Risk Identification at the Interface Between Business Case and Requirements

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Abstract. [**Motivation:**] The requirements engineering (RE) research community is aware of the importance of performing feasibility studies before starting requirements elicitation. Unfortunately, projects still frequently fail to achieve commercial success, responsibility is often unknown, and requirements engineers may be deemed responsible for mistakes made by others. [**Problem:**] There is neither empirical evidence available from a post-mortem risk analysis for projects that performed adequate RE but commercially failed nor guidance for requirements engineers on validating a business case analysis to mitigate this risk. [**Principal idea:**] By performing a post-mortem analysis of software development projects that failed to achieve commercial success, we investigate the root causes for the failures and, in most cases, trace the causes back to business case issues. We identify risk areas and provide practical due diligence guidance to the practitioner. [**Contribution:**] This exploratory case study performs an in-depth review of a detailed post-mortem analysis of three software development projects performed over a 2.5 year period. Each of the analyzed projects failed to make the expected transition to commercialization despite using appropriate RE techniques and achieving satisfactory deliverables. The analysis identifies risk factors that the RE practitioner should consider and we provide a checklist for RE practitioners to use when checking for these risks in an antecedent business case as part of their due diligence. A low-cost commercial viability assessment technique, employing Fermi approximation, is provided to equip the RE practitioner with a risk mitigation tool in the absence of business analyst resources.

Keywords: Risk identification, risk mitigation, commercial risk, due diligence, commercialization, commercial success, success factors, business case, business analyst

1 Introduction & Motivation

Many new product software development projects fail to achieve commercial success despite following established requirements engineering practices and development methodologies. Unfortunately, iterative refinement (independent of the methodology) can leave critical requirements unknown at project inception or even until late in the development cycle. As observed by de Marco [1], this imperfect knowledge can lead to issues such as inadequate budgets, significant changes to timelines, missing key skills (personnel mismatch) and, in the worst case, even project failure. When the unknown requirements are exposed later in an iterative process it can be challenging to ensure that the requirements are consistent with the antecedent business case, especially if stakeholder engagement has waned.

Problem: It is generally accepted that development risk is inversely correlated with knowledge. While numerous project risk management techniques exist, to our knowledge this is the first work focused on identifying risks at the boundary between the business case and requirements engineering efforts. This work focuses on the boundary between these efforts because it is at this boundary that responsibility often passes between different individuals or teams – a transition that offers increased opportunity for problems to occur.

In this work, we review the results of a major postmortem analysis effort performed upon a new product development program at an industrial entity (referred to hereafter as CASECO). The review sought risk factors of potential concern to RE practitioners, asking the following research questions:

RQ1: What are the risk factors identified in the postmortem analysis effort that exist at the interface between the business case and the software requirements? (Section 5)

RQ2: Are there mitigation techniques already available at CASECO that could be used to mitigate one or more of the risk factors? (Section 6)

Identifying antecedent business case risks that can pose threats to subsequent requirements efforts provides the RE practitioner the opportunity to mitigate these risks in a context-appropriate manner. To a degree, this work builds upon the work of Boehm [2] wherein he explicitly includes business case analysis as one of the seven key elements in value-based software engineering and also builds upon the work of Aurum and Wohlin who promoted better alignment of technical decisions with business strategy [3]. Our in-depth analysis of the risks at the interface between BA and RE, supported by significant industry-grounded empirical evidence, provides evidence-based support of the need for business case analysis and alignment with business strategy.

Contribution: This work provides three principal contributions toward risk identification and mitigation in RE practice. First, we contribute a post-mortem analysis of the CASECO new product development program (composed of three

in-depth reviews with internal and external stakeholders and 10 shallower reviews engaging internal stakeholders only). We provide evidence for necessitating that requirements engineers review the antecedent business case analysis upon which they should, in part, base their work.

Secondly, we provide support for due diligence efforts in the requirements process, at least in the context of new products and services, in the form of numerous questions that can be used as a basis for a risk identification checklist. The risks are grouped into eight categories and these categories have minimal overlap with those identified by [4], significantly extending the available practical guidance for risk management.

Thirdly, given that identifying the bounds on the commercial value of a given project is a critical element of the business opportunity assessment, we propose the use of Fermi[4] approximation techniques [5] as a low-cost approach to performing this assessment of commercial viability.

Outline: In Section 2 we discuss related work, in Section 3 we present the study description and in Section 4, the methodology followed. Our analysis and results are presented in Section 5 and risk mitigation via commercial viability assessment approximation is presented in Section 6. A short discussion is presented in Section 7 followed by the conclusions and directions for future work in Section 8.

2 Related Work

Several researchers have stressed the necessity for more interaction between business analysis and requirements engineering. Bubenko [6] states that most requirements problems can be traced to a lack of appreciation of their importance at the business management and IT management levels. Despite this rather early recognition (1995) of a strong link between requirements engineering and business management, the effects of a business case[5] on requirements engineering efforts seems to be under-represented in the literature. Among available studies, Gulla [8] discussed challenges of business modeling in re-engineering projects while Farbey [9] proposed a new design for a software supply chain, heavily influenced by the business perspective. Arao *et al.* [10] proposed a process where business requirements and system of software requirements are integrated in one information model and thus create a 'to-be' process. Lehtola *et al.* [11] proposed using roadmapping to link the business case to requirements engineering efforts while Monteiro *et al.* [12] proposed techniques for improved requirements sharing

[4] Fermi estimation is used to make high-quality estimations about the order of magnitude of a problem or, in the context of this paper, business opportunity. The technique enables surprisingly correct estimates, often within an order of magnitude of the exact answer, even for complex calculations with little available data.

[5] A business case captures the reasoning for initiating a project or task and should show how the decision will alter cash flows over a period of time, and how costs and revenue will change [7].

and requirements engineering collaboration, a possible solution to some of the communications challenges observed in this work.

Gordijn *et al.* [13] proposed using goal-oriented requirements engineering methods to better understand business goals. Wegmann *et al.* [14] stressed that early phases of requirements engineering in an IT system should be aligned with the business imperatives of the organization. Karagiannis *et al.* [15] presented a business-process based solution that assists requirements reporting based on core business processes supporting our claim for the need for greater collaboration between business analysis and requirements engineering. Finally, Wever and Maiden [16] investigated the barriers that business analysts perceive as hindering effective requirements work in business-oriented projects finding that there are mismatches and disconnects in training, application and recognition of the critical nature of the business analysis and requirements efforts from upper management to the project team.

Ropponen and Lyytinen empirically confirmed that using risk management methods improves system development performance [17]. A literature review by Lyytinen and Hirschheim [18] derived twelve categories for the reasons for IS failures. Lyytinen *et al.* [19] presented a framework for managing software risks that combines behavioral and organizational models, suggesting that risk management should be the responsibility of all team members. Palmer and Evans [20] proposed a method for quantitative identification and extraction of requirements-based software risk metrics throughout the requirements engineering life cycle.

Collectively, these works analyze facets of the interaction between the business perspective and the production perspective. However, none of them have analyzed an industrial postmortem review of a significant number of projects for contributions to requirements engineering practices. Analyzing projects after they fail is an important contribution, providing evidence that some risk factors are realized when appropriate counter measures are not taken.

3 Study Context Description

The study was performed at CASECO, a 25-year-old Information and Communications Technology (ICT) sector company with locations in five different cities spread across three jurisdictions. Each location has permanent employees, contract employees and interns (both student and professional). The management structure is hierarchical on the organization chart but is relatively flat in practice – senior management and junior management interact in an informal manner.

CASECO was chosen for this study because: (1) they were performing their own in-depth post mortem study, (2) they were involved in a large number of related projects, undertaken with a diverse set of clients, and (3) the researchers were granted access to the internal information. The diversity of the clients improves the probability that the results can be generalized given that this is not a study of a single commercial entity. While CASECO is a common factor across all projects, they were a service provider and not the project driver.

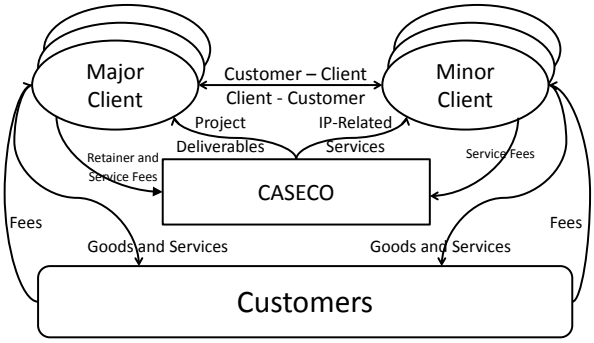

Fig. 1. CASECO operating environment

CASECO is a not-for-profit economic development organization whose goal is to accelerate the technological and business growth of Small and Medium sized Enterprises (SMEs) throughout the operating region. This growth is achieved by making in-kind investments of highly skilled manpower on specific projects done in partnership between CASECO and the client, appearing to a typical observer as some form of consulting service arrangement. Clients are of two types (see Figure 1). Major Clients pay a significant retainer fee to ensure access to CASECO services and to have a voice in determining the CASECO operating mandate. Minor Clients interact with CASECO on a fee-for-service basis wherein work performed for the Minor Client is subsidized as part of the not-for-profit economic development mandate. Both Major Clients and Minor Clients can have customer-client and client-customer relationships. Further, both classes of clients have customers to whom they provide goods and services in exchange for revenue. However, in the context of the current work the Minor Client can only access the Customer via the Major Client. Given CASECO's economic development mandate, each client project is expected to have clear commercialization objectives, set and controlled by the client, with responsibility and authority resident within the client organization.

A 2.5-year targeted R&D program was undertaken by CASECO in response to the complete replacement, with a new technology, of a fundamental platform used by the Major Clients to provide services to their Customers across a large, geographically dispersed serving area. During this period, approximately 10 person-years of effort (in total) were invested in three (relatively large) projects that were taken from product concept to the pre-production prototype stage. One of the three large projects had both Major Clients and a Minor Client while the remaining two large projects only had Major Clients. One of the three large projects was the design and implementation of a multi-jurisdictional development environment for the new fundamental platform. The development environment was commissioned under the assumption that the Minor Clients would use it to develop products and services that met the wants and needs of

the Customers of the Major Clients. In addition, approximately two more person years of effort were invested in 10 relatively small projects where a product or service concept was taken to the early prototype (proof-of-concept) stage. All of the early prototypes were sufficiently advanced that they could be placed before the end customer for market-based feedback.

Several RE techniques such as elicitation sessions, triage, prioritization and negotiation were used to define the functional requirements for each project (large and small) and every technical deliverable (software or hardware artifact) was considered successful. However, none of the projects moved beyond the identified stages and into production or commercialization. As products, every project was a commercial failure despite meeting the technical requirements for the project (as prototype or proof-of-concept).

4 Research Methodology

This paper reports on a case study that investigates an authentic [21] and significant [22] topic heavily grounded in industrial practice. A case study strategy is necessary to study phenomena in their natural context such as software engineering processes [22], facilitating our understanding of the complexity of the analyzed problem rather than abstracting from it [23]. In the paper at hand, an explanatory, curiosity-driven approach [24] was taken, principally employing qualitative methods for data gathering, focusing on risk identification (rather than risk mitigation) under the assumption that mitigation can only follow after identification and comprehension.

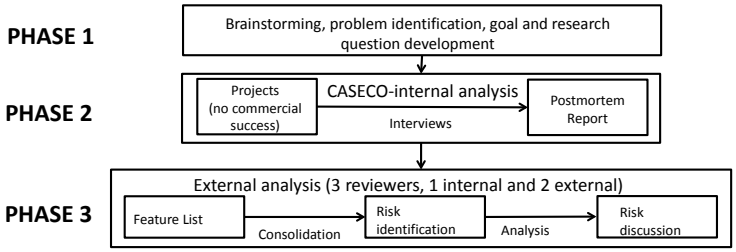

Fig. 2. Study Process

The case study was performed in three phases, see Figure 2. In the first phase, brainstorming and analysis of related work were applied in order to identify the scope and research focus of the study. Next, 13 projects were selected for analysis. Based on the results of the analysis, three projects were further analyzed during phase two interview sessions. In the third phase of the study, the results from previous steps were analyzed for specific evidence of the practices that RE practitioners could use to mitigate the observed risks or failures.

4.1 Phase 1: Problem identification

The first phase of the study was triggered by the following phenomenon: all of the reviewed projects at CASECO failed to make the transition to commercialization despite using appropriate RE techniques and providing satisfactory deliverables. Motivated by this observation, the research team gathered and brainstormed about possible reasons for the phenomenon generating two research questions:

RQ1: What are the risk factors identified in the postmortem analysis effort that exist at the interface between the business case and the software requirements? (Section 5)

RQ2: Are there mitigation techniques already available at CASECO that could be used to mitigate one or more of the risk factors? (Section 6)

The research team decided to use multiple sources of evidence during the investigation by using interviews and analysis of work artifacts for data collection [25], both set within a pragmatic research stance [26].

4.2 Phase 2: Project analyses

The set of 13 CASECO projects was reviewed by a post-mortem team composed of one executive, two business analysts, one combined business analyst and requirements engineer, two senior technology staff and one external consultant. The projects were selected for review based on their cost, complexity and importance to the internal and external stakeholders. Next, we performed both in-depth reviews within each project followed by a comparative review across the projects investigated for the post-mortem report to identify the risk factors to RE practice and their origins.

The review then focused on the three large projects (selected from the set of 13 projects), performing a series of interviews with developers and customer representatives. The interviews all followed the same format: a semi-structured interview consisting of an initial free-form discussion, followed by a structured interview session in which standardized questions were raised with the participants. The questions addressed issues of product definition, market requirements and shifting market forces, stakeholder identification and communication, product and project management and general feedback. After the initial responses were recorded, participants were asked to explicitly identify what went right and what went wrong in each of the question areas. Scribing services were provided by CASECO and meeting notes were provided to interviewees for review and corrections.[6]

[6] The anonymized interview questions are available for download at `http://www4.in.tum.de/~penzenst/sources/caseco-interview.pdf`.

The interview matrix is presented in Table 1. Each interview session has a unique identifier A through K. There are two types of CASECO interviews. The first set of interviews (G, H, J) were held with the CASECO team members directly responsible for the project. The second (shared) letter (K) denotes a series of group interviews wherein all CASECO team members participated. In all interviews but (K), the interviewees always had direct experience with the subject of their specific interview. During the (K) interviews the CASECO team members were invited to provide feedback on challenges experienced by the 10 proof-of-concept projects – each of the projects had some, but not all, of the CASECO team members on the development teams. The analysis showed that the challenges experienced by the proof-of-concept projects were effectively the same as the challenges in the large projects. If this observation can be generalized beyond this study by further work then we have identified an important pattern: If challenges in proof-of-concept projects are highly similar to the challenges if large-scale projects then consistently performing a proof-of-concept project as a precursor to a large project could result in significant risk reduction for the large project. Further, if the business case analysis antecedent requirement generalizes beyond this study then RE practitioners have another significant risk mitigation tool available.

Table 1. Interview Matrix

	Project 1 Customer Product	Project 2 Client Product	Project 3 Ecosystem
Major Client 1	A		E
Major Client 2	B		E
Major Client 3		D	E
Minor Client 1	C		
Third Party			F
CASECO Proof-of-concepts	G K	H K	J K

4.3 Phase 3: External analysis

After the interviews were completed, CASECO stakeholders were asked to formulate business rules and business policy guidance to be used to determine potentially viable commercialization paths for new products and services. The business models were generated and evaluated and conclusions presented to management.

Each of the three authors then independently performed a review of the material in the post-mortem report to extract the identified failure modes. These failure modes were translated into risks and the results are presented in the next

section. In each instance, we can identify risks that occur outside of an RE practice that is focused on products and/or services – yet have the potential to have significant negative impacts upon RE and subsequent development efforts. In most instances, these risks are related to business case elements that should have been considered, either by the stakeholders or by the RE practitioner(s).

4.4 Pragmatic Reflection on Commercialization Failure

Due to commercial confidentiality constraints, we can only provide a high-level of our observations of specific details regarding the root causes for commercialization failure. The project proponents, particularly the Major Clients, expected that the technology platform shift would enable a diverse third-party application market much like that which has developed around smartphones. Unfortunately, numerous issues arose. First, the customer *willingness to pay* was not properly evaluated; the market segmentation analysis was weak and assumed that customer behavior on the prior platform would be an adequate predictor of customer behavior on the new platform. This issue was compounded by inadequate analysis of the commercial viability of Minor Clients developing third-party applications and subsequent analysis showed that the revenue streams for these applications were inadequate to sustain a commercially viable business in this market. As a result, those Minor Clients that did succeed in entering the market place were soon in financial difficulty because the customer uptake was smaller than anticipated. While all of the products could be interesting incremental revenue streams for an existing player (perhaps acting as market differentiators or barriers to competitive market entry), none of them were large enough to sustain a new business venture.

5 Analysis and Results: Identified Risks

We present here the eight identified cross-project risks (R1-R8) together with short questions formulated based on the reviewed evidence, abstracted to generic forms. These questions are consistent with those used in business case analysis [27] and can be used as the basis for a risk identification checklist supporting practitioner due diligence efforts. For example, we ask *'Is there a product champion?'* as a succinct alternative to *'A product champion advocates on behalf of the project and often assumes the role of the project leader. The lack of a clear product champion can lead to issues such as...'*

To be identified as a risk, the authors had to agree that there was evidence of that risk in at least two of the projects in the post-mortem report. The categories for the risks were determined by the authors using an affinity grouping technique and the fact that the risks are present in all projects may be because all of the projects were performed with CASECO as part of the team

R1 Motivation: Projects without strong motivation or strong champions have a significantly greater risk of failure.

Question checklist: Is there a product champion? A pain point that is motivating the stakeholder, *e.g.*, customer dissatisfaction? A pleasure point that is motivating the stakeholder, *e.g.* significant revenue? Is the project interesting or boring to upper management? Is the project a cost center or a revenue center? Is the motivation for pursuing the project emotional, *e.g.*, positive or negative, rational, *e.g.*, participate in standards efforts, or business or some combination thereof?

R2 Time and Schedule: Companies that operate on significantly different timelines, such as great disparities in the required time to take a product concept to commercialization, have difficulty working together.
Question checklist: Are all parties, vendor and customer, moving to the same timelines, toward the same product release schedule? Are the priorities relatively consistent for all parties? Can the Minor Client survive when working on the schedule of a Major Client?

R3 Constraints: Business constraints such as supplier qualifications, years in business, capitalization, etc. are often not apparent to the RE practitioner.
Question checklist: Are the non-functional, non-technical constraints clearly identified? Have the constraints been thoroughly investigated?

R4 Customer: Many entities, particularly startups, still operate under *beliefs* about their customer and target market rather than *facts*.
Question checklist: Is there evidence of willingness and ability to pay (at a price point that makes the project ROI attractive)? Can a sale be closed at the concept stage or does it require a proven product? Is the cost of access to and engagement with a customer known? Is the cost of sales and distribution known? What is the total number of possible customers for this project? What share of the market can this project reasonably acquire?

R5 Stakeholder (management): A strong primary stakeholder who is a firm supporter of a project (perhaps dominating meetings, *etc.*) can conceal a lack of general support from other stakeholders.
Question checklist: What is the confidence level that all significant stakeholders have been identified? Does the project rely upon proxy stakeholders rather than direct engagement with the real signing authorities? Are the levels of risk tolerance (or aversion) known for each stakeholder?

R6 Competition: Assessment of threats from alternative technology solutions that also meet the same market need is often outside of the competency of business analysts and is not typically the responsibility of the RE practitioner.
Question checklist: Are the stakeholders potential internal or external competitors? Are there hidden requirements, hidden agendas? (For example, projects

with stakeholders from multiple organizations may not reveal their real requirements or may reveal only a subset of their requirements.) Is there a mechanism to force resolution of outstanding issues? Does the project have the ability (sufficient time and resources) to respond to competitive threats? Is the technology a commodity or are there non-trivial barriers to market entry? Is there a significant technology bypass threat?

R7 Value proposition: Scenarios where a Minor Client relies upon a Major Client to access the customer (*i.e.* a supply chain) have many potential levels of indirection. The RE practitioner should ensure these have been identified and resolved.
Question checklist: Are all stakeholders using consistent revenue, expense, and ROI models? Have these models been reviewed or validated? Do all shareholders share (approximately) consistent expectations regarding time-to-market and time-to-revenue?

R8 Communication: Significant size differences between parties can lead to communications challenges as they use the same domain specific terminology but in different contexts.
Question checklist: Do the project participants vary greatly in size? Is negotiation proceeding smoothly or does every point require significant discussion?

6 Risk Mitigation via Commercial Viability Assessment Approximation

Given the results of the postmortem review, we believe that there is substantial empirical industrial evidence that new product development efforts should have, as an antecedent, a sufficiently complete business case analysis before RE efforts begin. A prudent RE practitioner can mitigate risks by first checking for the existence of the business case and then performing a critical review of this information. If the project is an internal development effort that may not have a formal (or informal) business case, the RE practitioner can check to ensure that stakeholders, business goals and project authority (to start, stop and deem complete) have been properly identified. If there are concerns, the practitioner should be able to turn to the project authority for resolution.

However, appropriate resources may not always be available and the RE practitioner may have to extend themselves toward the role of the business analyst. We recognize that RE practitioners may not feel comfortable in this role and we would expect the project leader(s) (if they are not the RE practitioner) to assume this responsibility when necessary. We propose the use of Fermi approximation techniques [5] as a low-cost risk mitigation technique in this scenario. The technique can be applied by any team member and CASECO has successfully used Fermi estimation techniques in other projects *not* investigated in this

paper. We demonstrate the application of this technique to commercial viability assessment in the rest of this section.

Commercial viability assessment is an investigation of project ROI. An estimate for (probable) upper revenue bounds for the initial stages of market introduction (*e.g.* one to three years) are combined with the estimated cost of market entry to determine whether the project should be pursued. Fermi approximation techniques (dimensional analysis – what factors dominate the results, bounds identification – how large or small can these factors be, and domain appropriate estimates of probable values within the bounds – using results from similar products) can be used to identify a reasonable upper bound on market value. If insufficient market value is identified then management can support a project cancellation order. However, a finding of sufficient market value does not necessarily mean that the project should proceed – further analysis of market share is required.

To use Fermi approximation techniques to determine commercial viability the practitioner needs to know (typically readily available) demographic information to determine the maximum number of possible customers. The total market size is then discounted to reflect realistic market penetration within the period of interest. The form of the market must then be determined (or assumed) to form the basis for estimating market share. We estimate the number of competitors in the market (n) – where the market is one of monopoly (100%), dominant oligopoly (50% + 50%/n), oligopoly (100%/n, n is small) and commodity (100%/n, n is large). Then, estimate customer willingness and ability to pay and perform a comparative analysis with like products to estimate product retail pricing. Finally, identify the elements of the distribution channel and apply industry standard margins to estimate gross unit revenues.

Given these estimates, the RE practitioner can calculate the gross revenues that the project can expect to generate over the first year to three years – CASECO experience with other projects indicates that the utility of the approximations is in the range of one to three years. Given that the team is about to embark upon building the product they should have reasonable quality estimates of the cost of development and the cost of production. (If the team does not, this is another danger sign with respect to due diligence). Given revenue and expenditure estimates, estimated ROI can be calculated in a straightforward manner and management should be able to determine project viability.

7 Discussion

The post-mortem analysis clearly identified the need to modify CASECO business processes to ensure the commercial viability of future projects. While it is easy for RE practitioners to say that the CASECO business process failures were obvious, and directly led to the project failures, the post mortem report leads us to ask whether RE practitioners have a responsibility to look beyond the technology artifact and consider the underlying business case. While we do not feel it is reasonable for management to hold RE responsible for errors in the

business case perhaps there is a requirement for RE due diligence for validation of the business case for existence, accuracy and completeness. A due diligence effort by an RE practitioner (see Section 6) could have caught the business case issues and driven some form of project redefinition, perhaps even cancellation. It is possible that greater familiarity with project management [28] and business analysis [27] practices would provide greater practice scope for RE practitioners and may even improve practice reliability with knowledge of these domains.

Many of the risks presented in Section 5 are associated with a lack of valid information upon which to make an appropriate business decision. Further, these business decisions are often decisions as to whether to continue or cancel a project. For example, consider the scenario where the business case contains an inadequate investigation of the potential size of the market, failing to identify the portion of the market that the project may be reasonably expected to capture given the other elements of the business case. A due diligence process performed by the RE practitioner could include a check that the market investigation has been performed and that the validity of the market investigation has been assessed and agreed to by a second (or third) party. This due diligence effort could be used, for example, to justify stopping a development effort before significant resources are invested in developing a product for a market that may or may not exist. In this scenario, the requirements practitioner acts as a significant crosscheck for business process integrity.

In each project within the program review, this study can identify evidence that an appropriate commercial viability assessment was not performed. If the requirements effort had the performance of a commercial viability assessment, as a necessary precondition, the results might have been very different: the earliest projects undertaken would have identified the lack of commercial viability and the entire program might have been canceled much earlier (with the resulting savings to CASECO). Alternatively, if the RE practitioners had been familiar with the Fermi techniques described above they may have been able to perform the commercial viability assessment themselves.

While a rigorous determination of the root causes for the individual project failures is outside of the scope of this work, we emphasize that we found no evidence that the requirements engineering tasks within the analyzed projects were not performed as expected. Further work to strictly identify the root cause(s) for project failure is indicated.

Practitioners must be cognizant of the challenges and risks when performing a commercial viability bounds assessment on a project. Applying these economic constraints when exploring business systems, particularly at the early stages, can lead to projects being unnecessarily terminated if there is too much feedforward of existing business constraints. RE practitioners must remember that a business case is not a guarantee of commercial viability (or vice versa). For example, commercial viability assessment of dramatic innovations such as the smartphone is difficult and there may be significant disagreement regarding the probability of success. A checklist as we have proposed is useful in gathering evidence but is not a replacement for sound judgment.

Techniques that may be used to mitigate risks identified in this work include Fermi approximations for commercial viability assessment, more thorough identification of stakeholders and their roles (*e.g.* funding, adoption), expanded range of use-cases and scenarios, and mechanisms to help practitioners decide whether the RE phase of the project should even be undertaken.

Study Limitations and Threats to Validity: We discuss the limitations of the study based on the classification proposed by Yin [21]. To ensure *construct validity*, we used multiple sources of evidence while deriving presented risks. We confirmed subjective judgments from the interviews with the results from the project material reviews. The semi-structured form of interviews allowed investigators to ask follow up clarification questions. Finally, observer triangulation was used to minimize transcription and interpretation errors.

The exploratory nature of the study implies that threats to internal validity associated with causal relationships are not applicable in our case [21]. Further, the phenomena were observed in an unobtrusive way. The reviews were done by an independent, passive observer during the analysis phase. To ensure reliability [21] of the study we created a case study protocol and stored all documents associated with the study in a repository, ensuring that the results can be traced to the supporting empirical evidence.

With respect to *external validity*, we are aware that the study involves only one case company, raising concerns about our ability to generalize the results. Thus, the results should be interpreted with the case company context in mind. However, the CASECO company operates somewhat independently in three operating jurisdictions with significant client diversity by region, operations and size. Moreover, this case study is focusing on explaining or understanding a phenomenon in its natural setting. Thus, the attempt to generalize from the study is outside of the scope of this work [22].

8 Conclusions and Future Work

This paper provides an analytic review of a post-mortem analysis of the new product development program at an industrial partner. The post-mortem analysis was composed of three in-depth reviews with internal and external stakeholders (including interviews with developers and customer representatives) and 10 shallower reviews engaging internal stakeholders only. The analysis of the collected empirical evidence identified risks on the interface between RE and business analysis, particularly commercial viability assessment and competitive threat assessment.

Both research questions posed herein were answered in the affirmative with the results presented in Section 5 and Section 6. These results argue for more rigorous reviews of the business case by the requirements engineers when beginning their work on a project. The value-neutral perspective of many RE practices [3] can lead to a solution that meets the requirements but prioritizes aspects other than those present in the business case – especially if the requirements are derived without an antecedent business case. We have shown in this work there

are many risks that can result, risks that can lead to commercial project failure. This study provides a checklist of questions in support of the business case review activities and we promote Fermi approximation as useful tool in support of these review activities.

This work demonstrates the need for a future investigation of the overlap between the role and responsibility of the business analyst and the requirements engineer, both in theory and in practice, to ensure that boundary risks are minimized. Further analysis of the costs of business case analysis compared to the risks of pursuing projects without due diligence is needed. How much analysis is "just enough?" We only mention the identification and exploration of potential business models as part of the post-mortem process. Our observations of these business models show intriguing results: including the elaboration of the business models as part of the requirements process could lead to serendipitous discovery of alternatives. Further investigation is indicated. CASECO will be revisited to determine whether they have been able to successfully modify their business processes in response to the postmortem report. If so, what have the modifications been? If not, what factors kept CASECO from making a successful transition?

Acknowledgements: The authors would like to thank Daniel Mendez for helpful feedback on an earlier version of this paper. This work is partly funded by the SYNERGIES project, Swedish National Science Foundation, grant 621-2012-5354.

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