A Quality Evaluation and Improvement Approach driven by Multilevel Goals and Strategy Patterns

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Abstract. In any organization, goals should not be established in an isolated manner. Moreover, in order to know if business goals are achieved, it should be necessary to consider information need goals that can also require satisfying measurement and evaluation goals at operational level. If measurement and evaluation goals are not aligned with tactical or strategic business goals, the organization can waste its effort and resources. Furthermore, to achieve a project goal, a strategy should be selected for applying activities and methods to the project life cycle. To deal with these issues in a systematic way, organizations should adopt a holistic approach. In this direction, we have developed a quality evaluation and improvement approach that considers and relates multilevel goals, projects, strategies and strategy patterns. This paper discusses a conceptual base for linking business goals concepts with project, strategies and non functional requirements concepts. It also defines the step by step of the proposed approach and illustrates it through a proof of concept.

Keywords: Ontology, Multilevel Goals, Evaluation, Project, Strategy Pattern.

1 Introduction

In any organization, project goals should not be established in an isolated manner. Commonly, organizations establish *business goals* at strategic, tactical and operational levels. Basili *et al.* [3] indicate that a critical issue in an organization is the lack of linkage between goals formulated at a strategic (or management) level with those at an operational (or project) level. The right establishment of business goals at different organizational levels determines much of the success in carrying out projects [15]. Therefore, if goals at an operational level are not in alignment with goals at tactical or strategic levels, the organization can direct its effort and resources in a wrong way.

Besides a business goal, it is also necessary to have valuable information which allows to know if the business goal was achieved. An *information need goal* is a support goal which is always related to a main or business goal. A particular kind of information need goal is the *measurement and evaluation (ME) information need*, which is driven by ME activities. In summary, information need goals permit learning or knowing the level of achievement of business goals as well as to give the necessary information to reach them.

On the other hand, the different goals established in an organization are operationalized through projects. Usually, project management allows planning, executing and controlling the activities and resources of the project regarding the adopted life cycle [16]. For a given project life cycle, strategies should be used in order to help in the goal achievement. A strategy defines a specific course of action to be followed. That is, it specifies what should be done and how should be performed. As pointed out in [14], it is desirable for a strategy to have three integrated capabilities, namely: process specifications, method specifications in addition to a well-established domain conceptual framework. Furthermore, we have defined a set of strategy patterns [17] for the measurement, evaluation and change (MEC) domain. A strategy pattern represents a reusable solution for instantiating the suitable ME/MEC strategy considering the project goal and quality views [18].

Regarding the above mentioned research ([3, 15, 16]) and issues, we also consider that it is paramount for software organizations to have a systematic approach which is able to establish and align goals at different organizational levels, and arrange work by means of projects and strategies for helping to reach these goals. So, we have developed a systematic approach that considers and relates multilevel goals, projects, strategies and strategy patterns, which is called the *Holistic Quality Evaluation and Improvement Approach* (hereafter Quality Evaluation Approach). This approach includes four key aspects or principles: i) the definition of multilevel business and information need goals; ii) the definition of ME/MEC projects; iii) the consideration of quality views and their relationships; iv) the adoption of ME/MEC strategy patterns for the instantiation of specific strategies.

These principles of the Quality Evaluation Approach rely on conceptual bases which are structured into ontologies. For instance, the C-INCAMI (*Contextual-Information Need, Concept Model, Attribute, Metric and Indicator*) conceptual framework [12] deals with the ME domain and represents components such as non-functional requirements, measurement and evaluation. More recently, we have developed the quality multiview modeling framework that includes an ontology of quality views [18]. A year ago, we added the goal and project components [19] in order to strengthen the C-INCAMI framework and to link business and information need goal concepts with project, strategy and non-functional requirements concepts.

The contribution of this paper is twofold: First, to specify some new terms included into the goal and project components such as organizational level types and strategy pattern, which were left implicit in [19]. Second, to define the step by step of the Quality Evaluation Approach which links business goals at different organizational levels with ME information need goals regarding the instantiation of strategy patterns. Also, through a proof of concept the step by step is illustrated.

The rest of the paper is organized as follows: Section 2 analyzes related work on ME/MEC approaches and strategies that consider multilevel goals, which in turn are supported by conceptual bases. Section 3 deals with the goal and project components and their relations with the C-INCAMI components. Section 4 defines the step by step of our approach and illustrates its applicability through a proof of concept using the improvement of the Facebook mobile app as scenario. Finally, Section 5 summarizes the main contributions and outlines future research.

2   Related Work

In Software Engineering there exists research that addresses the importance of the alignment of measurement goals (at an operational level) with business goals of higher organizational levels, such as tactical and strategic levels [1, 3, 7, 15]. This alignment is paramount for decision making since ME information need goals give meaningful information to know in what extent a business goal has been achieved. In some cases, it also gives information on how to reach the goal. But reviewing the related literature in the area, we have not detected approaches with robust conceptual bases (i.e., ontologies) that integrate terms such as *business goal, organizational level*, *information need and ME information need goal, strategy, strategy pattern, project, MEC project*, among others, except in Barcellos *et al.* [1], which include some of these terms. On the other hand, considering that a strategy is an important resource in helping to achieve project goals, it should be noted that there exist few strategies that integrate the three abovementioned capabilities, as discussed in [14].

An approach related to integrated strategies is *GQM⁺Strategies* [3]. It includes a goal-oriented framework for the design and implementation of measurement software projects at different organizational levels. Unlike its predecessor, *GQM* [2], the business goals that *GQM⁺Strategies* defines can be aligned at different organizational levels through the establishment of strategies. In [3], strategies define objectives for reaching goals and require the definition and fulfillment of lower level goals. Therefore, business goals are linked to measurement goals using *GQM*. *GQM⁺Strategies* has a terminological base structured as a glossary where the main used terms are defined. But it lacks the semantic richness that an ontology provides.

Another related work is the *Goal-Driven Measurement* approach [15], which describes a process for the definition of measurement goals aimed at helping to understand aspects of the organizational goals. The process begins indicating that the organization should establish business goals at any organizational level. From these goals, questions or issues related to what stakeholders want to know or learn emerge. These issues allow identifying quantitative information through the decomposition of the business goal into related subgoals. With the list of subgoals and issues, entities and attributes are identified, following the *GQM* model and templates. This approach offers guidelines that serve as an important reference for engineers and practitioners, since these detail the measurement process through the goal decomposition to the measure quantification and analysis. It also uses the terms that *GQM* defines, but specific concepts such as *business goal*, *organizational level*, *information need goal*, *strategy* and *strategy pattern*, among others, are not explicitly defined.

Additionally, Goethert and Fisher [7] describe the *GQ(I)M* (*Goal-Question-Indicator-Measurement*) approach that combines the most prominent aspect of the strategy described in [15] with the *Balanced Scorecard* [10] paradigm for the decomposition of strategic goals into subgoals. *GQ(I)M* approach is used to establish organizational goals systematically for each quadrant that *Balanced Scorecard* defines. Also, it helps identifying and defining measures and indicators. *GQ(I)M* includes a glossary with the definition of some terms, which are not present in *GQM*. It is worthy to remark that *GQ(I)M* does not stress on the use of integrated strategies

to fulfill business goals from information need goals, nor considers strategy patterns as it is addressed in our approach.

Lastly, Barcellos *et al.* [1] define a measurement goal subontology. They argue that the measurement should be aligned with organizational goals in order to produce useful data for decision making. This contains terms, relations and restrictions related with measurement, goal and organization concepts. Also authors state that indicators are the measures which can be used to assess the level of goal achievement. However, the use of strategies are not described. Unlike [1], our proposal formally establishes the use of integrated strategies for helping to achieve both business and information need goals. Moreover, our approach specifies ME information need goals as well, which are linked to information need and business goals.

The business goal subontology specified in the next section discusses some concepts which are not modeled in [19]. For example, the strategy pattern concept which represents a knowledge asset. A ME/MEC strategy pattern embeds a reusable and customizable solution for a recurrent ME/MEC project problem in similar contexts. Likewise the process guideline offered in [15], we describe the step-by-step applicability of our approach, which in [19] was not explicitly considered.

3 Linking Business and Information Need Goals with Project, Strategy, and Strategy Pattern: A Conceptual Base

In the Introduction Section, we stated that our Quality Evaluation Approach relies on ontologies as a way to formally define the terms and relationships involved in quality measurement, evaluation and improvement issues. Originally, the C-INCAMI conceptual framework was composed of six conceptual components such as *non-functional requirements, measurement, evaluation, context, quality view* and *project* (see these packages in Fig. 1). The terms, attributes and relationships of these components arose from the ME ontology documented in [11, 12] and from the quality view ontology formalized in [18]. Also the *measurement* and *evaluation* components were semantically enriched by the process ontology presented in [4].

Recently, in [19], we have argued that C-INCAMI had not the necessary terms for linking ME information need goals with business goals. This is important for representing the alignment between goals at different organizational levels. Hence, we have added the *business goal* component and enlarged the *project* component (see Fig. 1). Basically, these components specify both business and information need goals at different organizational levels, which can be operationalized by projects and achieved by means of strategies. The terms, attributes and relationships of these conceptual bases were defined considering documents such as [1, 3, 5, 8, 9, 16] with the aim of having some adherence or contrast to well-known sources. However, in [19] a couple of terms were left implicit.

In Fig. 1, we include the added terms for the *business goal* and *project* components such as organizational level types and strategy pattern in addition to the previous ones. In tables 1, 2 and 3 the definition of terms, relationships and attributes of these subontologies are presented. In the sequel, descriptions of these terms are made. Note that terms are highlighted in *italic* the first time they appear in the text.
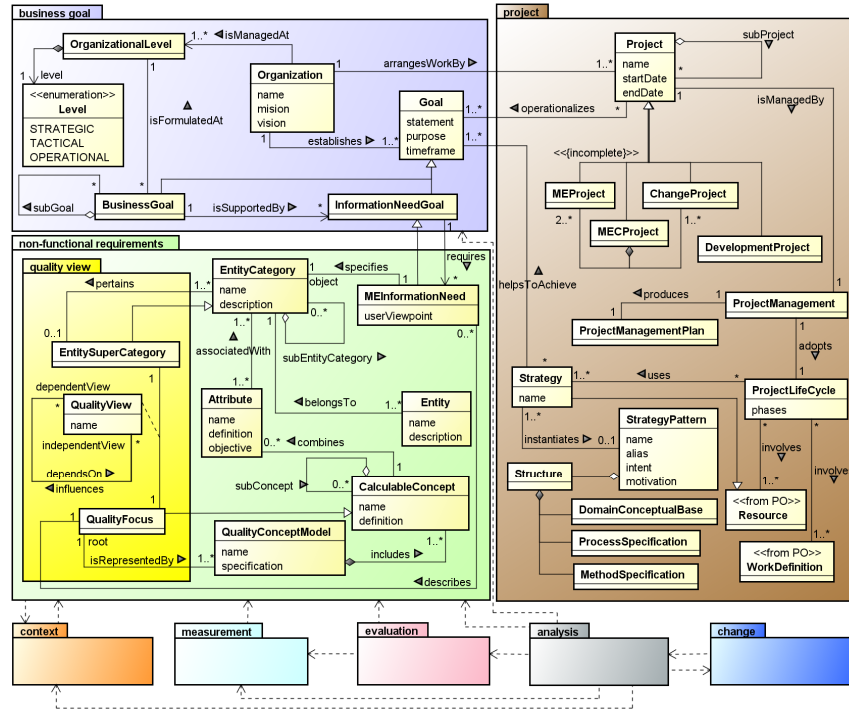
Fig. 1. Key concepts from the business goal domain (*business goal* package) and related relationships with some concepts for the project and non-functional requirements domains (*project* and *non-functional requirements* packages). Note: PO means Process Ontology; ME, Measurement and Evaluation; and MEC, Measurement, Evaluation and Change.

An *organization* is an entity that comprises people and is structured and managed to establish and pursue *goals*. The organization *establishes* goals which contain an explicit declaration (*statement*) about the major *purpose* that should be achieved in a period of time (*timeframe*). The purpose of a goal is the rationale for achieving it (e.g., to understand, improve and predict). The established time frame for the achievement of a goal can range from short and medium term to long term. Also, goals can be classified into *business* and *information need goals*. Business goals are the main or principal goals that an organization sets considering its *mission* and *vision*. Goals can be formulated at different *organizational levels*. An organizational level represents a management and decision-making level. Commonly, three levels are identified in the literature [3, 10] such as *strategic*, *tactical* and *operational* levels. In turn, a business goal can be divided into business *subgoals*.

On the other hand, information need goals are support goals for business goals. Usually, they provide useful information in order to know the degree of achievement of business goals. An information need goal can also require *ME information need goals*. The latter is a more specific type of information need goal which is driven by ME activities. Note that a ME information need specifies an object to be evaluated (entity category) considering also a quality focus (see the *non-functional*

requirements and *quality view* components in Fig. 1).

An organization *arranges work by* means of *projects*, which allow operationalizing the established organizational goals. There exist different types of projects such as development, maintenance, among others. For example, a *development project operationalizes* a business goal that has as purpose to build a new software product or system. Particularly, in this work we focus on ME projects, which operationalize ME information need goals, as well as on MEC projects which operationalize both business goals and their related ME information need goals with the purpose of improvement. Fig. 1 shows that a *MEC project* is composed by a ME subproject and a change subproject in which changes are driven by measurement and evaluation. A *change project* operationalizes a business goal with the purpose of changing or improving the current state of an entity.

Additionally, *project management* is the set of processes aimed to achieve the project goal. In [16], it is defined as "*the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements*". The project management process *produces* a *project management plan*, that is, the document which describes how the project should be executed, monitored and controlled. Besides, a project *adopts* a *project life cycle* which indicates the stages the project goes through from its beginning to its end. The project life cycle *involves* at least *resources* and *work definition*s and *uses* strategies. In [4], we have defined the *strategy* term so we consider that definition in Table 1. Hence, a strategy is a resourc*e* which *helps to achieve* a goal.

It is worthy to remark that our main line of research was devoted to ME or MEC strategies. Therefore, our developed strategies are intended to help to reach goals that are operationalized by ME or MEC projects. In addition to strategies, we have built recently a set of strategy patterns [17]. A strategy pattern is a knowledge asset that includes a reusable and customizable solution to a recurrent project problem in similar situations. Particularly, a ME/MEC strategy pattern is a reusable and customizable solution which deals with ME/MEC project problems. Fig. 1 shows that a strategy may *instantiate* a *strategy pattern*. In turn, a strategy pattern has a *structure* compound of three integrated capabilities, namely: 1) the *domain conceptual base*, 2) *process specifications*, and 3) *method specifications*. The domain conceptual base embraces a terminological base for a given domain, e.g., the ME domain. The second capability describes what to do by means of a model which relates a set of process elements such as activities, tasks, inputs, outputs, pre- and post-conditions, artefacts and roles. A process specification can also consider different process perspectives [4, 6]. The third capability represents how an activity should be carry out using a method specification based on a procedure and rules.

Finally, note that the terms included in the business goal component are the minimum and necessary ones for describing goals. The same occurs with the project component which relates terms as project, strategy and strategy pattern. The reader can surmise that, for instance, for the project management term there could be more specific related terms, but are not represented in our subontology due to its intended scope and objective. In Section 4, we instantiate these key terms for a MEC project, aimed at illustrating the steps of our approach.

Table 1. Term definitions for the *business goal* and *project* subontologies.

Term	Definition
Business Goal	It is a main or primary Goal that the Organization intends to achieve.
Change Project	It is a Project for operationalizing a Business Goal with the purpose of changing the current state of an entity. <u>Note</u>: Different kinds of changes (e.g., adaptive, perfective, corrective changes) can be made in maintenance projects. Also, changes can be made on entities in development projects.
Development Project	It is a Project for operationalizing a main Business Goal with the purpose of building a new product or system.
Domain Conceptual Base	It is a terminological base in which, for a given domain, the main terms or concepts are explicitly defined. <u>Note</u>: A Conceptual Base can be structured for instance in a glossary, taxonomy, or ontology, amongst other ways.
Goal (synonym **Objective**)	The statement of the aim to be achieved by the Organization which considers the propositional content of a purpose in a given time frame.
Information Need Goal	It is a Goal intended to get insight for a given Business Goal. <u>Note</u>: Information Need, as per [9], is defined as "Insight necessary to manage objectives, goals, risks, and problems".
MEC Project	It is a Project for operationalizing a Business Goal with the purpose of improving an entity by performing ME-driven changes. <u>Note</u>: A MEC Project comprises both Change and ME Projects.
ME Information Need	It is an Information Need Goal driven by measurement and evaluation activities.
ME Project	It is a Project for operationalizing a ME Information Need.
Method Specification	It is the representation of a method. <u>Note 1</u>: Method is the specific and particular way to perform the specified steps in the description of a Work Definition. <u>Note 2</u>: The specific and particular way of a Method –i.e., how the described steps in a work definition should be made- is represented by a procedure and rules [4].
Organization	It is an entity comprising people that is structured and managed to establish and pursue organizational Goals and is affected by and affects to its environment or context. <u>Note</u>: Most organizations have a level-oriented management structure that determines relationships between the different members and the activities, and subdivides and assigns roles and authority to perform different tasks.
Organizational Level	It represents a management and decision-making level in which Organization's Business Goals are formulated and Information Need Goals are taken into account. <u>Note</u>: Usually, long-term Business Goals are formulated at strategic Organizational Level, while short-term Business Goals are formulated at operational Organizational Level.
Process Specification	It is a model which relates a set of process elements such as activities, tasks, inputs and outputs, pre- and post-conditions, artifacts, roles, amongst others. <u>Note 1</u>: A process specification can consider different process perspectives such as functional, behavioral, informational and organizational [6]. <u>Note 2</u>: Usually, process specifications primarily state what to do rather than to represent how to do activity descriptions.
Project	It is an entity representing a temporary and goal-oriented endeavor with definite start and finish dates, which considers a managed set of interrelated activities, tasks and resources aimed at producing and modifying unique work products (i.e., artifacts, services or results) for satisfying a given requester need.
Project Life Cycle	The series of phases that a Project passes through from its initiation to its closure [16]. <u>Note</u>: Examples of phases to be managed in any Project are planning, scheduling, monitoring, among others.

Project Management	It is the set of managerial processes and activities intended to achieve the Goal operationalized by a Project. <u>Note</u>: The application of knowledge, skills, tools, and techniques to project activities to meet the project requirements, as per [16].
Project Management Plan	The document that describes how the Project will be executed, monitored, and controlled [16].
Resource	Asset assigned to a Work Definition. <u>Note</u>: An asset is an entity (e.g., agent, people, Strategy, method, tool, etc.) with added value for an Organization [4].
Strategy	Principles, patterns, and particular domain concepts and framework that can be specified by a set of core processes, in addition to a set of appropriated methods and tools, as core Resources, for helping to achieve the Project's Goal.
Strategy Pattern	It is a knowledge asset that includes a reusable and customizable solution to a recurrent project problem in similar situations. <u>Note</u>: A MEC strategy pattern is a reusable and customizable solution which deals with MEC project problems.
(Strategy Pattern) Structure	Generic and instantiable solution that the strategy pattern offers. <u>Note</u>: The structure of a strategy pattern aggregates three capabilities simultaneously, namely: (i) a domain conceptual base; (ii) process perspective specifications; and, (iii) method specifications [14].
Work Definition	Abstract entity which describes the work by means of consumed and produced work products, conditions and involved roles. <u>Note</u>: Work represents a process, an activity or a task [4].

Table 2. Some relationship definitions for the *business goal* and *project* subontologies.

Relationship	Definition
arrangesWork By	An Organization organizes its work or effort by means of Projects for the achievement of its established Goals.
establishes	An Organization *establishes* and pursues Goals as part of its Mission, and in alignment with its Vision.
helpsToAchieve	A Strategy gives support for achieving one or more organizational Goals.
instantiates	A Strategy can *instantiate* none or one Strategy Pattern.
involves	The realization of a Project Life Cycle *involves* Resources and Work Definitions, among other aspects.
isManagedAt	An Organization *is managed at* different Organizational Levels, such as strategic, tactical and operational levels.
produces	A Project Management process *produces* a Project Management Plan as artifact.
subGoal	A Business Goal can be divided into *sub-goals*, which are in turn Business Goals at lower granularity levels.
uses	A Project Life Cycle *uses* one or more Strategies.

Table 3. Some attribute definitions for the *business goal* and *project* subontologies.

Term	Attribute	Definition
Goal	**statement**	An explicit declaration of the aim to be achieved. <u>Note</u>: A statement is usually a written assertion in a high-level or natural language.
	purpose	The rationale for achieving a specified Goal. <u>Note</u>: Examples of ME Information Need's specific purposes are: understand, improve, etc.
	timeframe	A set period of time in which the Goal is pursued or is expected to be achieved. <u>Note</u>: A timeframe of a Goal can range from short-, mid-term to long-term period of time.
Organization	**mission**	It states the organization's core purpose and focus. <u>Note</u>: A mission statement normally remains unchanged over time.
	vision	It describes what an organization wants to aspire to, and what specific

		motivation binds together the organization's stakeholders. <u>Note</u>: A vision reflects the realization of the organization's values.
Organizational Level	**level**	It represents a specific level in which an Organization's Business Goals are formulated and Information Need Goals are taken into account. <u>Note 1</u>: Commonly, three levels are identified in the literature such as STRATEGIC, TACTICAL and OPERATIONAL levels [10]. Regarding [3] different goals exist at different levels of an organization such as the management level, the department level, the project level. These levels match to a great extent with the above mentioned levels. <u>Note 2</u>: Usually, a long-term Business Goal is formulated at a Strategic Level, while a short- or mid-term Business Goal is formulated at an Operational or Tactical Level.
Strategy	**name**	Label or name of the Strategy to be identified.
Strategy Pattern	**name**	A descriptive and unique name. Note: The label or name is usually expressed in English.
	alias	Acronym or other names for the strategy pattern.
	intent	Main objective for the strategy pattern.
	motivation	Project problem/goal solved by the strategy pattern.

4   Step-by-step Applicability of the Approach

As commented in the Introduction Section, we consider software organizations should foster a systematic approach which is able to establish and align goals at different organizational levels, and arrange work by means of projects and strategies for helping to reach these goals. In this direction, we have developed the Holistic Quality Evaluation and Improvement Approach. This approach is based on four principles, viz. i) the definition of multilevel business and information need goals; ii) the definition of ME/MEC projects; iii) the consideration of quality views and their relationships; iv) the adoption of ME/MEC strategy patterns for the instantiation of specific strategies. It also relies on conceptual bases (subontologies) related to these aspects as analyzed in Section 3.

   In this Section, we present the step by step of our approach which defines the necessary activities to establish goals and projects at different organizational levels. The step-by-step applicability can help stakeholders in the process of deriving business goals into ME information need goals in addition to formulate and perform ME/MEC projects. Next, we list the approach main steps (S) or activities:

   S.1. Establish a business goal at any organizational level.
   S.2. Refine the business goal, if necessary, in tactical/operational business goals.
   S.3. Establish information need goals for each business goal at the corresponding
         organizational level.
   S.4. Formulate ME/MEC projects for those goals that require ME activities.
         S.4.1. Select a strategy pattern for each ME/MEC project. For this selection, look at
               the amount of quality views and purpose involved in the project's goal statement.
         S.4.2. Per each selected strategy pattern, identify the concrete ME information
               need/business goals from the pattern process specification.
         S.4.3 Instantiate a strategy appropriately from each strategy pattern. Also, schedule
               this resource into the project life cycle accordingly.
   S.5. Perform the ME/MEC projects.
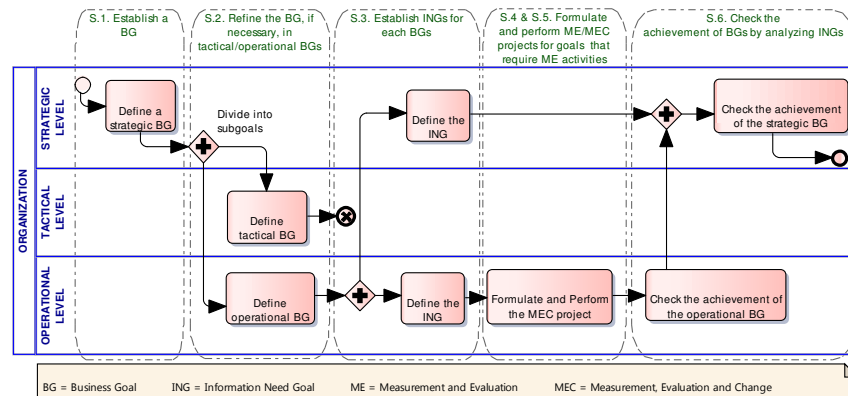   S.6. Check the achievement of business goals by analyzing information need goals.

Fig. 2. Main instantiated activities of the *Quality Evaluation Approach* for the Facebook mobileapp scenario, using BPMN.

To illustrate this process, we employ a proof of concept for the evaluation and improvement of the Facebook mobile app considering multilevel goals, a specific strategy and its corresponding strategy pattern. This particular scenario is shown in Fig. 2 using BPMN (*Business Process Model and Notation*). Also, many terms of the proposed components are instantiated in Fig. 3 and 4 following the same scenario.

Let's suppose "*Facebook Inc.*" organization establishes at strategic level (S.1 in Fig. 2) the following business goal "*Increase 20% the number of the Facebook mobile app' users for the 2016 year*", which is operationalized by a specific project (see also Fig. 3). For this business goal, two business subgoals are established in S.2:

(a) "*Increase 5% the Facebook mobileapp advertising*" (at tactical level), and;
(b) "*Improve 10% the Facebook mobileapp usability in 6 months*" (at operational level).

With regard to the (b) business subgoal, it can be achieved by making changes on the Facebook mobile app, which are driven by ME activities. Therefore, this subgoal is operationalized by a MEC project (see Fig. 3). To give supporting information to this business subgoal an information need goal can be established in S.3. E.g., "*Analyze if usability has improved 10% after changes*" across the 6-month time frame. This information need subgoal will allow to understand the extent the (b) business subgoal has been achieved after making MEC activities. Notice that the (a) business subgoal here is not analyzed since surely it will require subgoals, projects and strategies related to the marketing area, which is outside the scope of this article. Consequently, in Fig. 2 its respective step for the information need goal is not modeled.

Going a step forward (S.4.1), a strategy pattern may be selected for the (b) subgoal. To this end, the business goal *statement* ("*Improve 10% the Facebook mobileapp usability in 6 months*"), which embeds the "improve" *purpose* is compared against the *intent* field in the template of each strategy pattern stored in the catalog. After performing this matching -which also considers the amount of quality views, as we see later on- the selection of the suitable strategy pattern is made.
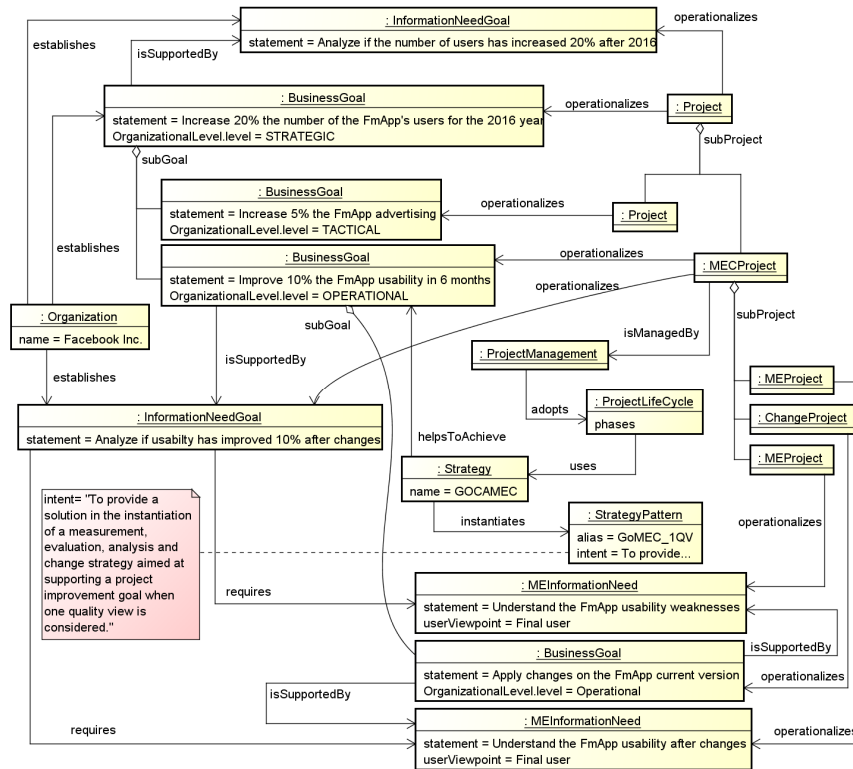
Fig. 3. Scenario instantiation where a *Business Goal* from the strategic level is decomposed in subgoals which are supported by *Information Need Goals* and *ME Information Need Goals*. Note: FmApp means *Facebook mobile Application* and ME, *Measurement and Evaluation.*

Specifically, the "*Improve 10% the Facebook mobileapp usability...*" statement in the (b) business subgoal involves one quality view, i.e., the "System Quality View". This is so, because the stated concrete entity is the "Facebook mobile app" that belongs to the "System" entity category, and "Usability" that is related to the "External Quality" focus. Therefore, GoMEC_1QV (*Goal-oriented Measurement, Evaluation and Change for one Quality View*) [17] is the suitable strategy pattern to be selected. This pattern is applicable to MEC projects in which the purpose is to understand and improve the quality focus of the evaluated entity for one quality view, such as Resource, Product, System and System-in-Use Quality Views.

Once S.4.1 was performed, the S.4.2 step considers the ME information need/business goals that the pattern process specification determines. Basically, GoMEC_1QV establishes three subgoals viz. (i) understand the current quality state of the entity, (ii) make changes on it, and (iii) understand the ulterior quality state (the improvement) after changes.

Particularly, in Fig. 3, the three concrete ME information need/business goals are:

(i) "*Understand the Facebook mobile app usability weaknesses*", (ii) "*Apply changes on the Facebook mobile app current version*", and (iii) "*Understand the Facebook mobile app usability after changes*". Analyzing this figure, we also see that the (ii) subgoal is a business goal, which is operationalized by a change project, while the rest of the subgoals are ME information need goals, which are operationalized by ME projects. In consequence, the three subprojects compose the MEC project which is carried out by using a particular strategy.

In the S.4.3 step, we use the GOCAMEC (*Goal-Oriented Context-Aware Measurement, Evaluation and Change*) strategy that instantiates the GoMEC_1QV strategy pattern. GOCAMEC personalizes the process and method specifications defined in this pattern. Additionally, a particular strategy considers as well the conceptual base capability that a strategy pattern specifies.

In order to illustrate the above (i) ME information need goal, Fig. 4 instantiates some terms of the *quality_view* and *non-functional requirements* components, which were specified in Fig. 1. For the "*Understand the Facebook mobile app usability weaknesses*" subgoal, the quality focus is "*External Quality*". This focus is represented by a quality model which includes the "*Usability*" characteristic (Calculable Concept), as well as the "*Understandability*" and "*Operability*" subcharacteristics. In turn, subcharacteristics combine attributes. Note that Fig. 4 includes just one attribute in order not to clutter the diagram (the complete requirements tree for this case study can be found in [13]).
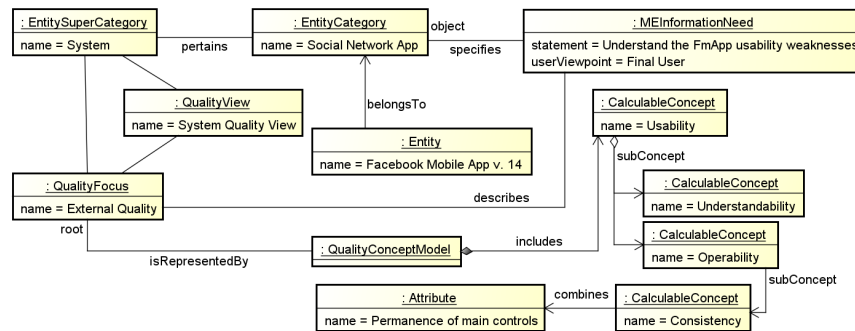

Fig. 4. Instantiation of terms for the *quality_view* and *non-functional requirements* components for the given *ME Information Need Goal*. Note: FmApp means *Facebook mobile Application* and ME, *Measurement and Evaluation.*

Furthermore, the above ME information need also specifies the object to be evaluated, which is the "*Social network application*". This is an instance of the entity category which pertains to the "*System*" entity super category. Finally, the association between the quality focus and the entity super category determines the quality view. For our proof of concept, we instantiated the "*System Quality*" view.

Once the ME/MEC projects, for those goals that require ME activities were planned and scheduled -by assigning resources such as the suitable strategies-, the S.5 step is performed.

Lastly, in the S.6 step, evaluators should check the achievement of business goals

by analyzing information need goals. In our approach, this is a bottom-up analysis in which the interpretation of the information need goal at operational level allows to inform not only that level, but also higher levels as the information is aggregated and rolled up. To our scenario, using the measure and indicator values that the MEC project yielded, we can "*analyze if usability has improved 10% after changes*" and then to understand if the linked business subgoal, i.e., "*improve 10% the Facebook mobile app usability in 6 months*" has been achieved. If the case were that it was not achieved and there would be time within the 6-month time frame, a new change and evaluation cycle can be performed using the GOCAMEC strategy again.

Ultimately, because all multilevel goals are to some extent linked, measurement, evaluation and improvement planning and results are organization-wide rather than limited to a single project or department, as Basili *et al.* state in [3].

5   Conclusions and Future Work

In this article, we have presented an evaluation and improvement approach which considers the linkage between operational ME information need goals with business goals at different organizational levels.

Regarding the first contribution listed in the Introduction Section, we have enhanced the conceptual base of the Quality Evaluation Approach by including for instance the strategy pattern term and organizational level types in the *business goal* and *project* components. It is important to remark that this conceptual base is structured in subontologies. Considering their scope, the terms included in the goal and project components are the minimum and necessary ones for describing goals, projects, strategies and strategy patterns. Ultimately, they are aimed at adding conceptual robustness to our approach in addition to the ability to support semantic processability, among other benefits. Regarding the second contribution, we have also defined and illustrated the step-by-step applicability of our approach which links business goals at different organizational levels with ME information need goals regarding the instantiation of strategy patterns.

Although there are a couple of relevant references for the business goal alignment, as those analyzed in the Related Work Section, the approach we have proposed formally establishes the use of integrated strategies for helping to achieve both business and information need goals. Also, our approach specifies ME information need goals as well, which are linked to information need and business goals. Furthermore, the approach fosters the use of strategy patterns as a reusable solution for instantiating the suitable ME/MEC strategy considering the project's goal statement and the strategy pattern intent.

As a final remark, this work pursues the idea that measurement and evaluation should not be an end in itself but a key factor to reach information need and business goals in an organization. As pointed out in [3], "*quantitative data is a prerequisite to understanding the relationships between the business and project-level goals and verifying the achievement of objectives*".

Considering the semantic processability, an ongoing work is the development of a strategy pattern recommender system as a practical use of subontologies. This

recommender system can be useful when an organization establishes ME/MEC projects. Hence, considering the project's goal statement and the strategy pattern intent, the recommender system will suggest the suitable strategy pattern that fits better to the project. Consequently, the particular strategy will be easier to instantiate.

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