deriving some KPIs related to such organizational objective. Then, a specific pattern will be used depending on the type of structure identified.

Proposed Patterns

The KPIs derivation process is carried out in a systematic way by identifying those relevant elements in the model suggested by the stakeholder and by analyzing such elements. In order to complete such task, we provide a set of patterns based on pre-conceptual schemas for systematically guiding the derivation process. In this section we present some examples of such patterns:

The *leaf-attribute pattern*: To be applied when an *attribute concept*—which is related to an *achievement relationship*—can be used for generating a set of candidate KPIs.

The *dynamic-relationship pattern*. To be applied when a *dynamic relationship*—which is related to an *achievement relationship*—can be used for generating a set of candidate KPIs.

Applying Patterns

The derivation phase can be initiated after modeling the domain of the enterprise related to an organizational objective. Thus, the proposed patterns can be used when some part of the pre-conceptual schema matches the pattern. In order to complete this task, a specific method for applying the proposed patterns is presented. The method comprises the following steps:

Step 1. Analysis of modeled elements.

Each of the modeled elements should be analyzed in order to determine if such an element can be considered as a candidate element. A candidate element should meet the features described in any of the proposed patterns.

Step 2. Identification of the appropriate pattern.

Once a candidate element—and the portion of the pre-conceptual schema—have been identified, the suitable pattern-type should be determined.

Step 2.1. When an attribute concept is encountered and it is linked to an *achievement relationship*, the *leaf-attribute pattern* (pattern 1) can be applied.

Step 2.2. When a *dynamic relationship* is encountered and it is linked to an *achievement relationship*, the *dynamic-relationship pattern* (pattern 2) can be applied.

Step 3. Derivation of KPIs.

The procedure described in the pattern solution should be followed up in order to carry out the derivation of KPIs from the modeled organizational objective.

Catalog of Patterns

In this Section, each pattern is explained in detail by using the structure defined by Martinez [36].

1) The leaf-attribute pattern.

Context

This pattern is applied when an *attribute-concept* is candidate for deriving a set of KPIs. An example of this structure is shown in Figure 5.

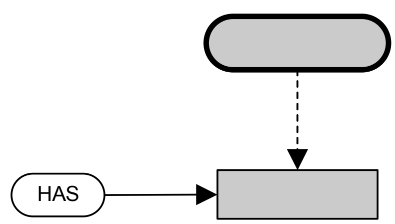

Fig. 5. Structure of leaf-attribute pattern. Source: The authors.

Problem

The problem relies on generating a set of KPIs from a candidate *attribute-concept*, which is determined by using the pattern 1. Also, the type of *achievement relationship*—improvement, maintenance, or accomplishment—linked to the concept should be identified. So, the appropriate KPI structure can be defined.

ISSN 2395-8618

Structure

The elements involved in this pattern are as follows:

Attribute-concept. The concept used for deriving the set of KPIs.

Achievement relationship. One of the relations linked to the concept. Such a relationship can be improvement-, maintenance-, or accomplishment-type.

Structural relationship. One of the relations linked to the concept. The type of this relationship is part/whole.

Solution

In this paper, the *achievement relationships* involved in the case study are treated as *improvement*-type. More detailed information about *achievement-type relationships* is provided by Lezcano [16]. The process for applying this pattern is as follows.

A KPI is obtained by writing a function name from the list: *amount of, average, maximum, minimum, number of*. Then, the label of the concept is added. Also, in case of *average* function, the KPI is formed as follows: writing "*average*" followed by the label of the concept and the word *per*. Then, the label of the source concept of the structural relationship is added. Similarly, when the function name is *amount of*, *maximum* or *minimum*, the KPI is formed by adding the word *per* and the label of the source concept in the structural relationship. Lastly, in case of *number of* function, the KPI is formed by writing *number of* followed by the label of the source concept, in the structural relationship—by using its plural form.

Example

The application of the *leaf-attribute pattern* (pattern 1) is illustrated in Figure 6.

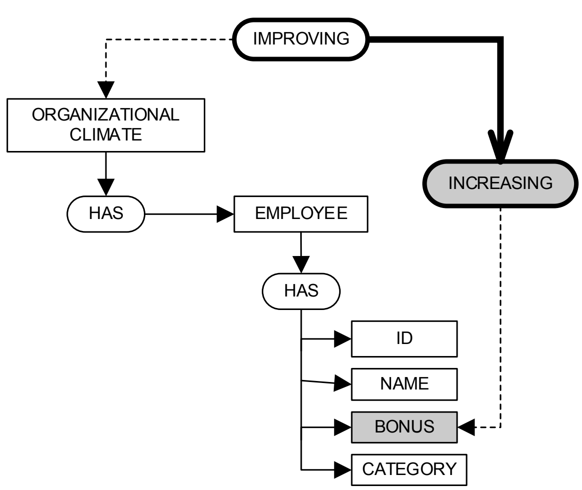

Fig. 6. Application of the leaf-attribute pattern. Source: The authors

A set of candidate KPIs is derived by following the process described by our proposal corresponding to pattern 1. As a result, the candidate KPIs are:

amount of BONUSES
maximum BONUS
minimum BONUS
amount of BONUSES per EMPLOYEE
maximum BONUSES per EMPLOYEE
minimum BONUSES per EMPLOYEE
average BONUSES
average BONUSES per EMPLOYEE
number of EMPLOYEES

2) The dynamic-relationship pattern.

Context

This pattern is applied when a *dynamic relationship* is a candidate for deriving a set of KPIs. An example of this structure is shown in Figure 7.

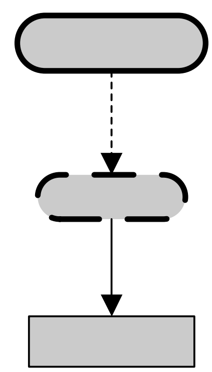

Fig. 7. Structure of dynamic-relationship pattern. Source: The authors

Problem

The problem relies on generating a set of KPIs from a candidate *dynamic relationship*, which is determined by using the pattern 2. Also, the type of *achievement relationship*—improvement, maintenance or accomplishment—linked to the concept should be identified. So, the appropriate KPI structure can be defined.

Structure

The elements involved in this pattern are as follows:

Concept. The target concept in the dynamic relationship.

Achievement relationship. The relation linked to the dynamic relationship. This relationship can be improvement-, maintenance-, or accomplishment-type.

Dynamic relationship. The relationship containing the action verb.

ISSN 2395-8618

Solution

In this paper, the *achievement relationships* involved in the case study are treated as *improvement*-type. More detailed information about *achievement-type relationships* is provided by Lezcano [16]. The process for applying this pattern is as follows.

A KPI is obtained by writing a function name from the list: *amount of* and *percentage of*. Then, the action verb is added by using its past participle. Lastly, the label of the target concept, in the dynamic relationship, is added.

Example

The application of the *dynamic-relationship pattern* is illustrated in Figure 8.

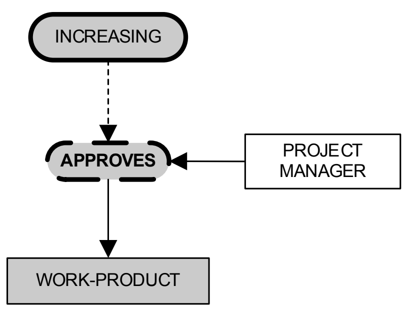

Fig. 8. Application of the dynamic-relationship pattern. Source: The authors

Figure 8 illustrates the occurrence of pattern 2, so a set of candidate KPIs is derived by following the process described in the solution Section corresponding to pattern 2. As a result, the candidate KPIs are:

amount of APPROVED WORK-PRODUCTS
percentage of APPROVED WORK-PRODUCTS

IV. Case Study

In this Section, we present a case study related to the organizational objective *IMPROVING SALES.* In this example, the domain related to such objective is modeled. So, *IMPROVING SALE* is represented by the achievement relationship IMPROVING and the class concept *SALE*. This organizational objective is in turn decomposed into two sub-objectives: *INCREASING REVENUES* and *INCREASING PRODUCT SELLING.*

After the relevant concepts and their relationships have been modeled, we can analyze the application of the proposed patterns. As a result, pattern 1 and pattern 2 are identified and a set of candidate KPIs are derived. This example is illustrated in Figure 9.

As a result, the set of candidate KPIs related to the organizational objective IMPROVING SALES are summarized in Table 2, including the pattern applied for selecting the candidate KPI.

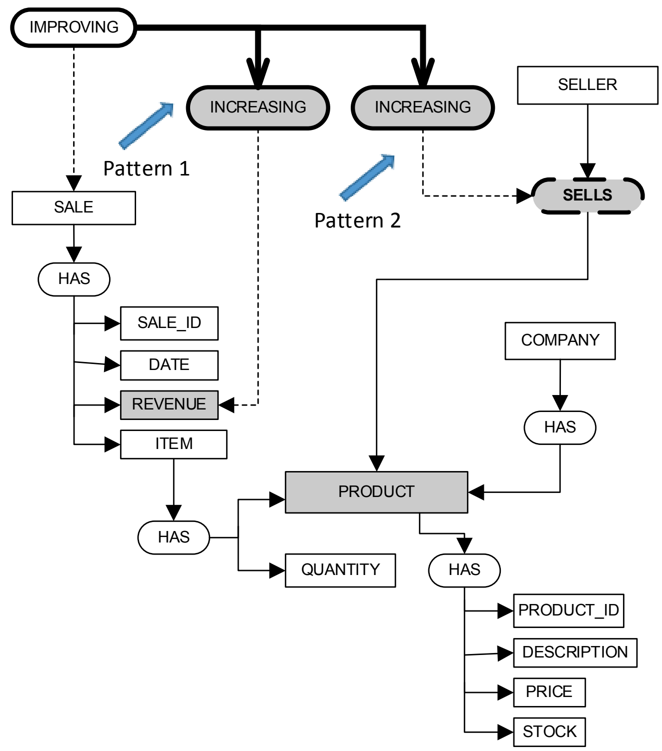

Figure 9. Application of the proposed method. Source: The authors.

TABLE II
Case Study About Candidate KPIs. Source: The authors

Candidate KPI	Pattern Applied
amount of REVENUES	1
maximum REVENUES	1
minimum REVENUES	1
average REVENUES per SALE	1
average REVENUES	1
amount of REVENUES per SALE	1
maximum REVENUES per SALE	1
minimum REVENUES per SALE	1
number of SALES	1
amount of SOLD PRODUCTS	2
percentage of SOLD PRODUCTS	2

V. Conclusions and Future Work

Strategic alignment involves holistic control of the organization. Such control should be assisted by appropriate methods that allow us to reason about the fulfillment of the organizational objectives. KPIs have demonstrated to be effective resources for assessing such fulfillment. By analyzing some contributions, we evidenced they exhibit some drawbacks for linking organizational objectives to KPIs. In this paper, we proposed a method based on patterns for deriving KPIs from organizational objectives as an appropriate solution for overcoming the identified drawbacks.

ISSN 2395-8618

Then, we demonstrated the application of the proposed method by using a lab study.

As a result, we experienced the advantages of using the pre-conceptual schemas as a mean for representing a particular domain. Such advantages rely on the proximity to the stakeholder language as well as the capacity for overcoming ambiguity problems. Moreover, the proposed patterns allowed for the derivation of candidate KPIs in a systematic way overcoming subjectivity problems. Thus, the use of such patterns demonstrated relevant advantages concerning the reuse, communication, and documentation of solutions to recurrent problems related to the generation of KPIs from goals.

Lastly, by applying the proposed method in this paper, the stakeholder is provided with a set of candidate KPIs intended to assess the fulfillment of the organizational objectives. Such KPIs are systematically obtained from a particular domain modeling, and they correspond with the own and specific needs an organization experiments. Since the candidate KPIs are systematically obtained, they can make aware the stakeholder about still undiscovered candidate KPIs.

Some lines of future work can be proposed: (i) the application of the proposed method on other different domains; (ii) the comparison of the results against the established indicators by specific frameworks; (iii) the full automation of the process for automatically deriving KPIs; (iv) the definition of new patterns for deriving candidate KPIs from goals; and (v) the automatic generation of source code from the candidate KPIs, to be included in the source code of the application to-be-developed.

REFERENCES

[1] M. Alyahya and M. A. Suhaimi, "A Conceptual Model for Business and Information Technology Strategic Alignment from the Perspective of Small and Medium Enterprises," *International Journal of Business, Humanities and Technology*, vol. 3, no. 7, pp. 83–90, 2013.

[2] C. Giannoulis, M. Petit, and J. Zdravkovic, "Modeling Business Strategy: A meta-model of Strategy Maps and Balance Scorecards," in *RCIS 2011: Research Challenges in Information Science*, France, 2013, pp. 1–6.

[3] A. Trendowicz, J. Heidrich, and K. Shintani, "Aligning Software Projects with Business Objectives," in *Joint Conference of the 21st International Workshop on Software Measurement and the 6th International Conference on Software Process and Product Measurement*, 2011.

[4] V. Basili, J. Heidrich, M. Lindvall, J. Münch, M. Regardie, D. Rombach, C. Seaman, and A. Trendowicz, "Linking Software Development and Business Strategy Through Measurement," *IEEE Computer*, vol. 43, no. 4, pp. 57-65, 2010.

[5] V. Basili, C. Lampasona, and A.E. Ocampo Ramírez, "Aligning Corporate and IT Goals and Strategies in the Oil and Gas Industry," in *PROFES 2013, LNCS 7983*, Springer-Verlag, 2013, pp. 184–198.

[6] F. Cosenz, "The Entrepreneurial University: A Preliminary Analysis Of The Main Managerial And Organisational Features Towards The Design Of Planning & Control Systems In European Academic Institutions," *Management Research and Practice*, vol. 5, no. 4, pp. 19-36, december, 2013.

[7] A. Kronz, "Managing of Process Key Performance Indicators as Part of the ARIS Methodology," *Corporate Performance Management: ARIS in Practice,* Springer-Verlag, pp. 31–44, 2006.

[8] HY. Wu, "Constructing a strategy map for banking institutions with key performance indicators of the balanced scorecard," *Evaluation and Program Planning,* vol. 35, pp.303–320, 2012.

[9] A. Shamsaei, A. Pourshahid, and D. Amyot, "Business Process Compliance Tracking Using Key Performance Indicators," *Lecture Notes in Business Information Processing*, pp. 73-84, 2011.

[10] A. Pourshahid, G. Richards, and D. Amyot, "Toward a goal-oriented, business intelligence decision-making framework," in *MCETECH 2011. LNBIP*, Heidelberg: Springer, 2011, vol. 78, pp. 100–115.

[11] D. Barone, L. Jiang, D. Amyot, and J. Mylopoulos, "Reasoning with Key Performance Indicators," *LNBIP*, ISSN: 1865-1348, vol. 92, pp. 82–96, 2011.

[12] A. Maté, J. Trujillo, and J. Mylopoulos, "Conceptualizing and Specifying Key Performance Indicators in Business Strategy Models," *LNCS*, ISSN: 0302-9743, pp. 282-291, 2012.

[13] S. Strecker, U. Frank, D. Heise, and H. Kattenstroth, "METRICM: a modeling method in support of the reflective design and use of performance measurement systems," *Inf Syst E-Bus Manage*, Springer Verlag, ISSN:1617-9854, pp. 241-276, 2012.

[14] U. Frank, D. Heise, H.Kattenstroth, and H. Schauer, "Designing and Utilising Business Indicator Systems within Enterprise Models – Outline of a Method," in *Modellierung Betrieblicher Informationssysteme (MobIS 2008)*, Germany, November 27-28, 2008.

[15] R. S. Kaplan, *Conceptual Foundations of the Balanced Scorecard*, Harvard Business School Accounting, 2010.

[16] L. A. Lezcano, "Elaboración Semiautomática de Diagrama de Objetivos," Ms.C. thesis, Universidad Nacional de Colombia, Colombia, 2007.

[17] V. Basili, A. Trendowicz, M. Kowalczyk, J. Heidrich, C. Seaman, J. Münch, and D. Rombach, "GQM+Strategies in a Nutshell. Aligning Organizations Through Measurement," *The Fraunhofer IESE Series on Software and Systems Engineering*, pp. 9-17, 2014. ISBN: 978-3-319-05046-1.

[18] L. Thevenet, "Modeling Strategic Alignment Using INSTAL," *Lecture Notes in Computer Science*, vol. 5232, pp. 261–271, 2011.

[19] K. Doumi, S. Baïna, and K. Baïna, "Modeling Approach Using Goal Modeling and Enterprise Architecture for Business IT Alignment," *Lecture Notes in Computer Science*, vol. 6918, pp. 249–261, 2011.

[20] C. Giannoulis, J. Zdravkovic, and M. Petit, "Model-Centric Strategy-IT Alignment:An Empirical Study in Progress," *Lecture Notes in Business Information Processing*, vol. 148, pp. 146-155, 2013.

[21] V. Popova and A. Sharpanskykh, "Modeling organizational performance indicators". Inf Syst. Elsevier. ISSN: 0306-4379, vol. 35 (4), pp. 505–527, 2010.

[22] C. M. Zapata, G. L. Giraldo, and S. Londoño, "Esquemas preconceptuales ejecutables," *Avances En Sistemas E Informática*, ISSN: 1657-7663 ed: Universidad Nacional De Colombia Sede Medellin, vol. 8, fasc.1, pp. 15-24, 2011.

[23] C. M. Zapata, A. Gelbukh, and F. Arango, "Pre-conceptual schema: A conceptual-graph-like knowledge representation for requirements elicitation," *Lecture Notes in Computer Science*, vol. 4293, pp. 17-27, 2006.

[24] E. Kavakli, "Goal-driven requirements engineering: Modeling and guidance," PhD thesis, University of Manchester, 1999.

[25] W. Engelsman, D. A. C. Quartel, H. Jonkers, and M. J. van Sinderen, "Extending enterprise architecture modelling with business goals and requirements," *Enterprise Information Systems*, vol. 5, pp. 9–36, 2011.

[26] E. Yu, M. Strohmaier, and X. Deng, "Exploring intentional modeling and analysis for enterprise architecture," in *Proceedings of the EDOC 2006 workshop on trends in enterprise architecture research (TEAR 2006)*, Hong Kong, Republic of China.

[27] J. L. De la Vara, J. Sánchez, and O. Pastor, "On the Use of Goal Models and Business Process Models for Elicitation of System Requirements,"

ISSN 2395-8618

Lecture Notes in Business Information Processing, vol. 147, pp. 168–183, 2013.

[28] G. Gröner, M. Asadi, B. Mohabbati, D. Gašević, F. Silva, and M. Bošković, "Validation of User Intentions in Process Models," *Lecture Notes in Computer Science*, vol. 7328, pp. 366–381, 2012.

[29] C. Giannoulis, M. Petit, and J. Zdravkovic, "Towards a Unified Business Strategy Language:A Meta-model of Strategy Maps," in *PoEM 2010, LNBIP,* 2010, vol. 68, pp. 205–216.

[30] R. S. Kaplan, and D. P. Norton, *Strategy Maps: Converting Intangible Assets into Tangible Outcomes*, Harvard Business School Publishing Corporation, 2004.

[31] I. Gmati, M. Missikoff, and S. Nurcan, "A Systematic Method for the Intentional Modeling and Verification of Business Applications," in *VII Conference of the Italian Chapter of AIS Information technology and Innovation trend in Organization*, Naples, Italy, 2010.

[32] E. Caputo, A. Corallo, E. Damiani, and G. Passiante, "KPI Modeling in MDA Perspective," *Lecture Notes in Computer Science*, pp. 384–393, 2010.

[33] A. Del-Río-Ortega, M. Resinas, C. Cabanillas, and A. Ruiz-cortéz, "On the definition and design-time analysis of process performance indicators," *Information Systems*, vol. 38, pp. 470–490, 2013.

[34] B. Wetzstein, Z. Ma, and F. Leymann, "Defining Process Performance Indicators : An Ontological Approach," *Lecture Notes in Business Information Processing*, pp. 227–238, 2008.

[35] C. Giannoulis, and J. Zdravkovic, "Modeling Strategy Maps and Balanced Scorecards using i*," in *iStar 2011*, Trento, Italy, 2011, pp. 90–95.

[36] A. Martinez, "Conceptual Schemas Generation from Organizational Models in an Automatic Software Production Process," Ph.D. thesis, Valencia University of Technology., Spain, and University of Trento, Italy, 2011.