Exploring a Three-dimensional, Requirements-based, Balanced Scorecard Business Model

On the Elicitation and Generation of a Business Model Canvas

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Abstract—Business models play a pivotal role in organizations, building bridges and enabling dialogue between business and technological worlds. Also, goals and rules associate with processes to compose its base structure, driving and supporting the organization’s strategy. Additionally, as balanced scorecards are the reference in strategy management, a combination of these three dimensions can lead to a stronger, more strategy-oriented, business model, aggregating functional, nonfunctional and strategy dimensions. Following our proposal for the specification of a three-dimensional business model, covering the elicitation of business goals and rules from process-level use cases, and their connection to balanced scorecard, we now aim to explore it with a practical application scenario. Taking advantage of a cube structure and a method definition within a SPEM approach, which is adaptable to model variations, our proposal allows for the use of different viewpoints to perform diverse business model transformations. In this paper we apply our proposal twice by revisiting a project of a two-step elicitation and generation of a business model canvas.

Keywords—Business Model, Use Cases, Goals and Rules, Strategy, Balanced Scorecard, Three-dimensional

I. INTRODUCTION

Business models (BM) play an ever more pivotal role in the development and continued management of information systems (IS/IT). The BM artifact, as a conceptual tool that contains a set of elements and their relationships, expressing the business logic of a specific firm and the value it offers, is seen as crucial for improving the dialogue between business and IS/IT. Our recent work in generating a business model canvas through elicitation of business goals and rules from process-level use cases, using the balanced scorecard (BSC) as an intermediary, stands as a contribution inside this topic [1].

The use of process-level use cases, together with business goals and rules associated information (PGR), integrating functional and nonfunctional perspectives, allowed developing an activity direct-mapped BM to present to stakeholders for validation. Nevertheless, it is not easily understood by different users, due to the diverse concepts involved and representations of the different perspectives. Recent research results over the BSC, when linking organizations strategy and operations [2], and its contribution inside the IS/IT area, in order to strengthen its alignment with business [3], support the importance and relevance of the BSC contribution to our proposals.

The relation between functional, nonfunctional and BSC perspectives can be viewed as a three-dimensional reality, lifting views from the plain one-dimensional prescriptions [4]. This added to the comfort perceptions presented to users by cube-like structures ([5], [6]), led us to propose a similar approach regarding the generation of a business model. Recurring to the requirements-based, two-dimensional PGR metamodel [7] and by extending it with BSC as its third dimension, we proposed a solution for the representation of the three related perspectives in a cube like structure, following those three axis, the PGR-BSC Cube [8].

This aids in the definition of general approaches and overall principles to assist analysts in better handling and understanding domain needs, as, in the end, only the experienced analyst perceives intuitively which method or technique is effective, in each circumstance, and is able to apply it. The main objective for this cube is that it can be understood and handled by different users, for diverse visualization and processing purposes. Also, as the entire method follows a model-based approach, the operationalization can be traced back and forth through the different perspectives, allowing for requirements traceability and a business-IS/IT aligned solution, while facilitating future tool development. To further support this solution, it has associated a specification of its method in the Software and Systems Process Engineering Metamodel (SPEM) [9].

In this paper we aim to explore the PGR-BSC Cube proposal, by further detailing its metamodel and associated method, and demonstrate its use by applying it in revisiting a project for the elicitation and generation of a business model canvas. There our method is tailored to specific visualization and processing objectives, according to each intended use.

This document follows with background research reviews on the current standpoints of business models, and functional and nonfunctional requirements elicitation, in section II. Next, section III details our PGR-BSC Cube proposal for a metamodel representation of its associated cube structure, added to the specification of a tailorable method to handle their visualization and processing. Then, in section IV, our proposal is applied twice in a revisited project, and in section V we discuss and frame our proposal inside the related work in the area, analyze contributions and envision the future work ahead. Finally, some conclusions are drawn for this paper.
II. BACKGROUND

This section presents related research regarding functional and nonfunctional requirements elicitation, and also business model representation approaches. For the business model topic, it focuses on the Business Model Canvas (BMC) [10] and the Balanced Scorecard (BSC) [11], but mainly in the BSC evolutions, due to their popularity and close relation. Regarding the functional requirements we center our attention on use cases (UC) models, defined inside the Unified Modeling Language (UML) [12], while for nonfunctional requirements we proclaim the use of goals and rules, associated to the business plans representation of the Business Motivation Model (BMM) [13]. This is due to its complete and business oriented side, which helps in defining the business requirements specification for business modeling.

As requirements engineering is constantly evolving, evermore there are implications of new principles, counting on new practices and realities as the integration of enterprise-level and nonfunctional requirements. These new ways approach requirements design with key principles as intertwining requirements and contexts, and evolving designs and ecologies. By managing through architectures and recognizing complexity, they move towards evolutionary platforms defined by complex consumption and production realities [14].

Alongside, there are challenges on how to tackle business semantics, which is often culture dependent, and the intercultural competencies necessary for requirements engineers operating in these environments. New techniques need to focus not only on the target technical system but also on the interplay between business and system functionality. Here, the four perspectives of BSC present themselves as an improvement on purely linguistic-based approaches, helping to bridge the communication gap between stakeholders and business analysts, and also the understanding of interrelations between strategic goals and system functionality [15].

A. Business Models

The BMC, a strategic management template for developing new or documenting existing business models, currently stands out as one of the preferred tools for their generation, especially in business related audiences. The BMC is based on the Business Model Ontology proposed by [10], where the formal descriptions of the business become the building blocks for its activities, which in turn was based on the BSC [11]. BMC and BSC are two different but complementary tools to achieve innovation, tactical directions and action plans in an existing or planned organization. While BMC determines part of the business strategy, BSC is aimed to track implementation and ensure that the organization strategy is executed.

The BSC stands as a reference in the strategy definition and orientation of an organization, being closely related to its business model. Its use has been increasing, within varying degrees of adaptation, as a number of organizations are actively using it to link their strategy and operations. Nevertheless, there is no warranty whether BSC can effectively enable strategy implementation by itself or in determining how effective it is in its strategic initiative [2]. Much research has been focused on crossing or complementing BSC with other methods, techniques and frameworks, as a way to overcome criticisms and some of its limitations, making it more reflective of changes and ensuring that the system implemented is linked to realities in the environment [16].

Several studies on BSC analyzed the strengths and weaknesses of this management tool [17]. Within its limitations it gives us a snapshot of organizational health, but not a three-dimensional picture, and it can point out problems, but does not reveals the solution. A significant number of one-dimensional models of performance already exist, with a tendency to integrate many individual measurements into a single performance index, which can make the overall picture somewhat fuzzy, adding significantly to its workload [18]. Question is that one-dimensional models do not meet the analytical requirements of management when various “viewpoints” must be taken into account simultaneously.

The BSC has been a widely used approach for multidimensional performance measurement in the context of IS/IT management, though the strong decrease in its application between 2006 and 2009, with recent publications indicating a renewed increasing attention to its usage in IS/IT [3]. As IS/IT services are becoming increasingly critical for daily operations, demanding more transparency and control, few tools are available to evaluate the service portfolio according to the strategic goals of a company from the business perspective, or to support business-oriented service and service portfolio decision-making in order to achieve alignment between business and IS/IT.

B. Functional Requirements

The process of requirements elicitation, including the selection of which techniques, approaches or tools to use, is dependent on a large number of factors including the type of system being developed, the stage of the project and the application domain, to name only a few. Because of the relative strengths and weaknesses of available methods and the type of information they provide, a combination of several different techniques is necessary to achieve a successful outcome.

Despite attempts to automate parts of the process and develop frameworks and guidelines, requirements elicitation still remains more of an art than a science. Inside the Object Oriented approaches, the UML contains several techniques with established yet flexible notations and formats such as UC diagrams, UML descriptions and class diagrams. UC are essentially abstractions of scenarios describing the functional behavior of the system, especially accepted in both research and practice despite short-comings as impreciseness [19].

As modeling literature has focused on techniques for functional design requirements, most introduced as individual techniques for representing an application domain, recent trends have been toward integrating across multiple perspectives. In addition to the widespread use of data models, several organizations denote sophisticated process modeling activity, including the application of UC as a central aspect, even in situations where other elements of UML were not fully adopted and modeling was often described as informal. These also involved the extensive use of supportive natural language narratives [20].
This significant adoption of UC brings greater precision in designer-user communication, but fulfilled through semi-structured natural language exchanges, demanding for formal models with well-organized and structured natural language representations [21]. As many practitioners and researchers go on providing guidelines, suggestions and techniques to construct high quality UC models, systematic reviews are conducted regularly in order to identify and amalgamate that knowledge [22].

C. Nonfunctional Requirements

Requirements of a business process can be classified into functional and nonfunctional, but while traditionally there is a comprehensive coverage of the functional characteristics, the nonfunctional part is treated in a less rigorous way. These later have been associated to the quality factors of business processes, but still defined and categorized into different dimensions; with diverse perceptions from several authors and lacking widely accepted approaches for its criteria and evaluation. So, although an information system’s utility is determined by its functional and nonfunctional features, most requirements models and specification languages lack a proper treatment of their quality characteristics [23].

Recently, a considerable number of methods and tools have been proposed for the treatment of nonfunctional requirements (NFR), due to the ample evidence that these play a significant role in the information systems engineering process. However, there is still an absence of an agreed position regarding their definition, classification and presentation, in order to categorize them, and discuss their scopes and characteristics to guide system developers [24]. Work is still needed in the systematic process of NFR engineering since all activities are isolated, and there is a disorderly sequenced of various methods and tools. Also, the elicitation of business goals and rules has been associated to NFR [25].

Current states and trends from both academia and industry over goal-oriented requirements engineering, point for goal models to be useful in supporting the decision making process at the early requirements phase [26]. These are generally complementary to other approaches and well suited for analyzing requirements early in the software development cycle, especially with respect to NFR, but its analysis and evaluation also presents many challenges [27]. A great variety of techniques for analyzing goal models have been proposed in these last years, but, on the other hand, this diversity creates a barrier for widespread adoption of such techniques, also due to the lack of guidance on which one to choose [28].

Complementarily, business rules are also an important artifact in the requirements elicitation process of information systems and a vital part in its development cycle. They describe ongoing policies, procedures and constraints, which concern an organization in order to achieve its business goals and objectives, helping to collect and organize supports for the implementation of change [29]. Having business rules as an integral part of this management and evolution, improves requirements traceability in design, minimizing the efforts of changes, as when they are systematically identified and linked to design elements, being easier to locate and implement [30].

Even so, their quality suffers due to the large gap between the way stakeholders present their requirements and the way analysts capture and express them, and also because requirements elicitation techniques tend to be much analyst oriented and dependent [31].

III. A THREE-DIMENSIONAL BUSINESS MODEL

Our proposed approach for a three-dimensional business model is grounded in a functional and nonfunctional requirements base, assembled within a process, goal, rule (PGR) trio, and in the balanced scorecard (BSC). This approach, from now on designated as the PGR-BSC Cube, is twofold.

On one side, there is a metamodel for representation of the:
- processes (one dimension, in the form of use cases);
- goals and rules (another dimension, with its constituent details);
- four dimensions of the BSC (as a third dimension of the cube).

Complementarily, we detail a method to handle the generated cube-structure, with its constituent activity, and associated tasks, work products and roles. This method is first specified, and then further tailored and organized, using the SPEM specification [9] for soundness and clarity reasons.

A. PGR-BSC Cube Metamodel

The PGR-BSC Cube [8] follows on our previous work in combining process use cases, widely accepted on the functional side of requirements elicitation, with business goals and rules, as one prominent solution on the nonfunctional counterpart, in a PGR metamodel [7]. These are then extended with the BSC information, relating them with the previous metamodel constituents (Fig. 1).

This relation has been previously explored in a method for generating a business model through elicitation of business goals and rules from process-level use cases [25]. There the BSC served as an intermediate stage to reach a business model canvas, where the BSC elements associated to each of the detailed individual elements of the PGR.

![PGR-BSC Cube simplified metamodel](image)

According to the PGR-BSC Cube simplified metamodel in Fig. 1, the BSC elements present themselves as a third standpoint connecting to the already existing two-dimensional
realities of process and goal/rule. On the relation between these three perspectives, an associated cube-like structure is built along three axis: use cases, goals/rules and the balanced scorecard four dimensions (Fig. 2).

![Three-dimensional, Requirements-based, BSC Business Model](image)

**Fig. 2.** (UC; G&R; BSC) axis and associated cube-structure

The length of the process perspective is variable and depends on the number of top-level use cases of the elicited information system structure (five in this example: UC1, UC2, UC3, UC4 and UC5). Regarding the goals and rules perspective, its length follows its detail constituents inherited from the BMM representation (three or six, depending on the desired level of detail), namely:

- Goal/Objective;
- Strategy/Tactic;
- Policy/Business Rule.

For the BSC perspective, its length is related to its four dimensions:

- Financial;
- Customer;
- Internal Processes;
- Learn/Growth.

Although these last two perspectives follow a more fixed length status, additional BMM or BSC dimensions can be added to the PGR-BSC Cube as needed.

This metamodel allows for the representation of information relating to the three perspectives and, recurring to the associated cube-structure, for its visualization according to the different intentions of its diverse users (business-process analyst, systems analyst, software architect, etc.).

**B. PGR-BSC Cube Method**

In order to handle the information in this metamodel and the associated cube-structure, we propose the design of a generic activity (using the SPEM specification), with its required detailed tasks, work products and roles. The activity is comprised of four tasks, four work products and a user role of business-process analyst (Fig. 3).

Regarding the tasks, three are associated to the handling of each cube perspective and one associated to the action to perform in each cube element (cubie). Related to the work products, three are associated to each cube perspective and one is associated to the business model cube itself (the set of cubies).

![Proposed activity with its tasks, work products and roles](image)

**Fig. 3.** Proposed activity with its tasks, work products and roles

So, the three first tasks involve the handling of the use cases, the goals and rules, and the balanced scorecard. These are the work products that form the structure of the business model cube, while the fourth involves the processing of the cubies. For the time being, only user performing these tasks is the business-process analyst. The detailed tasks are, respectively:

- Associate Use Cases;
- Relate Goals and Rules;
- Delineate BSC dimensions;
- Perform action!

Due to this specification, the activity can be tailored in a SPEM process, operationalizing it according to the users’ intentions. Each of the first three tasks in the activity can be organized and run in a cascading cycle, handling the elements of the corresponding perspective, and at the end, obtaining the necessary inputs or generating the intended outputs with the final task. The organization of the cascading tasks implies a corresponding visualization on the PGR-BSC Cube, as in Fig. 2, with the possibility to rotate each perspective accordingly.

That is, this type of cube-structure and associated tailorable SPEM process adapt to one another. When the cube switches in any of its three axis, the cascading order of the three first tasks should reciprocally switch too, in order to conform to the desired processing sequence or to the specific visualization perspective. The final task is the only one that should not switch, it is to be processed at the end, for each cubie. All-in-all there are six possibilities for cube rotations, by performing different rearrangements of the three perspectives (Fig. 4).

This cube-structure and its associated method allow performing a transformation from three one-dimensional perspectives to a three-dimensional reality. Conversely, the opposite is also possible, as in the case of extracting a business model canvas (a one-dimensional reality) from the complete cube information for the three perspectives. So, the activity can be tailored in a manner to elicit the related business goals and rules from the initial associated use cases, following the delineation of the respective BSC dimensions, or to run through the BSC dimensions, then use cases and extract the associated goals and rules statements.
IV. ELICITING AND GENERATING A BUSINESS MODEL CANVAS

By revisiting a project where a specification for the elicitation of business goals and rules from process-level use cases, and their mapping to a business model representation was used [25], it allows us to explore the possibilities of our three-dimensional, requirements-based, balanced scorecard business model approach, the PGR-BSC Cube.

Following the SPEM process used in the referred project, depicted in Fig. 5, the generation of a canvas from an initial set of use cases is done in two-step activities. First, the BSC were filled by inferring the business goals and rules from the process-level use cases, and then, the canvas blocks were mapped from the BSC cells. Both activities have internal iterative cycles to handle the elements of the involved work products. This way, the BSC functions as an intermediary stage between the two steps, referring both to the PGR and the canvas elements, allowing for future traceability issues [1].

By using the PGR-BSC Cube structures and the associated tailorable method to perform these two activities, we can obtain the same or even better results, in a more user-friendly way, through an improved, conceptualized, visualization of the entire method.

Next we will present the result of applying the PGR-BSC Cube approach to the two activities (Fig. 5):
- Inferring Goals and Rules from UC
- BSC to BMC mapping

A. From requirements to the PGR-BSC Cube

The first activity, ‘Inferring Goals and Rules from UC’, can be performed by our method through the use of one of the six available cube-structures (Fig. 6) and the corresponding tailored activity (Fig. 7). The chosen activity guides the user through a cascading cycle in the following way:
- Select a use case (A);
- Select a BSC dimension (C);
- Select a goal and rule representation (B);
- Elicit a business model statement (D)

In this particular case, first the user selects a specific use case, then selects a BSC dimension and finally a goal and rule representation. Having set the three perspectives, the user then performs the desired action, in this case eliciting a business model statement for the current cubie accordingly.

By iterating through these three perspectives in the stated order, the user will fill each cubie with an elicited business model statement, until all the entire PGR-BSC Cube is filled-up. The order of processing for the three perspectives was tailored according to our user’s preference (A-C-B), but depending on the preferences of other users they could be easily switched, always remembering that the activity should be tailored according to the selected cube-structure.
The execution of the final task at each cubie is the responsibility of the analyst, while the other tasks can be more or less automated according to each method implementation. Also, although filling all the cubies is not mandatory in this case, it is important to fill the most part of them for a wider business model coverage. Moreover, in order for this task to be successful, the business-process analyst must possess sound experience and knowledge regarding guidelines and heuristics on the topic of goals and rules elicitation.

B. From PGR-BSC Cube to the business model canvas

For the second activity, ‘BSC to BMC mapping’, our choice for one of the six available cube-structures can be seen in Fig. 8 and the corresponding tailored activity in Fig. 9. Following the customized method, the chosen activity guides the user through a cascading cycle in the following way:

- Select a BSC dimension (C);
- Select a use case (A);
- Select a goal and rule representation (B)
- Map a business model statement to the canvas (D)

In this particular case, first the user selects a specific BSC dimension, then selects a use case and finally a goal and rule representation. Having set the three perspectives, the user then maps the respective business model statement to the appropriate canvas block.

By iterating through these three perspectives in the stated order, the user will map each cubie business model statement to a corresponding block in the destination canvas, until all statements are mapped and the canvas complete. Again, the order of processing for the three perspectives was tailored to our user’s preference (C-A-B), but depending on the pretensions of other users they could be easily switched, as stated previously.

Once more, the execution of the final task at each cubie is the responsibility of the business-process analyst. In this case, mapping each element to at least a canvas block is mandatory, although sometimes the decision to which block to map or to divide the sentence in two blocks is not clear. Yet again, the analysts need to use all their experience and knowledge to make a correct decision.
Cube structures are interesting in the way they allow for better perceptions from the users and added flexibility in the techniques to work with them. This is important to aid in the work towards reducing the gap between experts and novices, by supporting practical roadmaps, frameworks, and guidelines that can be more linear and easily taught to students, novices or analysts outside a specific domain. These are key issues, as most approaches are hard to tackle at first and require a significant level of skill and expertise from the analysts to be used effectively [25]. As a standpoint, there are several research examples of using cubes to deal with three-dimensional realities, even some using BSC.

A. Related research

A major difficulty with organizational performance models in software engineering management (SEM) is to represent as many possible viewpoints quantitatively and in a consolidated manner, while at the same time keeping track of values of the individual dimensions of performance. In order to tackle this problem, Stroian et al. [5] presented a selection of multidimensional models of performance found in SEM, and also a review on visualization techniques. In fact, visualization means a graphical representation of data or concepts, which aids in having the right information at the right moment, being crucial in making the right decisions. As many criteria can be used to evaluate the effectiveness of a visualization technique, an important one is the use of three-dimensional cubes.

Another example of using three-dimensional perspectives, is a generic model termed the “Sustainability Innovation Cube” which consolidated the research on sustainability and innovations into a coherent framework, clarifying existing relations in the field [6]. The proposed model did not quantify the sustainability effects, but rather the qualitatively depicted areas of potentials and subsequently built on the current body of innovation methodologies. Such a generic conception facilitates its application to a wide field of businesses and products while at the same time enabling decision-makers to tailor the model by applying existing assessment methods.

An important part of enterprise business modeling is the creation of a high-level domain model that depicts the main business entities and their relationships that are of interest to an organization. The interrelation of the different perspectives involved in the connection of business models and enterprise architectures, supports the alignment and tracing between their elements. This establishes the basis for a sound and effective business model, and allows identifying and specifying appropriate service-oriented architectural elements at enterprise level from business models [32].

Also, as IT change processes affect an organization’s enterprise architecture, it must also be mirrored by a change in the organization’s business model, where its analysis may establish whether the architecture change has value for the business. One important reference in this specific topic proposed an approach to relate enterprise models specified in ArchiMate to business models, modeled using Osterwalder’s Business Model Canvas [33]. As intended, the approach facilitates the tracing of business requirements captured by motivation and business models down to the design specifications, expressed as enterprise architecture models.

V. DISCUSSION

The focus on the BSC allows for a stronger and clearer strategy management, enhancing the interconnection between the business and the IS/IT realities. Likewise, existing interconnection of BSC with both the problem-side elicited functional and nonfunctional requirements, and the management-side business model elements, permits widespread traceability throughout the entire solution and flexibility in applying any of the available transformation perspectives.

VI. CONCLUSION

Balanced Scorecards are at the heart of an organization strategy management, being closely related to its business model. Its interrelation with functional and nonfunctional perspectives, as business processes, and business goals and rules, allows for an expanded three-dimensional view and control over the entire strategy and vision of an organization.

With the use of modeling features as well as popular reference models inside the area for this proposal, it allows for
further development of the present solution and leaves an open door to future connections to other points of interest. Also, its ‘standard-oriented’, not so high-level neither low-level specification, intends to allow support and communication between managerial and technical sides.

The ongoing and planned work with the PGR and BSC framework integration, further detailing and analyzing the PGR-BSC Cube solution, while counting with the support of SPEM and BMM specifications, as well as the forthcoming development of a support tool prototype, present promising directions where to further develop, test, evaluate and evolve this research work.

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