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To propose a strategy-oriented and quality-aware business and IT alignment method through goal and scenario points analysis

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Abstract

Business and Information Technology Alignment(BITA) is a preferred condition in which the relationship between business and IT is optimized to maximize the business value of IT. BITA is a critical discipline allowing businesses to propose appropriate IT-enabled business solutions. A BITA method needs a well-designed process for identifying business problems, needs, and opportunities. Strategic BITA methods that are based on requirements engineering (RE) techniques can enable consideration of all business aspects and therefore fulfill expectations for the design of a suitable IT-enabled business solution. This study introduces a Strategy-oriented and Quality-aware BITA Method (SQBITAM) to facilitate alignment between business requirements for business systems and the business strategies. SQBITAM consists of a business requirements engineering method, using a combination of goal-oriented and scenario-based requirements engineering approaches and includes an early quality evaluation phase to assess the quality and performance of the designed IT-enabled business solution. Analytical evaluation of the qualities and performance factors enables assessment of the business strategy and TO-BE business process models. An ICT unit in a sample Power Distribution Company is used as a case study to demonstrate, exemplify and validate SQBITAM's steps. The results show a higher capability of SQBITAM than the currently existing BITA techniques.

Keywords: Alignment, Requirements Engineering, Business goals, Business solution, Business strategy, Business requirements
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1 Introduction

Over three decades, BITA has been considered one of the top 10 management issues for business and IT leaders [3, 23]. To date, several synonyms have been used for BITA including: alignment, map, synchronization, fit, linkage, harmony, fusion, integration, matching and complementing each other, support, synergy coordination, integration, the extent of adoption, and bridge have been used with the same meanings [3, 38, 17]. The BITA has many different definitions [3, 17, 31, 8], but this study, emphasizes the Reich and Benbasat definition as "The degree to which the

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IT mission, objectives, and plans support and are supported by the business mission, objectives, and plans [30]. Thus, usually BITA can realize at three levels: (1) The alignment of IT/IS with business goals and strategies, (2) The alignment of IT/ IS features with the business requirements of the organization, (3) The organization's future change [31, 8]. To realize BITA, many of BITA methods have been developed in distinct research area including: Alignment via architecture (e.g., BITAM, extended ATAM and CBAM), Alignment via governance(e.g. COBIT and ITIL), Alignment via communication , Functional alignment, Structural alignment, Temporal alignment , Strategic or intellectual alignment, Operational or process alignment, and Cross-domain alignment combining the intellectual and operational alignments [31, 8, 30].

The use of IT in an organization may alter the organization chart, structure, and tasks. The mission of BITA is to consider such changes in business before presenting any business solutions. In this respect, BITA techniques attempt to align business and IT activities, such as business strategy, business infrastructure, IT strategy, and IT infrastructure [17, 9]. The BITA can be achieved through the use of requirements engineering methods [35, 36]. Generally, requirements engineering methods are categorized into problem-oriented (e.g. Goal-oriented techniques, such as i*,KAOS,Tropos,GRL, AGORA, etc.)[2, 7, 22], solution-oriented such as Scenario-based approaches[29], and architectural approaches[24], are a combination of these approaches that minimize some of those RE approaches challenges[13, 10]. Problem-oriented methods are preferred to solution-oriented approaches because they consider the business goals and objectives before presenting any business solution [4]. These approaches develop business strategies through the construction and analysis of the business goal model. The goal model construction begins, at the top level, with the study of the business mission and vision. The primary goals, at the top, are decomposed into sub-goals as far as the business requirements are identified. Consequently, BITA is provided by introducing IT services in response to these requirements.

Some of the significant issues concerned with the BITA are: (1) Lack of a stopping criterion to end the business goals decomposition. The goal scenario coupling techniques have been highly recommended to appropriately determine the requirements as the leaves of the goal models [32] . (2) Lack of feasibility technique to estimates the cost of the designed business solution: Once the requirements are determined, the IT services could be defined to fulfill the requirements. Identification of the actors and a scenario for each goal enables the use of software sizing techniques [26] to estimate the cost of developing software for the achievement of the goal. (3) Lack of a suitable and efficient modelling technique for multidimensional analysis of organizational activities [35, 37]: As described above, a new extension of goal-scenario models could be of great use. From scenarios, one can ground argument with specific examples, and address the devil in the detail during the requirement specification and validation. On the other hand, during the phase of requirements validation, the scenarios can help in testing the models and specifications[11].(4) The alignment of IT and business strategies [36]: Strategic alignment of IT exists when the business goals and activities are in harmony with the information systems that support them [35]. Such alignments have been shown to lead to superior business performance [27]. Hence, any requirements for an organization IT should be in alignment with its business strategy. Requirements engineering models do not pay any considerations for representing business strategies, such as stakeholders' communication and strategic models. The business analyst should understand the business strategy models, document the business needs and goals, communicate with different stakeholders, and ultimately manage the concerns of the stakeholders [39, 34].

The main idea underlying BITA is to align IT with ordinary business activities, in such a way that the business can evaluate how IT impacts the achievement of its objectives. The target of the BITA method is to identify IT services in response to the business requirements. Business requirement elicitation begins with the identification of the business vision, mission, and strategy. On the other hand, SQBITAM proposes a strategy-oriented and quality-aware BITA method. SQBITAM is aimed at creating an IT-enabled business solution. It includes a new version of a modelling language of business requirements, introduced by Aboutalebi and Parsa [1]. the question is how to develop a RE-based BITA method to be utilized for business modelling? To design an unambiguous IT-enabled business solution, SQBITAM proposes a modelling language and a design method for translating the business needs into a business solution. The remaining parts of this article are organized as follows: Section 2 presents an overview of the proposed method. Section 3 uses a case-study to exemplify the steps of the SQBITAM method. In Section 4, some recently related works are reviewed. Section 5 evaluates the proposed method and offers conclusions.

2 SQBITAM method

SQBITAM is a strategic BITA method applying both the problem- and solution-oriented requirement engineering techniques to propose IT-enabled business solutions and using an early analysis phase for designing a qualified solution through analytical evaluation. All the business requirements engineering stages in SQBITAM are undertaken via a Joint Business Planning (JBP) process to ensure that all business requirements are approved by stakeholders and all the JBP artefacts are modelled in a business strategy modelling language.

2.1 Business Strategy Modelling Language

SQBITAM utilizes a requirements' modelling language to design business strategies. It includes many of the goal-oriented and scenario-based capabilities to minimize some of the current challenges of RE with three main components: (1) the AND-OR-XOR goal model, a version of the AGORA[22] method customized by adding an XOR decomposer (to describe the business strategy). (2) the business scenario, a textual description for meeting each of the business goals (it is explored to yield new business goals.). (3) the use-case diagram, relating business goals and their scenarios.

The goal model of SQBITAM is a directed acyclic graph that consists of the goal nodes, decomposer nodes, and edges. Goals include four main categories: soft goals or business quality objectives[6] showing by the clouds, hard goals or business functionality objectives[20] showing by the rectangles, dummy goals showing by the circles and finally business requirements that shows by the hexagons. Soft-goals are specified using relation 2.1 and hard-goals, and business requirements are specified using relation 2.2. Dummy goals simplify goals decomposition through creating composite decomposers. Each goal itself is associated with a preference matrix which organizes the opinions of stakeholders about each goal. Decomposers represent another element of the goal model which is shown by a circular sector. SQBITAM has three decomposers which include three categories AND, OR, and XOR. Each decomposer has an important attribute. Contribution values and elements of the preference matrix are integer numbers in the range [-10, +10].

$$<Verb><Object>[for<Destination(s)>/<Reason>]. \tag{2.1}$$

$$<Verb><Object>for<Destination(s)>by<Resource>]. \tag{2.2}$$

A business scenario is a textual tool of describing how to solve each business issue, if represented by the business goals, or describing how to decompose and simplify the issues, making SQBITAM a template for specifying the business goals solution. Figure 1(A) shows a scenario template for each business goal. By designing a scenario for each business goal, the BA can decide whether this goal should be decomposed. If the BA needs to decompose a goal, the scenario can help decide on the sub-goals and the relationships between them. Each part of the business strategy can be expressed by hard-goal or soft-goal scenario that includes some business events. A scenario of hard-goal can be expressed by applying relation 2.3, described below, and a scenario of soft-goals can be expressed by relation 2.4. Therefore, each business event consists of actor, activity (described by a verb and object pair), and resource. Besides, each activity needs some of the resources for completion of it [24]. consequently, each scenario contains an element called $<\mathrm{R}esources>$, indicating the required resources to perform the described activity. In this case, the amount of required resources is estimated in three ways: best case, worst case, and probable case.

At the beginning of the SQBITAM process, the required resources for soft goals are not yet fully understood. Accordingly, the required resources for each soft goal are estimated based on its sub-goals' resources at the end of the SQBITAM process, via a bottom-up process. Therefore, the purpose of the goal is to use the $<Destination>$ component to explain why a goal is adopted [18].

$$<Actor><Verb><Object>by<Resource>[from<best-case>to<worst-case>]. \tag{2.3}$$

$$<Actor><Verb><Object>by<Resource(s)>[for<Destination(s)>/<Reason>]. \tag{2.4}$$

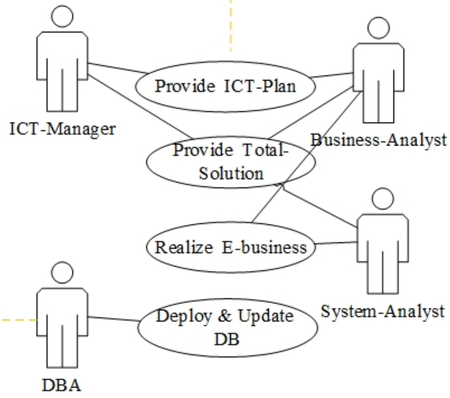
Reasoning about business goals and decomposing them requires the stakeholders to be identified and their opinions gathered. The use-case diagram is a conceptual tool for identifying stakeholders. Figure 1(B) shows a use-case diagram, modelling part of the business strategy for decomposing the "Manage ICT" business goal.

2.2 Proposed Joint Business Planning process

Because of the importance of considering how stakeholders coordinate their actions to design an acceptable and efficient business solution [18], SQBITAM applies a JBP process. Hence, SQBITAM process begins with modelling business qualities in the form of soft goals and business functionalities in the form of hard goals and ends when all the goal models' leaves represent a business requirement and proposes appropriate IT services based on the business

Goal-Scenario Document					
Goal ID: g1	Goal caption: Manage ICT				
Actors	ICT-office				
Informal description	Our enterprise expects to use the ICT facilities in order to successfully achieve. ICT features should be helped enterprise to achieve a higher maturity level.				
Business events	Actor	Verb	Object	Resource(s)	Destination(s)/Reason
	ICT-office	Provide	ICT-plan	By …	All business units.
	ICT-office	Provide	Total-solution	By …	Enterprise.
	ICT-office	Realize	E-business	By …	Enterprise.
	ICT-office	Deploy & update	Databases	By …	All business units.
Decomposer Type	AND [-]		OR[X]		XOR [-]

A)



B)

Elvaluator	Elvaluatee						
	Business Expert	HR-Manager	Manager	Business Allies	Business Analyst	System Analyst	DBA
Business Expert	0	3	2	5	1	6	4
HR-Manager	2	3	1	3	3	-5	1
Manager	3	4	2	3	4	3	0
Business Allies	5	5	4	2	7	4	5
Business Analyst	2	0	2	1	6	2	2
System Analyst	4	-3	7	1	6	0	3
DBA	4	3	4	0	4	-3	3

C)

Figure 1: The process of decomposing a goal includes three steps (A) designing a scenario to identify its sub-goals, (B) drawing a Use-Case diagram to identify its related stakeholders, and (C) providing a preference matrix to organize its stakeholders' opinions.

requirements. As mentioned above, the SQBITAM process is a JBP method using Kim's goal scenario analysis method[24] to develop an appropriate scenario for decomposing each goal.

Figure 2 illustrates the workflow of SQBITAM. The workflow begins with a detailed statement of the business vision and mission called business statement. Depending on whether the business needs change to be applied to achieve certain goals, such as success in the market, the workflow carries on with redesign of the business statement or the BITA process, respectively. The BITA workflow continues with deriving the primary goals, further decomposed to obtain the business goal-scenario model by a JBP, from the business statement in the first stage. The goal scenarios are used to define sub-goals and stakeholders. For each goal, a preference matrix representing the stakeholders' opinions about the goal is then constructed. The goals are decomposed as far as the business requirements are obtained. These requirements are analysed to define appropriate IT-enabled business solutions. Any conflict amongst the goals is followed by a goal alignment process, attempting to minimize the conflicts via altering the scenario for the parents with a relatively lower number of children and alteration cost. Each step of SQBITAM is outlined below.

3 Case Study

The ICT-office of the Mazandaran Power Distribution Company (MPDC)[1] has been taken as a case study to illustrate, validate and exemplify the SQBITAM process to design an IT-enabled business solution and to provide a practical illustration of each step of SQBITAM and articulate its process.

3.1 Introduction the Case Study Environment

In the MPDC, the ICT-office has the following responsibilities. (1) Standardizing the business operations to satisfy the business vision and mission, reduce costs and improve functionality via optimal usage of the existing resources. (2) Acquiring and maintaining all data and information needed by the MPDC ś departments and customers. (3) Developing the required information systems and other applications for MPDC. (4) Providing IT strategic planning for integrating, driving and connecting all business units. (5) Recognizing enterprise and business needs. (6) Implementing ITIL architecture. (7) Maintaining and updating all IT-based systems. The ICT office includes five software engineers,

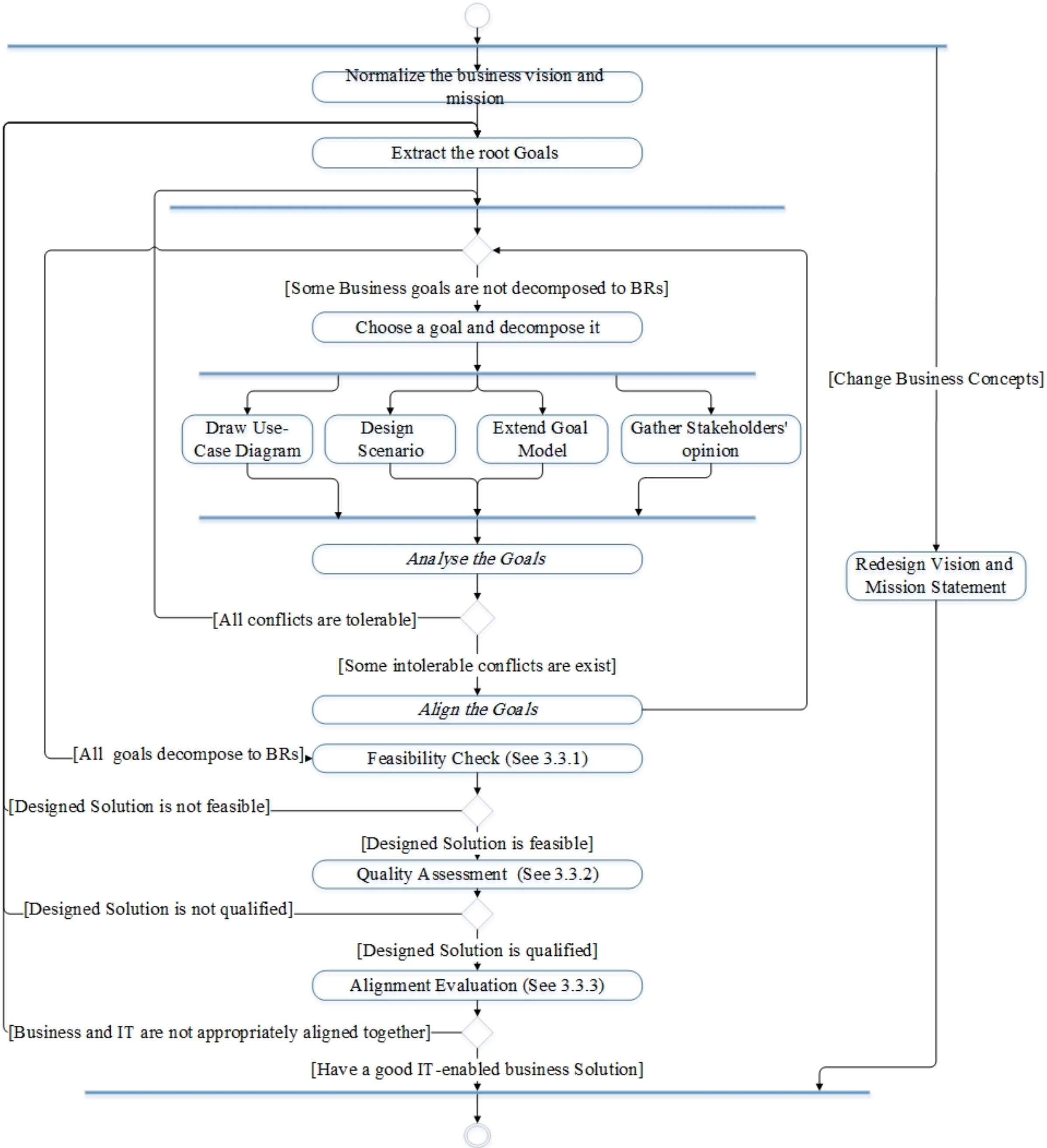


Figure 2: SQBITAM's designing workflow to propose an appropriate IT-enabled business solution which begins from business statements studying and ends with the offering required and aligned IT services..

five network and communication specialists, three BAs and one statistician. The ICT unit performs eight business processes, such as business and IT strategy design, business process design and maintenance all the IT-based systems. The vision and mission of ICT-office shown below.

1. Vision:
   "The vision of the ICT-office is to realize the full potential of the ICT and Information resources. It desires to drive a new era of enterprise maturity, satisfaction of customers and employees, and the right decision in all aspects of MPDC."

2. Mission:
   " The ICT-office manages and uses all aspects of ICT and Information resources in an optimum way to develop

and support technical infrastructure, maximizing the performance of e-business and innovation in all units of the MPDC."

This case study has provided a qualified and feasible IT-enabled business solution for the ICT-office. It is a part of a research study run by the authors for MPDC's R & D department to provide EA documents and business process models. This study took us about 56 working days. In the following sections, the outcomes and artefacts of the case study are reported.

3.2 Design a new business solution

Figure 3 shows a partial model of the designed business solution. To design it, SQBITAM applies the following steps:

1. Normalize the context of business vision and mission: at this step, each statement of business vision and mission, reformed by relation (1) and (2). (e.g. we transfer the statement "It desires to drive a new era of enterprise maturity" to "The ICT-office should be a platform for enterprise maturity.")
2. Extract the root goals: The initial goal model is created by adding a dummy root goal that combines all the subsequent derived initial business goals by an AND decomposer.
   Repeat steps 3 to 5 until all of the business goals decompose to business requirements and have minimum conflicts.

3. Decompose the goals: Firstly, design a business scenario for selected goal to detect its sub-goals, Secondly, draw a use-case diagram for designed business scenario to identify related stakeholders, thirdly, provide the preference matrix for each goal based on the its stakeholders' viewpoints and some important business-stakeholders such as HR-Manager and Business-Experts (see Figure 1), and finally determine the contribution value of each decomposed sub-goal.
4. Analyse the goals: Check each goals' relationships to find any of existing conflicts between goals and minimize them. In each goal model, there may be three types of goal conflicts as follows. (1) Achievement conflict; it detects through negative contribution values [22]. (2) Misunderstanding conflict: it reveals when the variance of the numbers in the primary diameter of the preference matrix is great and When a goal is misunderstood, the related stakeholders may have different opinions about it[22]. (3) Inconsistent specification conflict: it reveals when some goals' specifications components are the same [25].
5. Align the goals: Align the goals: Choose one of the conflicting goals that have the lowest cost of change and modify its scenario so that existing conflicts are minimized.

$$Change(g) = 1 - \frac{\#Child(g)}{\#Goals} \tag{3.1}$$

3.3 Validate the designed business solution

After the business solution design, to validate of the resultant solution, SQBITAM proposes the following steps.

3.3.1 Feasibility Check

A business can be implemented provided it has a desirable performance in the performance criteria of response time, cost and meeting all of the business constraints. Business costs consist of the required resources of the IT-enabled business solution. SQBITAM proposes a method to evaluate the business resources based on the goal model, taken in bottom-up order. Based on the cost vectors of the root goal and the resulting estimation of business performance, the BA may accept or reject the proposed solution.

1. **Cost estimation:** During the BITA process, based on the opinions of the JBP members, the BA estimates the required resources for each business requirement in three modes:Cost$(Br_i)_{Best}$, Cost$(Br_i)_{Worst}$ and Cost$(Br_i)_{Possible}$, organized by a vector of resources. This vector specifies each required resource, called R*esource_Schema*, by describing its name, unit, and enterprise value. Relation 3.2 gives a formal description of R*esource_Schema*, and relation 3.3 shows a typical resource vector that includes values such as v_{i_k}, showing the required unit of a resource that has $ResourceType_k$. SQBITAM estimates the cost of a designated solution

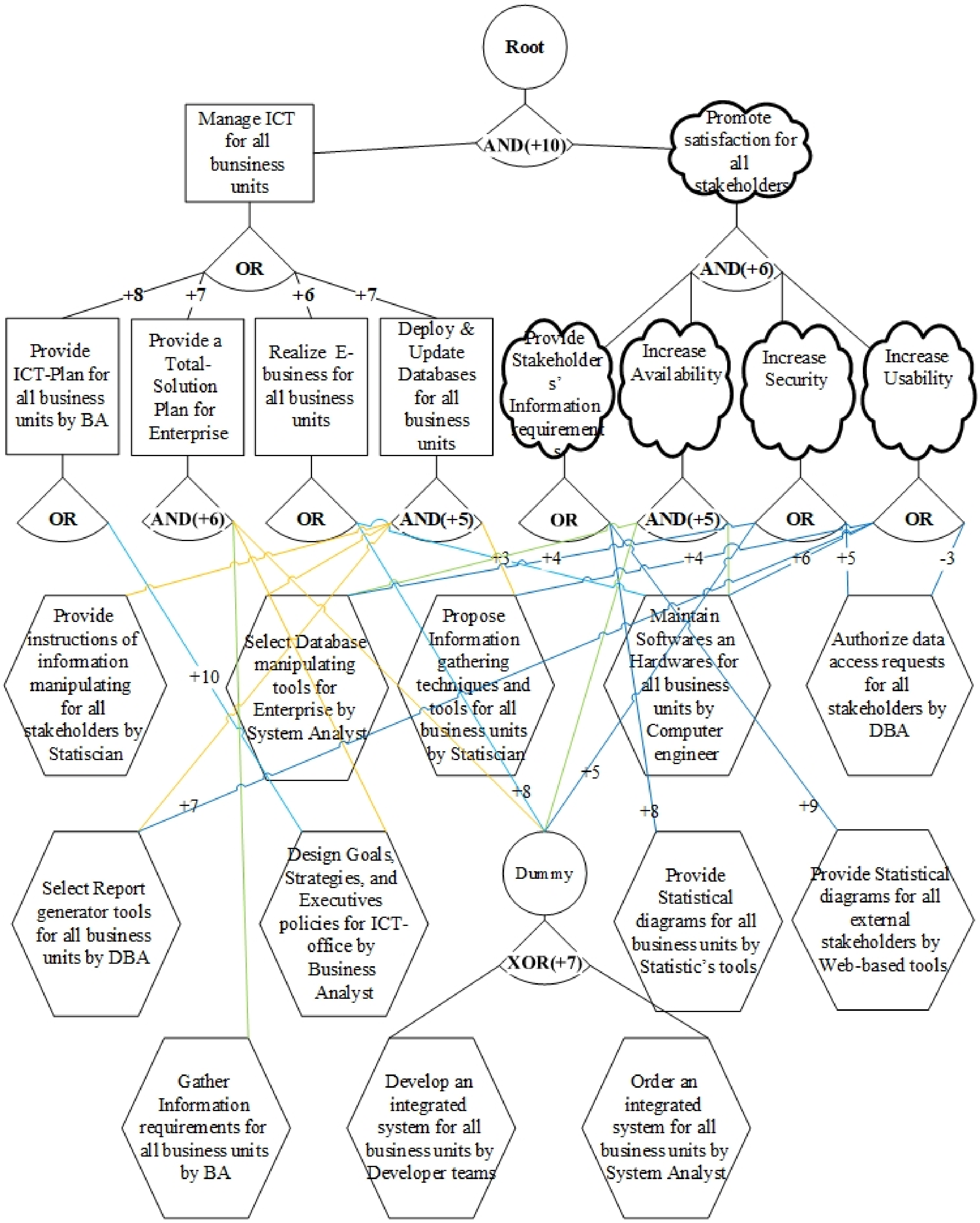


Figure 3: A Partial model of an IT-enabled business solution which is extracted based on the business strategy of the MPDC's company.

by evaluating Cost(Root) . Table 1 shows how SQBITAM evaluates the cost vectors based on the decomposer types and other related attributes. Relations 3.4 to 3.6 define three vector operators: MaxV, SumV, and AvgV. The MaxV operator computes and returns a resource vector that has a maximum value for each dimension of its parameters. SumV computes the relative sum of its parameters, and AvgV computes the weighted average of its parameters. The cost of each goal is equal to the cost of its associated decomposer. Relations 3.7 and 3.8

Table 1: Calculating functions to compute the cost of the proposed solution based on the required resources.

$Decomposer_{\bmod e}$	Cost Vector Definition
AND_{Best}	$SumV(\frac{\text{Cost}(g_{i_1})_{Best}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Best}}{InDegree(g_{i_m})})$
AND_{Worst}	$SumV(\frac{\text{Cost}(g_{i_1})_{Worst}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Worst}}{InDegree(g_{i_m})})$
$AND_{Possible}$	$SumV(\frac{\text{Cost}(g_{i_1})_{Possible}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Possible}}{InDegree(g_{i_m})})$
XOR_{Best}	$MaxV(\frac{\text{Cost}(g_{i_1})_{Best}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Best}}{InDegree(g_{i_m})})$
XOR_{Worst}	$MaxV(\frac{\text{Cost}(g_{i_1})_{Worst}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Worst}}{InDegree(g_{i_m})})$
$XOR_{Possible}$	$MaxV(\frac{\text{Cost}(g_{i_1})_{Possible}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Possible}}{InDegree(g_{i_m})})$
OR_{Best}	$MaxV(\frac{\text{Cost}(g_{i_1})_{Best}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Best}}{InDegree(g_{i_m})})$
OR_{Worst}	$MaxV(AvgV(\frac{c_1\times\text{Cost}(g_{i_1})_{Worst}}{InDegree(g_{i_1})},...,\frac{c_m\times\text{Cost}(g_{i_m})_{Worst}}{InDegree(g_{i_m})}),SumV(\frac{\text{Cost}(g_{i_1})_{Possible}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Possible}}{InDegree(g_{i_m})}))$
$OR_{Possible}$	$SumV(AvgV(\frac{c_1\times\text{Cost}(g_{i_1})_{Worst}}{InDegree(g_{i_1})},...,\frac{c_m\times\text{Cost}(g_{i_m})_{Worst}}{InDegree(g_{i_m})}),MaxV(\frac{\text{Cost}(g_{i_1})_{Possible}}{InDegree(g_{i_1})},...,\frac{\text{Cost}(g_{i_m})_{Possible}}{InDegree(g_{i_m})}))$

show the estimation of an IT-enabled business solution cost.

$$Resource\_Schema =< ResourceType_1, ..., ResourceType_n > \tag{3.2}$$

$$R_i(\text{Resource\_}Schema) =< v_{i_1}, ..., v_{i_n} > \tag{3.3}$$

$$MaxV(R_1, ..., R_m) =< Max(R_{1_1}, ..., R_{m_1}), ..., Max(R_{n_1}, ..., R_{n_m}) > \tag{3.4}$$

$$SumV(R_1, ..., R_m) =< Sum(R_{1_1}, ..., R_{m_1}), ..., Sum(R_{n_1}, ..., R_{n_m}) > \tag{3.5}$$

$$AvgV(w_1 \times R_1, ..., w_n \times R_n) = \frac{w_1 \times R_1 + ... + w_n \times R_n}{w_1 + ... + w_n} \tag{3.6}$$

$$Cost(G_i) = Cost(D_i) \tag{3.7}$$

$$Estimated\text{Cost} = \frac{\text{Cost}(Root)_{Best} + 4 \times \text{Cost}(Root)_{Possible} + \text{Cost}(Root)_{Worst}}{6} \tag{3.8}$$

2. **Time estimation:** To estimate the required time for designated business solution, SQBITAM gathers the three types of estimated times for each of the business requirements as$\text{Time}(br_i)_{Best}$, $\text{Time}(br_i)_{Worst}$ and $\text{Time}(br_i)_{Possible}$ and computes the estimated times for each of the business requirements using relation 3.10. To estimate the required time of the business solution, SQBITAM traverses the goal graph. It applies SUM to estimate the related time for the AND decomposer, AVE to determine the related time for the OR decomposer, and MAX to estimate the related time for the XOR decomposer. The estimated time for root goals is equal to the estimated time for the designated solution.

$$Estimated\text{Time} = \frac{\text{Time}(Root)_{Best} + 4 \times \text{Time}(Root)_{Possible} + \text{Time}(Root)_{Worst}}{6} \tag{3.9}$$

3.3.2 Quality assessment of the designed business solution

An IT-enabled business solution is well-designed and competitive provided it can run a business with a good quality of performance. Therefore, SQBITAM evaluates the quality of the designed IT-enabled solution in the following steps: (1) Evaluate the quality of the business requirements model by computing some requirements model's quality factors, especially quality factors which are introduced with IEEE 830[21] such as correctness, unambiguity, completeness, verifiability, modifiability, etc.,(2) assessing the quality of the TO-BE business process model as a business solution's behavioral model such as coupling, cohesion, modularity, size, etc.[19][33][12].Tables 2 and 3 show how to compute these factors. Table 4 shows how to calculate the auxiliary functions used to estimate these mentioned factors.

Table 2: Some business strategy model quality factors and their calculations.

Business requirement quality factors	Computation method	Case study sample value
Correctness	$\frac{Satv+Pos+Bup}{3}$	$\frac{0.525+0.961+0.560}{3}=0.683$
Unambiguity	Vdv	0.913
Verifiability	$\frac{\#Verbs}{\#Actions}$	0.635
Modifiability	Tre	0.7
Completeness	Cov	1
Consistency	$\frac{Hdv+Pos}{2}$	$\frac{0.884+0.961}{2}=0.922$
Traceability	$\frac{BkTr+FwTr}{2}$	$[\frac{0.515+0.508}{2}=0.511$
Rank of Importance and Stability	$\operatorname{Im}p(br_i)\times Stab(br_i)$	...

Table 3: Some TO-BE business process model quality factors and their calculations.

Business process quality factors	Computation method	Case study sample value
Coupling	$Avg\{Coupling(g_i)\|g_i\in Goals\}$	0.67
Cohesion	$\operatorname{Re}sourceCohesion(BP)\times\operatorname{Re}lationCohesion(BP)$	0.396
Complexity	$\frac{AC+CFC+RC}{3}$	24
Modularity	$1-Avg_{g\in Children(Root)}M(g)$	0.393
Size	$FSize+BSize+ISize+OSize$	198

Table 4: Required quxiliary functions that is used to estimate quality factors.

Auxiliary function	Computation method
Hd(m,s)	$AveDev_{st \in Stakeholders}\{m_{st,s}\}$
Hdv	$1 - Avg_{br \in BRs}\{\frac{Hd(m,s_1)}{10} \mid m = \Pr eferenceMatrix(m) \wedge s_1 \in Stakeholders\}$
Sat(br)	$Avg_{br \in BRs}\{Min_{g \in Children(Root)}\{Cntrb(br,g) \mid Path(br,g) \neq \varnothing\}$
Satv	$\frac{Avg_{br \in BRs}(sat(br))}{10}$
Cp(g,br)	$\sum_{p \in Paths(g,br)} \prod_{\{c_i \mid \exists e \in p.Contribution(e)=c_i\}} \frac{c_i}{10}$
CtrbP(g,br)	$Cp(g,br) > 1?1 : Cp(g,br)$
PositivePath(g,br)	$\{p \in Path(g,br) \mid \forall d_i \in CtrbP(g,br) > 0\}$
Pos	$\frac{\# \bigcup_{g \in Children(Root) \wedge br \in BRs} PositivePath(g,br)}{\#\{p \in Path(Root,br) \mid br \in BRs\}}$
Bup	$Avg_{br \in BRs \wedge m = \Pr eferenceMatrix(m) \wedge s \in Stakeholders}(\frac{m_{s,Bu\sin essExpert}}{10})$
Vd(s,m)	$AveDev_{st \in Stakeholders}\{m_{s,st}\}$
Vdv	$1 - Avg_{br \in BRs}\{\frac{Vd(s_1,m)}{10} \mid s_1 \in Stakeholders \wedge m = \Pr eferenceMatrix(br)\}$
Tre	$\frac{\#\{g \mid g \in Goals - InitialGoals \wedge \#Parents(g)=1\}}{\#\{g \mid g \in Goals - InitialGoals\}}$
Cov	$\frac{\#\{g \mid g \in children(Root) \wedge \exists br \in BRs.(Path(g,br) - PositivePath(g,br) = \varnothing\}}{\#Children(Root)}$
BkTr	$Avg_{g \in Goals - Initia\,l\,Goals}(CtrbP(i,g) \mid i \in InitialGoals)$
FwTr	$Avg_{br \in BRs}(CtrbP(g,br) \mid g \in Goals - BRs)$
$Stb(br_i)$	$\frac{\#\{p \in Paths(Root,br) \mid br \in BRs\}}{\#\{p \in Paths(Root,br_i)\}}$
$Imp(br_i)$	$Avg_{br_i \in BRs}(CtrbP(Root,br_i)$
Coupling(g)	$\frac{\#\{br \in BRs \mid \exists g_i \in Goals.Path(br,g_i) \cap Path(br,g) \neq \varnothing\}}{\#\{br \in BRs \mid Path(br,g) \neq \varnothing\}}$
ResourceCohesion(g)	$\frac{\#\{sg \in Children(g) \mid \exists g_i \in Children(g).g.Operations \neq g_i.Operations \wedge g.resources \cap g_i.resources \neq \varnothing\}}{\#\{sg \mid sg \in Children(g)\}}$
ResourceCohesion(BP)	$Avg_{g \in Goals}(\mathrm{Re}\,sourceCohesion(g))$
RelationCohesion(BP)	$\frac{\#\{g \in Parents(br) \mid br \in BRs \wedge \exists g_i \in Parents(br) \wedge br_j \in Children(g_i) \wedge br_j \in Children(g)\}}{\#\{g \in Parents(br) \mid br \in BRs\}}$
AC	$\sum_{s_i \in Bu\sin essScenarios} \#Operations(s_i)$
CFC	$\sum_{a_i \in And-Decomposers} 1 + \sum_{o_i \in Or-Decomposers} 2^{subgoals(o_i)} + \sum_{x_i \in Xor-Decomposers} subgoals(x_i)$
RC	$\#\{r_i \in \cos t(Root)\}$
M(g)	$\frac{\#\{p \in Paths \mid \exists g_i \in Children(Parents(g)) \wedge \exists br_1, br_2 \in BRs.g \neq g_i \wedge Path(br_1,g) \cap Path(br_2,g_i) \neq \varnothing\}}{\#\{p \in Paths \mid \forall br \in BRs.Path(br,g) \neq \varnothing\}}$
Fsize	$\sum_{g_i \in Goals} OperationNO(g_i)$
BSize	$\#Bu\sin essGoals + \#BRs$
ISize	$\#\{r_i \in \cos t(br_i)\}$
OSize	$\#\{r_i \in \cos t(br_i)\} + \sum_{A_i \in Actors} UseCaseNo(A_i) + \sum_{s_i \in Bu\sin essScenarios} ActionsNo(s_i)$

3.3.3 Evaluation of alignment factors

Measuring the degree of alignment between business and IT in the designed IT-enabled solution, to determine the degree of compatibility of the solution with the existing business conditions and the probability of its successful implementation. Measuring the alignment's degree between business and IT-enabled business solution is one of the most important steps in the BITA process. Among many of BITA's researchers, only Doumi et al. [14] have introduced some measurable alignment factors to measure the level of fitting the business and IT/IS. Their introduced alignment factors are either Intentional or Functional factors.SQBITAM applies and customizes these factors to estimate the alignment degree. Intentional factor includes three metrics: (1) percentage of goal supported by business processes (PoGBP). Relation 3.10 estimates PoGBP based on the average value of the degree of business statements covering that computes by Cov,the percentage value of achieving goals which evaluate using Pos, and the degree of content of business statements which are related to business requirements. (2) percentage of resources used by business processes related to goal (PoRBP). Relation 3.11 estimates PoRBP based on the ratio of the required resources to cover the Root goal divided by the number of resources in the real mode that used to cover each business requirement. , and (3) percentage of actors that contribute to achieving a goal (PoACG). Relation 3.12 estimates PoAcG by dividing the of the number of actors who perform business events that have a positive effect on the achievement of goals on the number of total actors. Functional factor includes two metrics: Percentage of business processes which are supported by information systems (PoBPsIS). Relation 3.13 estimates PoBPsIS based on the ratio of the number of business requirements which are related to an IT-service divided by the total number of business requirements., and Degree of Cooperation between direction of information systems and managers (CoISM). Relation 3.14 estimates CoISM by computing the ratio of business analyst's and system analyst's opinion differences about each business requirement. Relations 3.153.163.17 show how to estimate alignment degree based on the above mentioned factors. Table 5 reports the estimated values of MPDC's alignment factors.

$$PoGBP = \frac{Satv + Pos + FwTr}{3} \tag{3.10}$$

$$PoRBP = \frac{\sum\limits_{br_j \in Bu\sin ess\mathrm{Requirements}} \sum\limits_{v_i \in Bu\sin essValues} v_i \times \mathrm{Cost}(br_j).i}{\sum\limits_{v_i \in Bu\sin essValues} v_i \times \mathrm{Cost}(Root).i} \tag{3.11}$$

$$PoACAG = 1 - \frac{\#\{a_i \in Actors | \forall g_k \,.\, a_i \in UseCase(g_k) : \prod\limits_{c_j \in \{p \in Path(g_k, root) | \exists e \in p.has(e, c_j) \wedge c_j \in Contribution\}} \frac{c_j}{10} < 0\}}{\#Actors} \tag{3.12}$$

$$PoBPsIS = \frac{\#\{br_i \in Bu\sin ess\,\mathrm{Re}\,quirements | \exists IS_k \in InformationSystems \,.\, Achieve(br_i, IS_k)\}}{\#Bu\sin ess\,\mathrm{Re}\,quirements} \tag{3.13}$$

$$CoISM = 1 - \sum_{br_i \in BRs} \frac{|Avg(Vd(BA, br_i.m)) - Avg(Vd(SA, br_i.m))| + |Avg(Hd(BA, br_i.m)) - Avg(Hd(SA, br_i.m))|}{2 * \#BRs * AveDev(br_i.m_{k,k})} \tag{3.14}$$

$$IAlignment = \frac{PogBP + PoRBP + PoACAG}{3} \tag{3.15}$$

$$FAlignment = \frac{PoISsBPs + CoISM}{2} \tag{3.16}$$

$$Alignmentdegree = \frac{IAlignment + FAlignment}{2} \tag{3.17}$$

4 Related works

Our surveys show that the realizability of the business requirements and the inefficient and lengthy process of translating business requirements into business services are currently the two significant challenges in RE-based BITA. BITA's methods align the capabilities of the information system with business goals. These methods should be able to analyse and align the interrelations among business system components, such as the IT system, business environments and stakeholders [28].

Ullah and Lai proposed a BITA method, called GOBRE as a goal-oriented requirements engineering approach to better understand the organization's business goals by BA and IT development team [36]. GOBRE is an operational

Table 5: MPDC's alignments factors estimation.

Function	MPDC's estimated values
$PoGBP$	0.667
$PoRBP$	0.790
$PoACAG$	0.901
$PoBPsIS$	0.667
$CoISM$	0.880
$IAlignment$	0.786
$FAlignment$	0.774
$Alignmentdegree$	0.780

alignment method with two main parts including: A strategic alignment model (SAM) and business infrastructure and a way to extract and model the system requirements [35]. Some major difficulties of GOBRE are: (1) Goal tree cannot model all the possible relationships between business goals, such as XOR. (2) State chart diagram is not an efficient diagram to model and extract system requirements. (3) SAM model does not introduce a well-formed way to determine business needs.
Brian Elvesæter et al. proposed a BITA method, called EPJC in this article[16], as an operational alignment method aligning via architecture. EPJC uses a goal model to model business goals and combines the service-oriented architecture modelling language (SoaML) with the BMM methodology to define business motivation models and uses the BPMN language to describe business processes. It is lack of a well-formed component for business strategy modelling.
Carlos E. Salgado et al. proposed an OMG-based BITA method called SMM in this article[7]. SMM is an intellectual alignment method which aligns via governance. It uses Use-case model and BMM language as a requirements modelling language. To align the business and IT/IS, SMM uses a V model. All the SMM activities are done via a SPEM process which aligns business requirements with service quality characteristics using logical architectures and derives logical architectures by focusing on eliciting functional and non-functional requirements[7].

Karim Doumi et al. proposed a strategic BITA method called DBB in this article[13]. DBB is an i*-based intellectual alignment which aligns business and IT via architecture. It uses goal modelling at the strategic level and enterprise architecture at the functional level. As a major difficulty of DBB, Correspondence between strategic indicators and the blocks of the information system do not give a practical approach to assessing the level of alignment.

Chen et al. proposed a cross-domain alignment method for managing misalignments between business and IT architectures and called it BITAM [9]. BITAM integrates business analysis and architecture analysis, defines mapping between three layers: the business models, business architecture and IT architecture, and gauges misalignments, either qualitatively or quantitatively. BITAM uses a scenario-based RE modelling language. Then, BITAM has improved using SOA concepts and introduced BITAM-SOA by Chen[8]. As a major difficulty of BITAM, no specific and practical procedures have been introduced to gauge the qualitative and quantitative misalignments.

Jaelson Castro et al. introduced a requirements-driven information system developing method called CKM in this article. CKM is a Cross-domain alignment method which aligns via communication. It tries to build a semantic bridge between the information system's development and its operational environment based on Tropos method [**?**]. It maps i* concepts to JACK constructs. The following difficulties have been found in this method: (1) Requires some additional details for validating the quality of the designed solution, (2) Difficulties in business goals identification: it needs to check all the business documents during the RE process.

Steven J. Bleistein et al. proposed an intellectual BITA method and called it Strategy-Oriented Alignment in Requirements Engineering (SOARE). SOARE aligns business and IT via architecture. To improve SOARE, they proposed a requirements analysis framework method to validate organizational IT based on strategy, context, and process by combining the i* goal modelling language , Jackson's Problem Diagram, and Role Activity Diagrams into one overall top-down method called B-SCP [5]. B-SCP aligns a business strategy with IT requirements. They have used a business strategy analysis technique to deconstruct a business solution[5]. Two major limitations of B-SCP are: (1) The complexity of B-SCP is high, because it has a number of heterogeneous diagrams such i* goal modelling diagrams, Jackson's Problem diagram and so on, (2) B-SCP needs to meet some of the rules for extracting business goals from mission.

5 Evaluation and Conclusion

This section compares SQBITAM with some of the other recent works which are reviewed. For fair evaluation, this comparison is based on the evaluation framework criteria introduced by El-Mekawy et al. [15]. This framework includes four different aspects: (1) design-related aspect which consists some comparing criteria including: Business architecture consideration, IT architecture consideration, IT planning methodology, Method of development, Modularity and Customizability, (2) organization-related aspect which consists some comparing criteria including: Organizational size, Domain specification, and Dynamic nature, (3) analysis-related aspect which consists some comparing criteria including: Analytical purpose of the model, Working strategy, Level of assessment, Information strategy content, Analysis of the business status, Risk awareness, Measurability of alignment, and Step-by-step support for analysis, and (4) Usability related aspect which consists some comparing criteria including: Practice guidance, the user's role, Comprehensiveness, Complexity of use & application, Internal consistency, Scope of alignment, Effect/efficiency vs how things done, and finally Time to value. The comparing results are summarized in Table 6. These results shows that in most the most aspects of evaluation, SQBITAM behaves more appropriately than others.

Table 6: Quality factors of business process models and their calculation.

Comparing Aspect	GOBRE	EPJC	SMM	DBB	BITAM	CKM	SOARE	SQBITAM
Design-related	M	M	H	H	H	M	H	VH
Organization-related	H	M	M	VH	H	VH	VH	H
Analysis-related	L	M	L	M	H	L	H	VH
Usability-related	VL	L	H	L	VH	VH	M	VH

SQBITAM, as a new version of QABPEM's RE phase [1], was proposed for BITA. It proposes a RE language for modelling the business strategy which enables the business analysts to analyse and substitute all the IT-enabled business solution alternatives. One of the most important and individual innovations of the SQBITAM is the capability of analyzing the alignment degree between business and IT for the proposed IT-enabled business solution. In this way, the analyst can find out the appropriateness of the designed solution with its business environment. Quantifiability assessment is another advantage of this method, achieved through estimating the cost and time required for the designed IT-enabled business solution. Cost and time analysis could be appropriately performed while analysing the business scenarios in requirements modelling. Based on the number of required resources and their business values, SQBITAM can estimate the costs of each IT-enabled business solution and based on the execution time of business events, SQBITAM can estimate the response time of the designed solution. SQBITAM is more precise than the RE phase of QABPEM, as shown by the results of our case study for estimating the time and cost of a business solution. Other advantages of SQBITAM include: (1) capability to have a computerized tool that supports all its steps, (2) capability to produce an XML-based output based on StratML, as introduced by ISO $17469-1:2015$ and (3) modifying the notation of business requirement modelling. In the future, researchers will be able to use SQBITAM as a business process reengineering method by coupling it to a BPE method. Another research area is the estimation of other quality factors, such as security. Designing a secure IT-enabled business solution is a well-known challenge for any B2B system, and SQBITAM can be extended to these areas. Another research area which can be of interest involves designing BITA methods for cloud-based businesses. Other future research avenues involve developing an extended version of SQBITAM that can estimate and evaluate other TO-BE business processes' quality factors. These could, to exemplify, include the quality factors mentioned by Heravizadeh et al. [19], ISO 9000 and business maturity factors, which can promote a business maturity model.

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