Boundary Objects for Value-based Requirements Engineering

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Abstract: Value-based requirements engineering focuses on the alignment of requirements engineering decisions and business value decisions. There is much evidence on the importance of this alignment and there are several approaches for tackling specific alignment decisions such as e.g. release planning. However, for the general picture of what this alignment is about, a common language between requirements engineering and business decision makers is needed. The goal of this paper is to make explicit the boundary objects between requirements engineering and business value decisions. These boundary objects have been derived from literature and are evaluated in three typical scenarios of how software can provide value to business: (1) the product management scenario, where software is (part of) a product sold by the company, (2) the IT procurement scenario where the software and related services are procured by the company, and (3) the IT development scenario, where software is developed in-house to be used in the IT infrastructure of the company. An empirical study of the relevance of the identified boundary objects is the most important future work.

1 Introduction

Value-based software engineering emphasizes the importance of stakeholder values, in particular of business decision makers and users, for the software engineering (SE) product and process. Thus, it links value propositions of stakeholders to technical decisions during software development. It ties together work on using qualitative and quantitative approaches for continuous decision making during software development [BAB+05]. Typical examples are value-based approaches for requirements prioritization, architecture trade-off and test focus decisions. As a first step for all these activities it is crucial to elicit and understand the value of the stakeholders. This is an important part of value-based requirements engineering (VBRE). In the following we focus on the business stakeholders and their values with respect to software.

There is a long history of studying the value of information technology (IT)[1] for the business in the management of information system (MIS) literature under the heading of IT alignment. A recent survey on IT alignment collects the most important questions and results [CR07]. The studies and approaches described typically focus on models and factors for successful alignment, but give little guidance on what exactly needs to be aligned. This makes it difficult for SE researchers to integrate this alignment viewpoint into their work. This gap is also identified in [BCV06] who propose an integration of problem diagrams and goal modelling to make the link between business strategy and IT requirements explicit. Here we do not want to introduce a specific modelling approach for alignment. Instead we want to identify the objects of the alignment. [BCV06] speaks about vision, mission, objectives, strategies and tactics, but not about what aspects should be considered for the vision and so on. In practice, as emphasized in [CR07], a common language between business and IT is an important prerequisite for successful alignment of business and IT. Similarly, we strongly believe that for successful research on VBRE a common understanding of the alignment objects and the nature of the alignment relationships is important.

Thus, in the following we aim to identify so called **boundary objects (BO)** between researchers and practitioners in requirements engineering (RE) and researchers and practitioners in business decisions. BO is a term introduced by Star and Greisemer [SG89] to describe objects that serve as an interface between boundaries of domain knowledge. BO have been investigated in the knowledge management literature, but also in the information systems literature, e.g. [PR00]. In this article we use the term to denote concepts or artefacts which are in the business domain, but should also be known in RE so that IT requirements decisions are aligned with business values. The BO and the terminology used for the BO will be specific for each company, but it seems to be viable to provide a general framework of BO so that the BO of one company can be viewed as an instantiation.

We have searched for general standards in the area of business value decision to identify the BO. We only found very few and tried to generalize them. To evaluate the resulting framework we have investigated in more detail 3 typical scenarios of how software can provide value to business. They are also characterized in [Chil02]: "Software business models and financial implications also differ based on whether the software is a consumer product, an outsourced development project, a service, or an internally funded application development project. Each presents stakeholders with different financial models, margins, and long-term possibilities."

The BO constitute a model of the important entities of the business – IT alignment process. The goal of the paper is to present the model as a point of discussion and a starting point for empirical investigations of VBRE.

The rest of this paper is structured as follows: in the next section we describe the BO we have identified. In section 3 to 5 we discuss its instantiation for product management, IT procurement, and in-house IT development respectively. In the conclusion we give a

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[1] Note that we use IS (information system) and IT interchangeably in the context of this paper.

summary of the contribution of this article and sketch future work.

2 Boundary Objects

In this section we describe our framework of BO for business – IT alignment and how it was derived. We are requirements engineers and not business specialist. Thus, we have searched in the management information system (MIS) literature from an outsider point of view. Our framework is based on previous work on VBRE as well as on standards in the MIS field.

We set out by partitioning the objects into different categories. Aurum and Wohlin have categorized the RE decisions related to business into a 3 by 3 matrix [AW05]. The columns characterize the scope of the decision: the whole company, the software product or system, and the project which delivers (part of) the product or system. The rows distinguish decisions as strategic or tactical (that means they define the resources) or operational (that means the day to day decisions). Strategic decisions are detailed into roadmaps on the system level and into plans on the project-level. We focus on the 2 by 2 matrix of the strategic and tactical decisions on company and system scope in the following.

These 4 cells have been investigated for many years in the business-IT alignment literature (for an overview see [CR07]). The underlying standard is the so called Strategic Alignment Model. It comprises on the strategic level the business strategy and the IT strategy, and on the tactical level the company infrastructure and processes and the IT infrastructure and processes. As can be seen in Figure 1 the alignment decisions take place in a broader context relating the business domain, competitors and human factors on the one hand with the IT domain, the global IT platform and the IS implementation processes on the other hand.
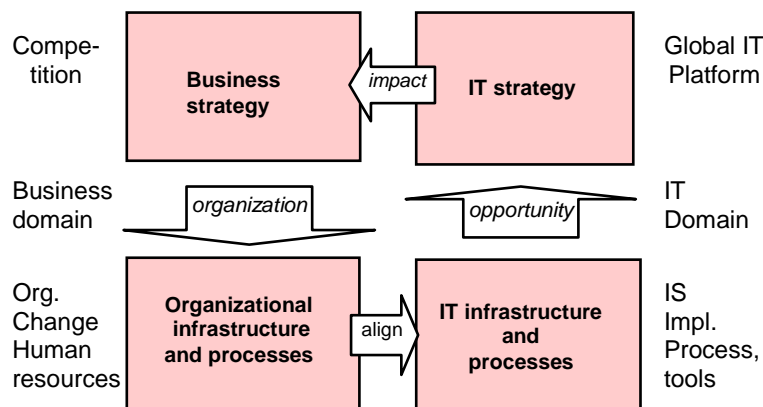

Figure 1: Business - IT Alignment Process (adopted from [CR07])

However, what are the BO which constitute each of the 4 categories? In the MIS

literature a lot of examples are given, and a lot of differences are discussed between different kinds of strategic decision making. These differences are important for how the decisions are made, but in RE we are interested in the outcome of the business decisions. So by reading through textbooks and standard literature we have identified in each of the 4 categories several BO as depicted in Figure 2. They are explained in the following subsections.

Corporate strategy

| Corporate soft goals | Corp. financial goals | | System soft goals | Sys. financial goals |

align

Based on

| Corp. Int SWOT | Customer SWOT | Corp. Ext SWOT | | Syst. Int. SWOT | Customer value | Syst. Ext. SWOT |

align

organization

| Corporate Resource | CRM | Corp.Ext Actions | | System resource | Features, customer support | Syst. Ext. action |

align

Based on

| Corp. IT tactics | Corporate int. change | | Feasibility, quality | System Dev. change action |

align

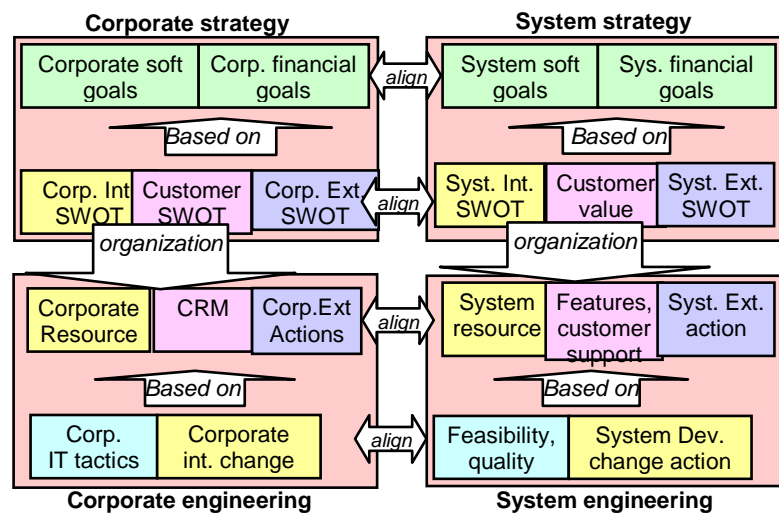**Corporate engineering**   **System engineering**   **System strategy**

Figure 2: VBRE BO

As we are not business experts there is of course a high risk that we have overlooked something important. Therefore we have chosen the three scenarios mentioned before and standard literature for them to evaluate the comprehensiveness of the framework. There is also the risk that we have abstracted too much to limit the number of BO. We believe that this level of abstraction is one step forward in closing the gap between RE and business decision making. This will be further discussed in the conclusion.

In the following subsections we explain the BO in the 4 categories in more detail. We have changed the terminology slightly compared to Figure 1. As "business" is such a general term, we call the business strategy in the following **corporate** strategy to emphasize the corporate-wide scope. As IT often only refers to the IT infrastructure and not to the software as a product, we use the term **system** instead of IT. The tactical levels are called **engineering levels** to emphasize that on this level for the software system the major pre-project engineering decisions are made. In the last subsection we discuss the relationships between the BO.

2.1 Corporate Strategy

For the **corporate strategy category** we rely on the well-known framework of the Balanced Scorecard [KN05]. This framework distinguishes the **financial perspective,**

the innovation and learning perspective, the customer perspective and the internal business process perspective. The financial perspective is the viewpoint of the shareholders, the innovation and learning perspective focuses on the ability for innovation, the customer perspective on the relationship to the customer and the internal business process perspective on how to achieve the financial, innovation and learning, and customer relationship goals through internal excellence.

Each of these perspectives comprises typical BO. We call the BO of the financial perspective *corporate financial goals*. The innovation and learning perspective captures the intangible goals, which we call *corporate soft goals.* Typical examples are competitive advantage or improved practice. The other two balanced scorecard perspectives help to compare these two kinds of goals to the current internal and external state of the company to assess the feasibility of the goals.

The current state is typically analyzed in terms of strengths, weaknesses, opportunities and threats (SWOT) [CaYe04]. There has been some debate about the usefulness of SWOT for strategic decision making [HiWe97]. Typically strengths and weaknesses are only considered for the internal state and opportunities and risks only for the external state. We do not want to determine a specific method of thinking about SWOT. As illustrated in [SMD02], SWOT can apply entirely to internal and external state. So, e.g. an internal opportunity could be to use IS to improve documentation or decision making for some internal process, and an external weakness could be problems with suppliers. The main difference important here is that strengths and weaknesses apply to the past and the current state achieved, while opportunities and threats try to forecast the future and how that might alter the current state. Thus, in the following we introduce two BO for two full SWOT considerations of the internal and external state, respectively. The *corporate internal SWOT analysis* focuses on the internal business process perspective. This comprises the current resources, in particular the core competencies to achieve the goals. Similarly, the goals have to be compared with the current external state, namely through the *corporate external SWOT analysis*. It focuses on external factors that cannot be influenced by the company, such as the competitors or legal regulations.

The corporate external SWOT analysis is the first of the BO for the customer perspective. There is also an in-depth analysis of the customer view needed, the *Customer SWOT*. It focuses on market trends and the overall customer relationships of the company. In the Balanced Scorecard the external state wrt competitors and external regulations is on the one hand part of the customer perspective and on the other hand part of the innovation and learning perspective. We decided to separate BO which are important for different actors. In the sections describing the three scenarios these actors are illustrated explicitly in the figures..

2.2 System Strategy

For the **system strategy category** we did not find a standard reference. However, we noticed that the BO types identified for the corporate strategy are also useful for the system strategy. Here the goals and the SWOT analyses focus on the system and not the overall company. We believe that this similarity of BO types between corporate strategy and system

strategy is very helpful for the mutual understanding. This is is also emphasized in [BDNP07] whoc introduced the IT scorecard as a means of business – IT alignment. It is important to emphasize that this similarity does not mean that corporate strategy and system strategy deal with the same issues. It means that the strategies use the same perspectives to analyze their issues. In the alignment process typically the BO of the same perspective need to be aligned most closely (see also section 2.5.).

The BO of the financial perspective are the *system financial goals*, typically the return of investment (ROI) to be gained from the system. There are also *system soft goals* associated with the system, namely its influence on the innovation and learning of the company and the innovation and learning of the system itself. The *system internal SWOT analysis* focuses on the resources, processes and costs associated with the system and the *system external SWOT analysis* on the external factors which influence the system.

For the system strategy the customer perspective in terms of the *Customer value* is again very important. There is much literature in marketing and MIS on what constitutes the customer value of a product. [AW07] have summarized the most important aspects from an RE point of view. They distinguish the following aspects of the customer value: the product value, the customer's perceived value (CPV) and the relationship value (RV). The product value is the market value of the product (i.e. exchange value), the CPV (i.e. use value) is the perceived benefits / perceived price, where the perceived benefits and the perceived price are both measured relative to competing products, and the RV is created through the social relationships between the company and the customer.

2.3 Corporate Engineering

The **corporate engineering category** comprises the tactical BO to achieve the corporate strategy. As in the Strategic Alignment Model, the tactical level comprises roadmaps and processes about what parts of the strategy to achieve when and how. Here we have chosen the roadmaps and processes to mirror the perspectives of the SWOT analyses. Again, this helps in the alignment process so that the strategic goals of a perspective are most closely aligned with the tactics of the same perspective.

The *corporate resource roadmap* encompasses the company-wide planned resource allocation in terms of overall budgets and personnel. It takes into account the internal and external SWOT. The overall *customer relationship management processes (CRM)* have to take into account the customer SWOT. Furthermore**,** a roadmap and processes for *corporate external actions* such as marketing have to be defined.

The tactical level also comprises the organizational pre-requisites for the processes and roadmaps. On the one hand these are *corporate internal changes,* such as restructuring or training. On the other hand these pre-requisites come from the long-lasting IT decisions. So, we introduce a further perspective: the **technical perspective**. This is due to the overall influence of technology on business processes. In the context of business – IT alignment, this should be captured explicitly. On the corporate level the technical perspective comprises company-wide *IT-tactics* such as overall platform or tool decisions. As in Figure 1 these general technology decisions are not captured in the

system category. They are the glue between business decisions and individual system decisions. .

2.4 System Engineering

In the **system engineering category** again the BO mirror the BO of the corporate engineering category, and we believe that this similarity is very helpful.

There are *system resource roadmaps* which define system budget and personnel. This has to take into account the corporate resource roadmap as well as the internal and external system SWOT. The *system external actions* focus on marketing and related actions wrt system. They have to take into account the external actions on the corporate level and the system external SWOT. For the customer value perspective the *features* of the system have to be defined and the *customer support* for the system which has to take into account the corporate CRM. These roadmaps and processes are in turn based on *system specific development process changes* such as development team organization or training. The technical perspective encompasses the *feasibility* of the features as well general technical processes wrt. system, e.g. *quality standards.* Both have to be compatible with the corporate IT tactics captured in the corporate tactical level.

2.5 Relationships between BO

The alignment process comprises all BO. However, there are stronger relationships between some BO than between others. On the one hand the system strategy BO and the corporate strategy BO have to fit to each other. As discussed in the literature, e.g. [BBK02], it is not possible to determine which comes first. The corporate strategy can be triggered by the system strategy and vice versa. For the alignment we believe it is helpful that the BO in these two categories are very similar. So the alignment can focus on BO of the same perspective. On the one hand the goals of the two categories and on the other hand the SWOT analyses of the two categories should be aligned very closely. Similarly the BO of the two engineering categories should be aligned.

Furthermore the engineering BO have to fit to the strategy BO. In Figure 1 there is a distinction between organization and opportunity, where the system engineering influences the system strategy, but the corporate strategy the corporate engineering. We believe that in general the purpose of the engineering level is to realize the strategy level. That is why we call this an organization relationship. The opportunities are considered in the SWOT analysis.

Besides these very close relationships it seems to be true that each BO may influence every other BO. So, e.g. as corporate engineering defines overall resources, this might limit even the options for system strategy, since it influences the internal and external SWOT with respect to. the system.

The BO have been derived from a few key literature sources. In the following they are evaluated by analyzing three typical business - IT alignment scenarios in more detail.

3 Product Management

In this section we examine the BO in the product management scenario. This scenario focuses on the value the software can deliver as part of the main product of the business. Surprisingly there is not much generalized knowledge on product management (compared e.g. to the PMBOK, the project management body of knowledge [PMI04]). And even less on managing software as a product. The need for the latter has been prominently advocated by Ebert, and his recent article gives some insights into product management at Alcatel. [Eber07]. One of the few standard text books on this topic is [Gor06] which we use as the major source for this scenario.

According to [Eber07], product management is responsible for product (system) strategy and product (system) engineering. Ebert mentions the following BO on the enterprise and product level: product vision, portfolio (investment, capital, assets), marketing and sales strategy, marketing, functional and technical roadmap and product-life-cycle management. In synchrony to our framework the product vision comprises the soft goals, the portfolio the financial goals. Marketing and sales strategy relate to the customer value perspective and the external perspective. On the engineering level these are detailed into roadmaps taking into account the necessary life-cycle processes.

[Gor06] gives more details on these BO: For the system (product) strategy she mentions

- Soft goals: new uses, repositioning, product line extension, quality improvement
- Financial goals: balance between product costs and market prize
- Product SWOT: capacity utilization
- Customer SWOT: target markets, customer value management
- External SWOT: competitive differences

For system (product) engineering she mentions

- Product Resources: prizing
- Features and customer support: service level provided by the company; unique selling factors, warranty, training
- Product external actions: promotional alternatives, marketing research and plan, exchange market share with sales, distinguish key accounts, target accounts and maintenance accounts; prizing, advertising, field sales plan, distribution plan
- Technical viewpoint: Feasibility and quality standards
- Internal changes: Product team change

We did not find any concepts in this book which do not fit to the BO. This handbook does not detail the corporate side, but stresses "a product manager needs a broad knowledge of virtually all aspects of a company along with very focused knowledge of a specific product or product line and its customers".

In Figure 3 we have depicted the BO and the actors mainly responsible for them in this scenario. Note this induces a new grouping of the BO so that strategic and tactical BO specific for one actor are combined in one box. This picture illustrates the complex communication and decision processes necessary for the alignment of the product and the business. To make the figure more specific for this scenario we have sometimes mentioned the specific BO listed above instead of the general one, e.g. marketing plan instead of external action, or the different value aspects of the customer value.
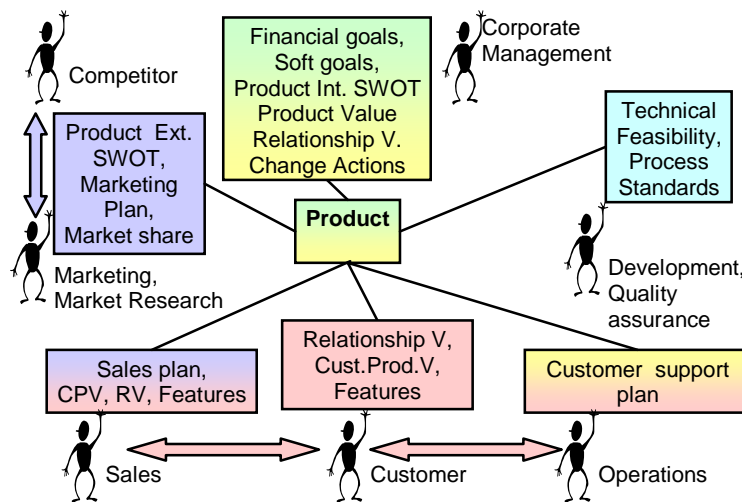

Figure 3: Product Management Communication

4 IT Procurement

In this section we analyze the BO in an IT procurement scenario. As IT becomes a commodity .

[Carr04], companies can not afford developing all of their IT themselves. Thus, software is part of the IT infrastructure bought or procured from suppliers. For this IT procurement scenario we have relied on a recent study (literature and empirical) to identify outsourcing issues: [HL07] identified the most prevalent factors for outsourcing decisions. We have assigned these to system strategy and system engineering in the following list. The discussion in [HL07]does not distinguish clearly between corporate and system strategy. The match to the corporate strategy is implicit in these considerations. Thus, we only look at the system level of our framework.

System strategy needs to reflect

- Financial goals: strategic importance (competitive advantage)
- Soft goals: intellectual property

- Internal SWOT: cost, time, internal resources (competencies), organizational factors, development and performance risks
- External SWOT: market maturity, standards and regulations
- Customer SWOT: internal maturity, commoditisation

System engineering needs to reflect

- Features and Customer Support: Requirements fit, support from the supplier
- Technical Viewpoint: Scale and complexity

All the system goals and SWOT BO are mentioned above. Intellectual property is an example of an intangible benefit. As typical for in-house resources, the financial benefits are not explicitly discussed, but clearly part of the strategic importance. Organizational factors refer to internal cultural issues like management support and knowledge management.
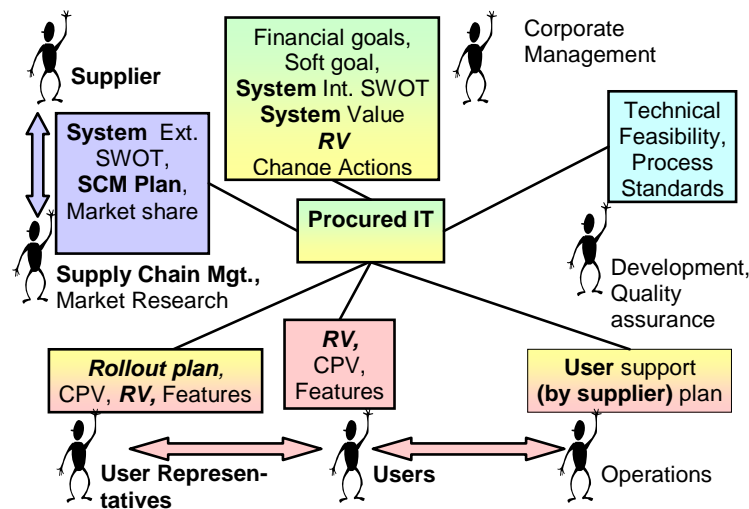

Figure 4: IT Procurement Communication

In this scenario the relevant market is not the market of the company, but the supplier market and the external regulations. Thus, the market maturity is an instance of the external SWOT (and not of the customer SWOT as in the previous scenario). Furthermore, the customers are not the customers of the company, but the internal (and possibly external – in case of E-commerce) IT users. Therefore the considerations on internal maturity and commoditisation are instances of the customer SWOT. These differences to the product management scenario are also highlighted in Figure 4 which illustrates again the responsible actors and their communication. The main differences are in the external considerations (suppliers are more important than competitors for this

scenario and thus supply chain management (SCM) is more important than marketing) and in the customer considerations (the customers are the users of the system and instead of sales the user representatives are important).

As [HL07] discusses success factors and not plans and actions, the internal SWOT and changes and the external actions are not mentioned. [CPP00] proposes a more detailed framework for make-or-buy decisions which is also covered by our framework. Thus, also for this scenario our framework seems comprehensive enough.

5 In-house development

As the final scenario, we look in this section at in-house development. This situation is typically discussed in the textbooks on IS (project) management, e.g. [BBK02][CaYe04][Olso00].

These textbooks typically have one or two chapters on strategic issues before they go into details on the IS development and the project management. We take as the reference [Olso00] which mentions the following BO:

Corporate strategy

- Soft goals: intangible factors like increase in market share or better corporate image, value analysis
- Financial goals: cost/benefit analysis
- External SWOT: response to competition, satisfaction of legal requirements
- Internal SWOT: better support for management decisions, probability of achieving benefits

System strategy

- Soft goals: hidden outcomes affecting organizational power and communication, value analysis
- Financial goals: cost/benefit analysis
- Internal SWOT: probability of project completion, risk identification,
- Customer Value: user needs, failure analysis

System engineering

- Features: Requirements
- Feasibility, quality: introduction of new technology

So again, all concepts mentioned are covered by our framework. For the corporate strategy the customer SWOT is not mentioned and for the system strategy the external

SWOT. Corporate engineering is not mentioned at all and only some system engineering BO. The main emphasis of these books is on the project level which is not treated so far in our framework.

In Figure 5 we depict again the involved actors. The in-house scenario is somewhat in between the product management and the IT-procurement. As there are no suppliers the emphasis of the external SWOT is on the competitors as for the product management. It is well known that in-house development is important if the company wants to establish its competitive advantage based on the IT. We have included partners as further actors for the external considerations in case of e.g. E-commerce support. These could also be introduced in the IT procurement scenario. For the customer value, similar to the IT procurement scenario, the users and their representatives are important.
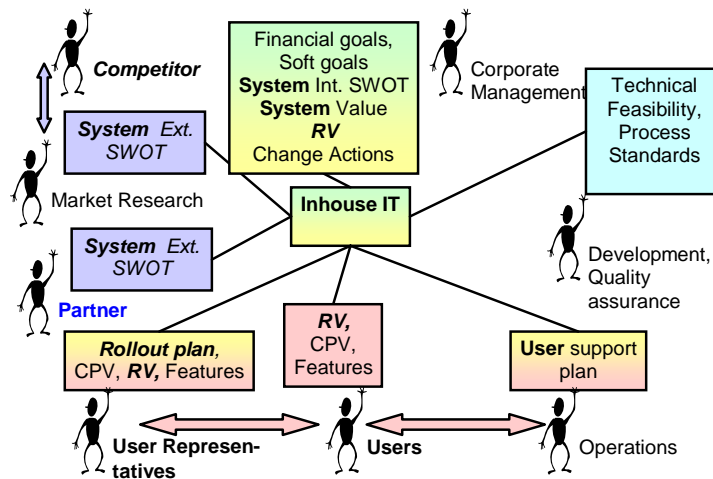

Figure 5: In-house Development Communication

6 Conclusion and Future Work

The main contribution of this paper is a refinement of the strategic alignment model in terms of boundary objects for business – IT alignment from the viewpoint of RE. The BO are the main concepts and artefacts which need to be communicated between business decisions makers and IT decisions makers, in particular during the RE. We have shown that our framework is comprehensive enough to cover 3 typical scenarios of how software can deliver value to business. The main advantage of our framework is to capture the major concepts and artefacts in a small set of BO associated systematically to a small set of perspectives. On the strategic level the perspectives of soft goals, financial goals and external, customer and internal SWOT apply to both the corporate and the system scope. On the tactical level these perspectives are mirrored in roadmaps and processes for external actions, internal resources and changes, and customer relationship. Furthermore a technical perspective is added to reflect overall IT tactics on the corporate

and on the system level.

A further contribution of this paper is a consequence of small set of universal BO: we could easily identify major commonalities and differences between the three scenarios. It is important to keep them in mind when detailing the BO into specific alignment decisions.

While these BO are still quite coarse, they are helpful as a starting point to incorporate business value considerations into RE methods. Existing methods for VBRE typically either treat very specific decisions such as e.g. requirements prioritization,or treat strategy on a very high-level (e.g. [BCV06]). Our framework is more general (as it applies to all VBRE decisions) and more specific (as it defines more specific BO) at the same time. Thus, existing and future modelling approaches for the alignment of business and requirements decision can be evaluated in how far they reflect the BO. For example, RE methods for goal analysis like i* which already incorporate goals and soft goals can be extended to specifically deal with the other BO [CNY00]. We believe that this level of specificity needs to be achieved by the modelling approaches so that business and IT practitioners and researchers can communicate well. Furthermore, the framework can serve as a checklist for teaching VBRE. While it is rarely possible to include a whole curriculum on business and economics into a SE curriculum, we believe it is important that every software engineer at least learns some basic concepts from this domain.

Clearly as a first step for future work case studies are necessary which identify the BO in different companies and compare them with our framework. These case studies then serve as an empirical validation of the accuracy of the framework.

There are also several ways on how to extend the framework. So far we have not treated the BO on the project level and the operational level. We expect them to be refinements of the BO of product and tactical level.

Acknowledgement

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