

Aligning Riva-based Business Process Architectures with Business Goals Using the i* Framework

Yousra Odeh, Mohammed Odeh and Stewart Green

Software Engineering Research Group, Faculty of Environment and Technology
University of the West of England (UWE), Frenchay Campus
Bristol, United Kingdom

Yousra.Odeh@uwe.ac.uk, Mohammed.Odeh@uwe.ac.uk, Stewart.Green@uwe.ac.uk

Abstract— The i* framework has been widely used to derive business process models as an attempt to fulfill business strategies in the business/IT environment. However, in a dynamic environment the derivation methods do not easily adapt to radical changes required either in goals or process models due to the absence of a business process architecture that permits business processes improvement. The current approaches for business process architecture modelling, and particularly the Riva-based method, lack the integration of business goals for both deriving the process of business process architecture development and/or aligning business goals to a pre-existing business process architecture model. In this paper, we propose a novel approach that is i*-based to align a Riva business process architecture with business goals, and vice versa, with full traceability in both directions to tackle the above shortcomings. This approach has been initially evaluated using the Cancer Detection pilot study in the Cancer Care and Registration process in Jordan. This goal-driven alignment has demonstrated a systematic bridging of the gap between goal-oriented and business process models in a dynamic environment. Moreover, the business goals integration has improved the Riva business process architecture development process and produced new knowledge for the as-is Riva process architecture and its associated business process models, where many are run as software services.

Keywords—Goal; Riva; Business Process Architecture; i* Framework; Business Process Model.

I. INTRODUCTION

The business/IT alignment discipline has attracted many researchers in the last two decades [14][15]. Their contribution aims to increase the competitiveness of enterprises where software systems are developed to meet the continual changes in business needs in terms of plans, objectives and processes. The current approaches to Business Process Architecture (BPA) [10] modelling, and particularly the Riva-based method, contributed to the business/IT alignment and in fact to the Requirements Engineering (RE) processes by deriving candidate software services along with associated capabilities in [14].

The Riva BPA [10] method aims to blueprint the current overall chunking of core Business Processes (BP) that stem from the business an organisation is in [10]. Ould has asserted the existence of invariant process architectures for organisations that are in the same business [10]. However, the Riva-based method lacks the integration of business goals for deriving the process of BPA development, and/or

aligning business goals to a pre-existing BPA model. This shortcoming has resulted in an inability to determine some core elements that initiate Riva-BPA development and/or to assist in redesigning an as-is BPA to adapt to organisational business changes. This shortcoming and its consequence have weakened the generation of an optimal BPA design and/or have obstructed further improvements. And according to Ould's previous assertion [10], they might in turn diminish the competitiveness in the long term due to many enterprises that are in the same business with different business goals that might generate different BPA models.

In this paper, we develop a novel approach that is i*-based [6] to align business goals to a Riva-based BPA, and vice versa, with full traceability in both directions. This complement is anticipated to improve the BPA development process and hence to generate new knowledge to BPA and associated BPs where many are executed by software systems. The Cancer Detection (CD) process pilot study, as a part of the Cancer Care Registration (CCR) process in Jordan's health care sector, validates this work.

The paper is structured as follows, Section II presents the required background. Section III applies the current Riva method using the CD pilot study. In Section IV, we propose using an i*-based approach for aligning Riva-based BPAs with business goals using the CD study. A discussion is carried out to assess the alignment approach in Section V. And finally, Section VI concludes the work.

II. BACKGROUND

This section starts with a brief description of the pilot study that is the Cancer Detection process. Then it presents the related background, with regard to the i* framework and the Riva-based BPA and associated BP models respectively, with a brief analysis afterwards.

A. Cancer Detection Process: A Pilot Case Study

In this paper, the Cancer Detection (CD) process, which is a sub process of the CCR, is employed as a pilot study in order to compare the proposed approach with the Riva approach [9][10]. The CD process was designed to address two main objectives that are considered as sub goals of the parent goal "improve administration of cancer treatment". The first goal is diagnosing patients and the second is determining their cancer type and site. Five roles are involved in this process to fulfil the aforementioned objectives: Patient, Receptionist, Doctor, Lab and the Imaging Department. A detailed BP workflow model has been illustrated using RAD and BPMN in [9][16][14].

However, a corresponding goal-oriented model that represents the strategic view has not been addressed yet [17]. Due to the detailed representation of the CD process, the paper validates the alignment using a partial and simple comparison of the goal and BPA models.

B. Business Goals and the i* Framework

Business objectives or goals have been defined in various ways either from the business or system perspective in [2][3][6][4][13]. However, the authors agreed to adopt what they judged to be the most comprehensive and related definition for this paper. So business goals are precisely defined as “*the high level objectives of business, organisation or system that capture the reason why a system is needed and guide decisions at various levels within enterprise*” [1]. In this context, goals have to be addressed not solely with respect to technological needs, but also with respect to organisational ones in social style of cooperation. Therefore, business goals are anticipated to guide BPA design decisions for an enterprise.

The i* framework is classified under the problem-oriented RE school that aims to understand and highlight associated problems within business structure, processes and systems [3][5][12]. Other goal-oriented approaches join this school with the i* framework (e.g., NFR framework [13] and [3][5]).

In particular, the i* framework aims to understand early on during the requirements phase the current situation of a business organisation in the form of a network of dependencies among actors [6][3]. It is based on two types of strategic models. The first is the Strategic Dependency (SD) model, which illustrates a network of dependencies in external relationships between actors where the depender depends on a dependee to achieve a dependum, whether it is a goal, soft goal, task or resource [6]. Actors are active entities that could be humans (e.g., physician) or non-humans (e.g., e-learning system). They either hold intentions to attain dependums and/or abilities to achieve them. The second model in the i* framework is the Strategic Rationale (SR) model, which elaborates the abstracted SD for a better understanding by modelling internal relationships within actors using means-end and task decomposition links. In reality, the aforementioned steps are carried out in parallel. While re-engineering a BP, this has produced better design alternatives in delivering the actors’ interests.

The authors have adopted the i* framework as an agent- and goal-oriented approach due to its ease of adaptability and its richness of business-oriented concepts that may motivate an early integration with other business models with full traceability. The i* framework has been widely applied in re-engineering the detailed workflow of BPs [11]. However, the i* framework lacks the ability to derive and/or re-engineer a BPA that manifests how BP fragments are interacting and steers their improvement. This inability has been revealed because of the absence of an adaptable and viable BPA modelling approach that is compatible with the i* framework.

C. The Riva-based Business Process Architecture and associated Business Process Models

The Object Management Group defines a business architecture as “*a blueprint of the enterprise that provides a common understanding of the organisation and is used to align strategic objectives and tactical demands*” [17]. They agreed that a business architecture must encompass five key views that are: business strategy view, business capability view, business process view, business knowledge view and organizational view [17]. Ould proposed the Riva methodology to create a BPA and associated core BPs as a blueprint that aims to address the second and the third views stemming from the business an organisation is in [10]. This methodology is required in an enterprise in order to manifest the BP’s collaboration where many of them are run as software services. Thus, it assists in their improvement and development.

The Riva-based BPA is based on brainstorming the Essential Business Entities (EBEs) that are the subject matter of the business an organisation is in [10]. This BPA is generated after applying the following steps [10]: 1- brainstorm for EBEs that characterize the business an organisation is in. An EBE could be either physical (e.g., book) or abstract (e.g., module). 2- filter the previous EBEs to ones that have a lifetime that an organisation is interested in and call them Units of Work (UoWs). 3- link UoWs to one another via dynamic relationships, namely “generates” to make up the UoW diagram. A one-to-one or a one-to-many cardinality must be associated with each dynamic relationship. 4- the UoW diagram must follow some rules to generate the 1st cut BPA that consists of a set of interrelated Case Processes (CPs) that each corresponds to a UoW. Therefore, a UoW diagram is useful to predict the BPA model. A CP generates one or more instances that are managed through a corresponding Case Management Process (CMP) if needed. 5- the 1st-cut BPA is reduced after applying a set of heuristics to generate the 2nd-cut process architecture namely, the Riva BPA [10]. Each process in the Riva BPA is designed using a role-oriented business process modelling approach. The BPMN and RAD are two well know notations to describe a role-oriented BP [16][10].

The Riva method appears to be a good candidate for the desired alignment as it is easy to comprehend and it encompasses all the required business-oriented concepts that are needed to integrate goal models with full traceability. However, the Riva method does not guide the architect in how to meet/respond to new organisational objectives. This is mainly because it develops a BPA from the business an organisation is in rather than the rationales that stimulate this business. This is likely to end with gaps in the BPA due to missing but required Riva elements and/or identified but unrequired ones (e.g., BPs). This limitation may require the Riva method to integrate the strategic view as an attempt to fulfill business goals in its as-is BPA model via a systematic alignment approach.

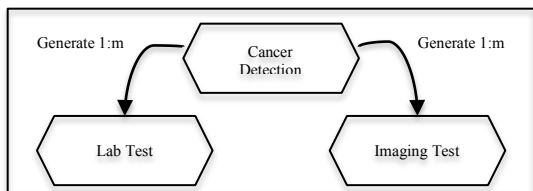


Figure 1. The Cancer Detection Non Goal-based UoW Diagram.

III. DERIVING CANCER DETECTION PROCESS RIVA-BASED BPA

This section applies the current Riva approach presented in Section II on the CD study. The Riva BPA has been already established with its core elements (e.g., EBEs and UoWs) and evaluated in [14].

The current Riva approach that designed this BPA stemmed from the business rather than from the aforementioned goals. This has resulted in 24 EBEs and 3 UoWs where each UoW corresponds a business process. Figure 1 illustrates the resulting non-goal-based UoW diagram that is used to predict the BPA. The authors agreed to compare it with the goal-based UoW diagram rather than using the 2nd-cut architecture for comparison. In Figure 1, the cancer detection UoW generates the other two UoWs. Limitations of this approach have been already presented at the end of Section II.

IV. ALIGNING THE RIVA-BASED BPA WITH BUSINESS GOALS USING THE CANCER DETECTION EXAMPLE

This section presents the proposed alignment approach

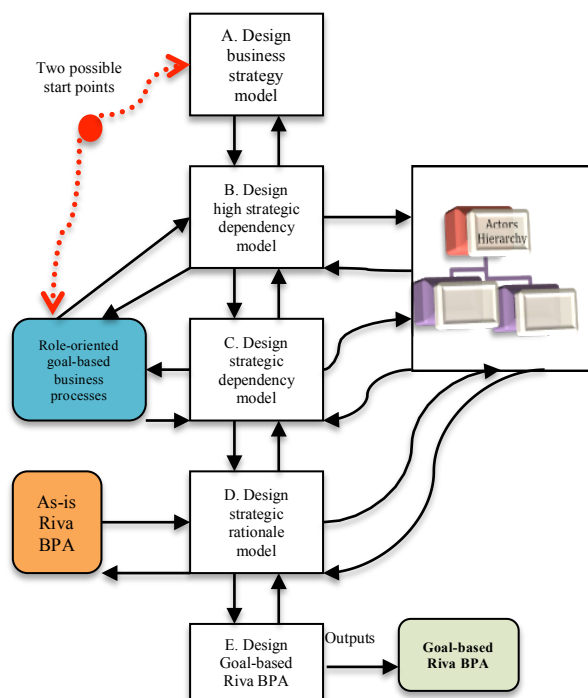


Figure 2. The Alignment Process Designed Activities for Integrating Business Goals to as-is Riva BPA.

that aims to re-engineer and/or improve the already established Riva BPA model using the i* framework along with CD study. The re-engineered BPA model is produced from a set of designed activities that constitute the alignment process as depicted in a coarse grain manner in Figure 2. The proposed alignment process inputs the as-is Riva BPA and associated role-oriented Goal-based Business Processes (GBPs) to generate i* models that will in turn be aligned to output a goal-based BPA. The five-core activities of the alignment process are overlapped and iterated as shown in Figure 2 as to be discussed in detail in the next sub sections. The second and third core activities generate associated goal-oriented dependency models where a depender depends on a dependee to achieve a goal dependum. In both activities, setting a goal and assigning it to an associated depender and dependee will be carried out in a parallel manner. However, three extra activities constantly overlap with the core ones to adjust the alignment: (1) reusing role-oriented GBPs, (2) reusing as-is BPA and (3) building the actors' hierarchy. Feedback is required between all the above activities, as an overlapping activity will assist in performing the overlapped activities if needed. For example, the design SD model activity (C) assists in performing the design SR model activity (D), as depicted in Figure 2. As Figure 2 shows, the alignment process starts either to immediately design the Business Strategy (BS) model, or not immediately by reusing role-oriented GBPs to deduce the Highest Business Goals (HBGs) to then design the BS model.

A. Designing the Business Strategy (BS) Model for CCR

In this first stage, the boundary of an individual organisation and its associated Highest-Business Goals (HBGs) are agreed using the canonical list of goal types provided in [7]. A business organisation could be an enterprise, a department, a main process in a business sector or even a group of individuals that are collaborating to accomplish at least one HBG, which refers to an ultimate main business goal. The modelling notation is inspired from the use case modelling in the software engineering discipline due to its flexibility in initiating early and easy communication between stakeholders [8].

With regard to the CD study, Figure 3 depicts this model where the business organisation, which appears on the left, aims to achieve its HBG, that is to improve the CCR business process, which is denoted by the top ellipse on the right side. This HBG is deduced from lower goals that are inferred from the main objective statement of CCR, that is:

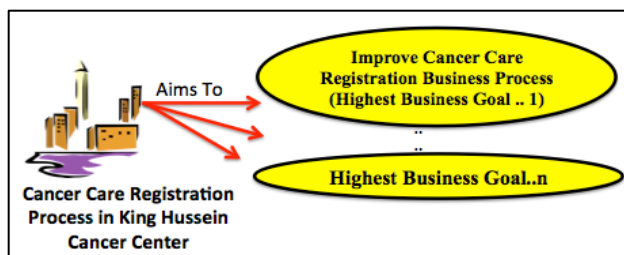


Figure 3. The BS Model for an Individual Organisation in the Kingdom of Jordan

“to improve the Administration of cancer treatment” and to improve “collection of information about cancer cases”[9]. Using the canonical list of goals and these two [7], the authors conclude that the HBG is improving the cancer care registration business process. The BS model is not immediately generated as the authors started the alignment process from reusing role-oriented GBPs. This work complements the work done on bridging the gap between business process models and system models in the semi-formal automation of generating use-case models from business process models without consideration of business goals [8].

B. Designing the High Strategic Dependency (HSD) Model

This phase elaborates each HBG into associated sub goals namely, Immediate Highest sub Goals (IH-G). The IH-G set is a new term derived from the previous phase to generate a first goal-oriented dependency model. The HBG is decomposed using a decomposition relation to be satisfied by a number of achieved IH-Gs as shown in Figure 4. As from the HBG perspective, the IH-G set is defined as the set of immediate decomposed goals that make up the HBG parent. And from a Goal-based Business Process (GBP) perspective, the IH-G is defined as the main objective for a number of collaborating GBPs that aim to meet the IH-G parent. The HSD is similar to the SD model in the i* framework but with actors that are either a key (e.g., Patient) or set of roles (e.g., Cancer Care Team). It is required as it derives the i* strategic models.

In the study, the generated IH-Gs **dependums** (e.g., administration improvement of cancer treatment) must have **dependers** (e.g., patient) and **dependees** (e.g., cancer care team) that are linked via dependency relations to make up a goal-oriented dependency model as depicted in Figure 5. The CD process is embedded in the bottom dependency in Figure 5 as will be shown in the next activity. The two dependums are sub goals of the HBG in Figure 4. Very few EBEs have been detected using the as-is Riva (e.g., patient) due to the high abstraction of the HSD model.

C. Designing the Strategic Dependency Model

In this stage, the i* framework gradually starts to emerge by elaborating prior goal-oriented models. However, this requires further refinements as we have denoted the parallelism in defining goals and actors.

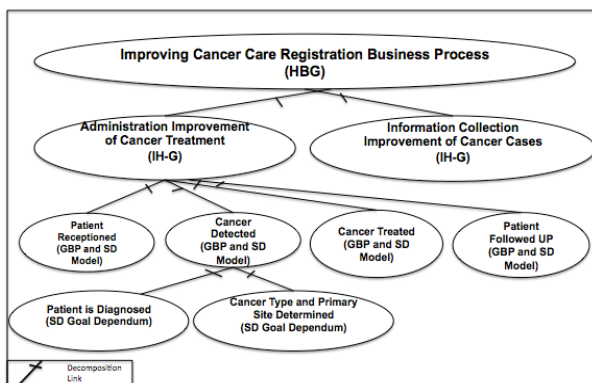


Figure 4. The Hierarchical Network of Goals

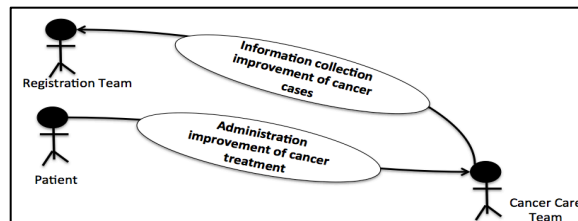


Figure 5. Partial HSD Model for the CCR Process

1) Discovering the Corresponding Goal-based Business Processes

This sub phase aims to look for interrelated GBPs that fulfill a corresponding IH-G parent implying that it is a **business process itself with associated goals** in order to adjust the aimed alignment. Therefore, each IH-G parent will be decomposed, using decomposition links, into a set of GBPs that are collaborating with each other to fulfill the corresponding IH-G parent. Figure 4 depicts the cancer detection as a GBP that collaborate with its three siblings to fulfill their parent. In the next sub section, for each role-oriented GBP there will be a corresponding SD model.

2) Deriving the SD Model from the Corresponding GBP

The SD diagram models a corresponding GBP in [6] followed by a one-to-one relation between the GBP and the SD model. The GBP is fulfilled by a consequent decomposition of goals, as shown in Figure 4, that are depicted in the form of dependencies with their associated dependers and dependees to design the SD model. The goal dependencies will be only illustrated in the SD model as the rest of lower business-oriented concepts will emerge later in the form of operationalizations (e.g., tasks and resources) in the corresponding SR-model as below [13].

Finally, the as-is EBE list from the pre-existing Riva BPA will assist to detect EBEs that exist in this phase rather than brainstorming them to adjust the alignment. Also, the SD model might generate a few new EBEs that are likely to be the goal dependums. This phase will iterate for each corresponding GBP.

Consequently, the CD GBP corresponding SD model is depicted in Figure 6 where its goal dependencies and associated actors are extracted from the CD GBP’s goals and roles [9]. For example, a patient depends on a doctor for a cancer-diagnosed goal where the patient and doctor are

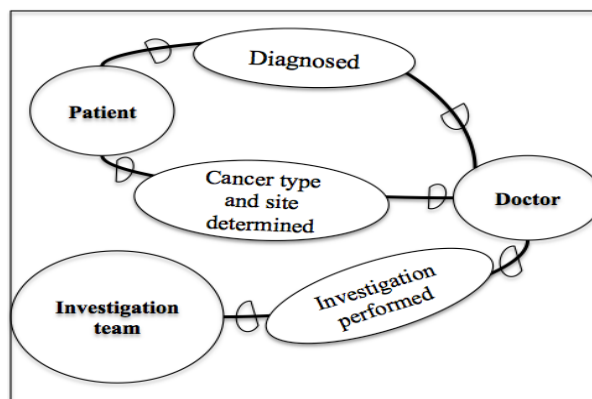


Figure 6. The SD Model for Cancer Detection.

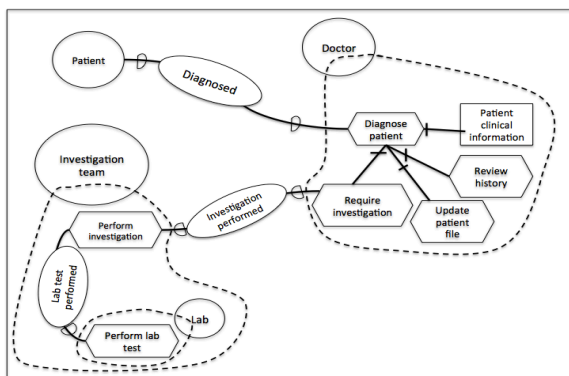


Figure 7. Partial SR Model for Cancer Detection Process detected as pre-existing EBEs. Figure 4 illustrates how the cancer detection is decomposed into these two sub goals using two decomposition links. These two sub goals turn out to be two EBEs that do not exist in the as-is EBE list. Therefore, they are derived rather than being detected from the as-is EBE list. In Figure 6 the investigation-performed goal dependency appears later on while designing the corresponding SR model.

D. Designing the Strategic Rationale Model

The SD goal dependencies will be achieved from an actor point of view. Therefore, the corresponding SR model fulfills the SD goal dependums by designing the internal structure of an actor’s abilities in the form of tasks and resources that are lower than goals in their abstraction [13]. The internal structure of an actor is designed using two relationships: (1) means-end and (2) decomposition links. The SD goal dependum in the goal dependency is elaborated into sub goals, tasks, or resources to be satisfied as discussed in Section II. The first relationship aims to make the means satisfy the end and hence to model alternatives. The second aims to decompose a goal, resource or task into sub parts as discussed in Section II.

In fact, the actual alignment emerges here with a higher number of detected EBEs using again the as-is EBE list and this demonstrates the overlap between designing the SR model activity and reusing the as-is BPA. An EBE could be an actor, sub actor, goal, task, or a resource in the SR model. Moreover, the means-end and the decomposition relationships will assist in delivering the alignment between goal models and a corresponding Riva- based BPA with traceability. If it appears somewhere in the SR model that an actor will depend on another to achieve either a task or resource, then it must be embodied in a goal dependency to be part of the previous corresponding SD-model.

With regard to the CD study, its SR-model elaborates the previous SD-model and detects more EBEs from the as-is EBE list. Figure 7 partially depicts how a doctor achieves the cancer being diagnosed SD goal for a patient through a set of decomposed tasks and resources. However, somewhere the doctor will depend on a new actor, the investigation team, for investigations to be performed as a new goal to assist in achieving the cancer being diagnosed goal. Hence, this demonstrates the overlap in reusing its as-is BPA, designing its SR and designing its SD models in the proposed alignment process. Finally, this denotes that the goal

dependencies in the SD model are not conclusive as new SD-goal(s) will have the opportunity to emerge somewhere while modelling its SR model as shown in Figure 7.

E. Optimising the As-Is Riva BPA

In the previous activities, and particularly while designing the SD and associated SR models, EBEs have been detected and matched using the as-is EBE list. This detection activity is required to address the alignment rather than brainstorming for EBEs. However, a few new EBEs are likely to emerge which did not exist in the as-is EBE list. These new EBEs (e.g., some SD goals such as patient is diagnosed) will join the as-is EBE list to alert for a required re-engineering process for the as-is BPA with the respect to the new EBEs. The as-is BPA will be refined to design a model with full traceability namely, goal-based BPA.

Finally, the as-is BPA of the CD is now improved after integrating the three new strategic EBEs that are cancer patient diagnoses, cancer type and site determination, and investigations performed. Based on the Riva method heuristics, only the first and the second EBEs turns into UoWs as they possess a lifetime the CCR is interested in. The output of this approach appears in Figure 8.

V. DISCUSSION

This section discusses the proposed approach benefits and limitations through comparing two cancer detection UoW diagrams as qualitative results. The first UoW diagram, which appears in Figure 1, was established using the Riva method in [10]. The second diagram is generated after re-engineering the first using the alignment process as shown in Figure 8. EBEs have been manually detected in the alignment approach by matching the goal-oriented entities with the as-is EBE list.

The reader should note the increased number of EBEs, from 24 to 27, and UoWs from, 3 to 5. As a qualitative evaluation, this new partial UoW diagram adheres to our business strategies and presents new important knowledge because it has been learned from Section II, a new UoW corresponds a new BP. Therefore; the two new UoWs have generated two new BPs in the goal-based BPA.

With regard to addressing the OMG views, the new UoW diagram addresses the first three views instead of two because it is established using the process’s rationales. This is anticipated to benefit the requirement engineers in eliciting highly complete, consistent and correct functional requirements. With regard to the BPM, the approach attempted to deliver well-defined BPs in the BPA that stem from business goals and consequently an elegant BPM lifecycle that is well-designed and configured.

The authors asserted the alignment strategy of Riva BPA with goals against the derivation strategy of BPA from goals. This desired order does not establish the BPA from scratch using goals yet it reengineers it to accommodate with rapid business goal changes. Hence, a reengineering process reuses the as-is models in order to accomplish an improvement where required with minimal architecting effort.

Integrating the dynamical Riva, with the goal-oriented approach has given the latter an opportunity to engage in a

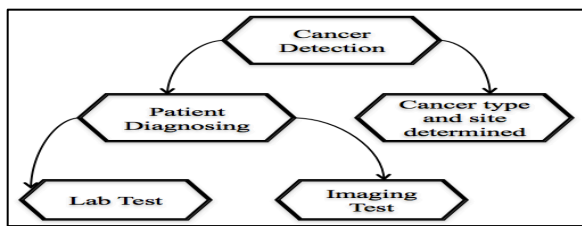


Figure 8. The UoW Diagram After Integrating Business Goals

dynamic environment. Thus, the i* framework is likely to be compatible with the rapid changes of business goals and process. The complexity of the alignment process reveals the overlap between the activities, as one will call another when required. However, these consequent overlaps merit the accommodation with changes that might emerge either in goals or EBEs. Finally, the proposed approach is limited to individual organisations rather than interrelated ones. The non-functional requirements in the aforementioned models are not aligned yet (e.g., security).

VI. CONCLUSION

In this paper, we have proposed a systematic novel approach for aligning a non goal-based, already established Riva BPA, which is a pre-existing BPA, with business goals using model-based *goal-driven approach*. This work is proposed as an attempt to answer the shortcoming of the Riva BPA method in addressing business process and organisational strategic goals. The work was evaluated using the cancer detection pilot study [9]. The UoW diagram has been assessed and has generated new BPs that stem from the related goal models. Any difference that appears in the UoW diagram must immediately modify the required cost and effort to meet the new design requirements. Also, any further manipulation on goals will immediately encourage and alert the business architect and the requirements engineer to align the as-is BPA with these goals. Hence, this enhances systematically the requirements elicitation activity ahead with advanced analysis and traceability mechanisms to detect any gaps in satisfying goals.

Furthermore, a significant corollary of this alignment is demonstrating the adaptability of the Riva-BPA method to bridge the gap between goal-oriented and business process modelling approaches with the ease of managing the concepts mapping challenge between the two paradigms.

Finally, the authors tend to evaluate the work with more examples to verify its validity. In our next stage work, we will be addressing soft goals by marrying this approach to an NFR framework [13]. Another further work is the necessity for developing a tool to automatically detect EBEs while generating the goal models. It is likely this will attain a faster alignment process execution. Finally, we plan to enrich this approach with a semantic representation using OWL-DL as a further evolution of [14].

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