Proactive Risk Identification in Cross-organizational Business Processes

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Abstract

Although the alignment of business objectives and corresponding activities in cross-organizational processes is critical in assuring performance from distinct supply chain partners and sustainability of the supply chain, to date the important question – how can this alignment be enabled – remains unresolved. We address this question by formalizing the relationship between individual and shared (dyadic) objectives of supply chain partners and between risk and performance objectives in a dyadic relationship. Further we integrate objectives and business processes at the level of a supply chain buyer-supplier dyadic relationship. In achieving this we use the design science research approach to extend the Risk-aware Value-Focused Process Engineering modeling methodology to formally represent the collaborative risk management objectives of buyers and suppliers, and associated performance creation mechanisms. We then review the merit of this extension through application of the evolved modeling methodology to the process of supply chain sourcing.

Keywords

Risk identification; risk-aware decision support; cross-organizational business processes, Risk-aware Value-Focused Process Engineering (RaVFPE)

INTRODUCTION

Proactive risk identification is increasingly emphasized as one of the critical goals of the overall risk management process in modern organisations (Neiger et al., 2009; Tang and Musa 2011). For instance, in the context of supply chain management, a primary purpose of the *supply chain risk identification process* is "to recognize future uncertainties to be able to manage … [the resulting] … scenarios proactively" (Hallikas and Virolainen 2004, p.57). Despite growth in the inter-connectivity between organizations, research into risk identification in cross-organizational business processes is lacking (Suriadi et al. 2012). Specifically, gaps in knowledge concerning proactive risk identification in cross-organizational business processes include:

- Lack of understanding about the nature of the risks involved in cross-organizational value creation. This affects value creation at the level of distinct partners and the overall partnership, as each partner seeks to maximize performance and minimize risk (Ravindran et al, 2010; Hoffmann et al., 2013);
- Lack of explicit differentiation and linkage of performance and risk-related objectives in cross-organizational business processes that emerge from individual business processes; and
- The absence of formal conceptualization of the effective alignment of activities and decision making processes by partners. This leads to cross-purposes and duplicate activities that comprise value-creation in cross-organizational partnerships.

Given cross-organizational business processes are the "next wave of process-oriented enterprises" (Hoyer et al. 2008), we address these gaps by looking at the simplest form of such a process that involves two organizations, namely *the dyadic* buyer-supplier partnership (Dowlatshahi, 2000; Hartley, et al. 1997). Herein our aim is twofold:

- to formalize the relationship between the individual and dyadic objectives of two organizations within the dyadic buyer-supplier partnership, and between the risk and performance objectives in this dyadic relationship; and
- to enable explicit integration between objectives and cross-organizational business processes at the level of a buyer-supplier dyadic relationship.

In achieving this aim we focus on three key elements of proactive risk identification:

- common business objectives of the partners involved (i.e. buyers and suppliers);
- the individual and cross-organizational business processes;
- and a holistic perspective of the dyadic relationship between the partners involved. Herein partners are required to work *together* as a system, whereby they possess not only individual properties/objectives, but also emerging shared properties of the buyer-supplier partnership itself (including *mutual advantages* greater than those achieved individually).

Leveraging the work of March and Smith (1995), who demonstrated the relevance of design science in the context of research on decision support, the expected outcomes of this study correspond with the following major outputs: *constructs*, *models* and *methods*. Through application of the design science research approach (Hevner et al. 2004) we demonstrate how the Risk-aware Value-Focused Process Engineering (RaVFPE) modeling methodology (Rotaru et al. 2011) can be extended to formally represent both the collaborative risk management objectives of distinct organizations (i.e. buyers and suppliers) in cross-organizational business processes, and the performance creation mechanisms. Herein our model for integrating risk and performance objectives in a dyadic relationship creates the potential to generate benefits for both decision-making and value delivery.

The remainder of the paper is structured as follows: in the next section we seek to position the study in the existing body of knowledge. We then outline the chosen modeling methodology before reporting on results from applying it to the context of collaborative supply chain sourcing. Finally we conclude the paper by suggesting how we contribute to appreciation of risk-awareness in cross-organizational supply chain processes.

BACKGROUND

The importance of cross-organizational business processes, as both a research topic and an issue facing practice, is manifested in the rich and diverse body of literature dedicated to examining different aspects of its value creation. Viewed as a system where value creation for the overall business process is supported by value-adding from its distinct partners (Keeney 1992), effective alignment of activities and decision making processes within supply chains, and alignment of objectives and corresponding activities in cross-organizational processes is critical to assuring the performance of distinct supply chain partners and the overall supply chain [60,76]. In this context, each partner seeks to maximize its own performance, while the sustainability of the overall supply chain is assured through jointly achieving the objectives of all supply chain partners (Cachon 2004; Chen et al. 2009). In essence cross-organizational relationships are driven by heightened decision making, targeted at achieving individual and mutual supply chain objectives, which are facilitated by the underlying supply chain processes and activities.

At the operational level, value can only be created if the "internal business processes of … cooperative enterprises … interact to pursue common objectives that will be profitable for all parts" (Alfaro et al. 2009, p.887). This assures sustainable, long-lasting and reciprocally profitable relationships between buyers and suppliers. Herein risk has an impact, which in accordance with the international standard on risk management (AS/NZS ISO 31000:2009), we view as "the effect of uncertainty on objectives". When taken more broadly in this study and its focus on buyers and suppliers, "[s]upply risk is defined as the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety" (Zsidisin 2003, p.222). The challenge is that although collaborative risk management, as a component of value creation in cross-organizational processes, is an important factor in the decision making of individual supply chain partners (i.e. Ravindran et al. 2010) and the supply chain as a whole (i.e. Oehmen et al. 2009), to date it has not been extensively researched. Yet in achieving effective decision support it is important that a *clear*, *formal conceptual relationship is established between the contextual representation of collaborative supply chain processes (especially, cross-organizational interfaces) and* *the risk and performance components required to realistically represent the values of collaborating partners, including risk-performance trade-offs*.

Achievement of this can lead to value creation. For example: collaborative and inter-enterprise performance measurement systems such as incentive alignment, performance enhancement and quality issues (e.g. Verdecho et al. 2012; Angerhofer and Angelides 2006); contracting including service level agreements, governance coordination and legal aspects (e.g. Edgington et al. 2010; Cachon 2004); the impact of business analytics on supply chain performance (Trkman et al 2010); and the effects of relationships and social capital (e.g. Autry et al. 2010; Carey et al. 2011).

In line with our research objectives, we consider *performance maximization* (i.e. Angerhofer and Angelides 2006) nd *risk minimization* (Gaudensi and Borghesi 2006; Neiger et al. 2009) as two pillars of value creation in these processes. The challenge is that it is impossible to achieve the required agreement (congruence between conflicting objectives) at both the level of individual supply chain partners and the buyer-supplier dyadic relationship, without acquiring a clear understanding of the business objectives and business processes, and without understanding whether these objectives and processes are working together to enable supply chain partners to collaborate. This is where process modelling can help.

Issues of objectives modeling and quantification in cross-organizational supply chain processes have been widely addressed by adopting approaches like game-theoretic (e.g. Kim and Cho 2010) and multi-criteria decision making (e.g. Tan et al. 2012; Gaudenzi and Borghesi 2006). Conversely, the modeling of business processes that support cross-functional collaboration and collaborative planning across supply chains have predominantly been addressed within the domain of business process modeling (Kulp et al. 2004; Mentzer et al. 2001). This interdisciplinary disconnect means that the literature *does not address how* alignment between supply chain partners' business *objectives* and the *activities of supply chain business processes* can be achieved. Consequently a knowledge gap exists concerning *whether and how supply chain activities contribute towards achievement of individual objectives of supply chain partners as well as the supply chain as a whole*.

Drawing on the design science research approach we address these needs by extending the RaVFPE modeling methodology. Herein, extension of this modeling methodology allows us to formally represent and visualize the value creation mechanisms, which are driven by collaborative performance improvement and collaborative risk management that occur at the interface of the buyer-supplier collaborative business process. This ensures alignment of supply chain activities with these mechanisms.

MODELING METHODOLOGY: RaVFPE

RaVFPE enables systemic representation of the value generation (including performance- and risk-related) mechanisms of a business through integration of two objectives- and process-based business modeling methodologies, namely Value-Focused Thinking (VFT) and Extended Event-driven Process Chain (e-EPC). A summary of RaVFPE is provided below and illustrated in Figure 1. For a detailed description see Rotaru et al. (2011).

- *VFT:* The RaVFPE modeling methodology draws on VFT (Keeney, 1992) to create linkages between business processes and business objectives at both the operational and strategic level.
- Using seamless links between graphical symbols, the *e-EPC* modeling methodology (Scheer, 1999) incorporates a comprehensive description of objects and flows associated with given processes. Among other elements, e-EPC provides formal definitions of *processes* and *functions* (also referred to as *activities*). Here processes are described as complex functions at the top level of the functional tree that can be divided into sub-functions to reduce complexity. Each function is preceded and followed by at least one *event*, which represent changes in the state of the business process over time.

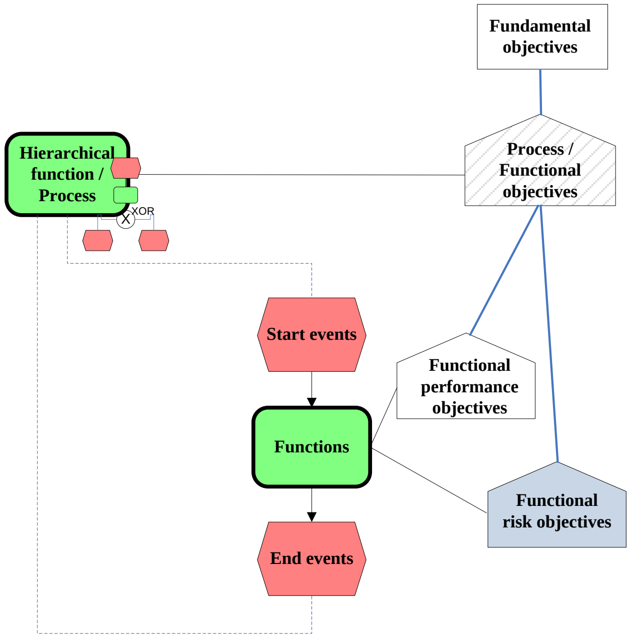

Figure 1: Overview of risk-aware value-focused process engineering

Through inheriting the properties of VFT and e-EPC, RaVFPE allows risk and performance value generation mechanisms to be interpreted as emergent properties of a supply chain process that are shaped by the interaction of the elements therein. For example, at the level of a single process activity, risk is formalized by RaVFPE as an activity-related emergent property that can be directly evaluated through a scale that is uniquely linked to a specific *activity-related risk objective* and can potentially result in an *adverse event* that immediately succeeds the activity under consideration (Rotaru et al. 2011). Additionally, the RaVFPE methodology formulates rules for hierarchical decomposition of risk and performance in business processes according to organizational objectives, which are subsequently decomposed to individual process activities [ibid.].

Thus, the RaVFPE modeling methodology: (a) seamlessly integrates the notions of risk and performance into a goal-oriented business process model; (b) conceptualizes risk and performance-based objectives associated with a given business process at the level of individual process activities; and (c) enables process-based risk and performance to be decomposed to their elementary level representation.

RESULTS

Collaborative Supply Chain Sourcing Scenario

In this section we provide both the motivation for, and a detailed description of, the illustrative cross-organizational supply chain process '*Supply Chain Sourcing Process*', used in our study to demonstrate the power of the Collaborative RaVFPE modeling methodology (see Section 5). Drawing on the purchasing function suggested by van Weele (2010), Monczka et al. (2011) and Scheer (1999), in this study we limit the focus to discussion of two complex (hierarchically decomposable) functions: *Selecting Supplier* and *Contracting* (see Figure 2). These represent the dyadic relationship between the "buyer" and the "supplier" and can be seen as a segment or sub-network of a larger scale supply network. For example in the case of supply chain triads (Choi et al. 2009), they would benefit from adoption of the suggested methodology in the same manner as its sub-network.

In Figure 2 the "Sourcing" process is decomposed into a flow of activities with an "enterprise-supplier" interface used to define the process owners. This decomposition provides the analyst with a detailed dynamic view of the process for each process owner. The high-level objective associated with this function is to "*Maximize the effectiveness and efficiency of the sourcing process*", which should incorporate the individual values of both buyers and suppliers. As such it not only specifies the individual preferences of the buyer and supplier that lead to the collaborative process, but also the direction or means of value creation in the overall dyadic supply chain.

Application of the Collaborative RaVFPE modeling methodology to the supply chain sourcing scenario

Drawing on the supply chain scenario presented in Figure 2, we now demonstrate how RaVFPE can assist in representing and understanding the value generation trade-offs that occur at the interface of cross-organizational processes.

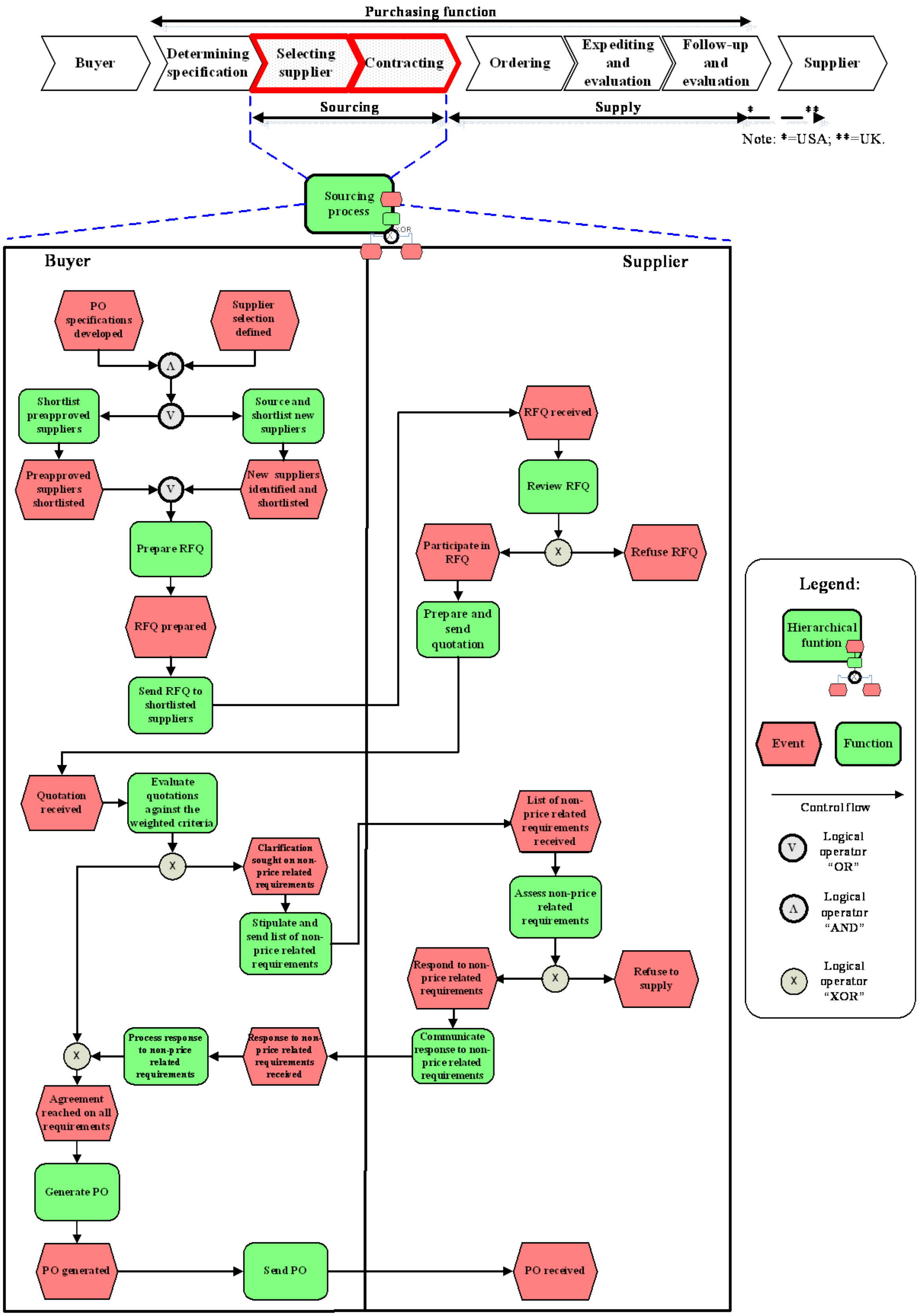

Figure 2: Decomposition of the high-level cross-organizational Supply Chain *'Sourcing Process'* using the e-EPC modeling approach

Step 1: Modeling risk-performance trade-offs at the level of individual activities

The process model used to support RaVFPE includes a generic objective that is associated with each process/function. Figure 3 shows how the hierarchical "*Sourcing*" process is associated with the high-level functional objective "*Max the effectiveness and efficiency of the sourcing process*". Following the modeling rules conveyed by RaVFPE, by decomposing this high-level "*Sourcing*" function into a lower-level process that details the activities and associated functional objectives shared by two members of the dyadic "buyer-supplier" supply chain, the generic functional-based objectives of distinct supply chain partners can be identified. It is important to note that the objective "*Max effectiveness and efficiency of the sourcing process*" refers to the overall hierarchical "*Sourcing*" function. Consequently it reflects a greater perspective on value creation than the sum of individual functional value-driven objectives on the side of either the buyer or supplier. Hence it can be regarded as an emergent objective that arises as a result of the interaction between buyers and suppliers.

Next, both *risks* and *performance aspects embodied* within cross-organizational processes are represented as a subset of functional means objectives. These objectives depict the risk-performance trade-offs made in the *"Sourcing"* process, which subsequently lead to value creation mechanisms in the processes of individual supply chain partners, as well as the buyer-supplier cross-organizational interface. As shown in Figure 3, at the top of the value hierarchy the high-level functional objective "*Max the effectiveness and efficiency of the sourcing process*" is decomposed into two distinct objectives: (1) the *performance objective "Max the performance of the sourcing process"*, which aims to achieve process/function-specific potential in terms of quality and other performance indicators; and (2) the *risk objective* "*Min risk exposures in the sourcing process*", which aims to minimize the overall process/function-based exposure to possible adverse events. According to Keeney (1992), such representation assures business value is achieved.

Step 2: Objectives-driven decomposition of risk and performance

This step involves identifying the components of functional risk and performance objectives, which are associated with collaborative supply chain processes. Herein, the VFT component of RaVFPE provides the necessary rules that guide the process of decomposing risk and performance objectives. Given that the risk and performance objectives structures connect at the higher level of the objectives network, for ease of representation and without loss of generality, only the rules that apply to risk objectives decomposition are illustrated in Step 2 and Step 3 of this paper.

At Step 1, the high-level risk objective has been defined as "*Minimize risk exposures in the sourcing process*". The components of this objective were identified through an extensive literature review of risk management in collaborative supply chain processes. To preserve the argument flow, these components are presented as column headings in Figure 5.

Step 3: Synchronized decomposition of risk and performance objectives structures

Based on the guidelines for RaVFPE synchronized decomposition (Rotaru et al. 2011), the risk objectives structures derived in Steps 1 and 2 are synchronized. This is achieved by:

(a) using the goal-oriented workflow patterns (Neiger and Churilov 2006; Neiger et al. 2008) as a representational mechanism, and decomposing the performance objectives structure and risk objectives structure (Figure 4) according to the collaborative supply chain process flow;

(b) decomposing objectives-driven risk into its functional components (see Figure 5). By representing the matching process in a matrix form, attributes of higher level objectives (i.e. '*Min risk exposures in the sourcing process'*) can be expressed as functional risk objectives that are associated with specific activities within the collaborative business process (note due to space constraints, this step is only performed for risk objectives). As demonstrated in Figure 5, this approach enables clear identification of the multiplicity of activities that may potentially be the source of a particular risk (column view), as well as the multiplicity of risks potentially resulting from a given activity (raw view); and

(c) combining the two views into a single fully decomposed integrated objectives structure (Figure 6) maintains a direct link to the collaborative process activities with which the risks are associated.

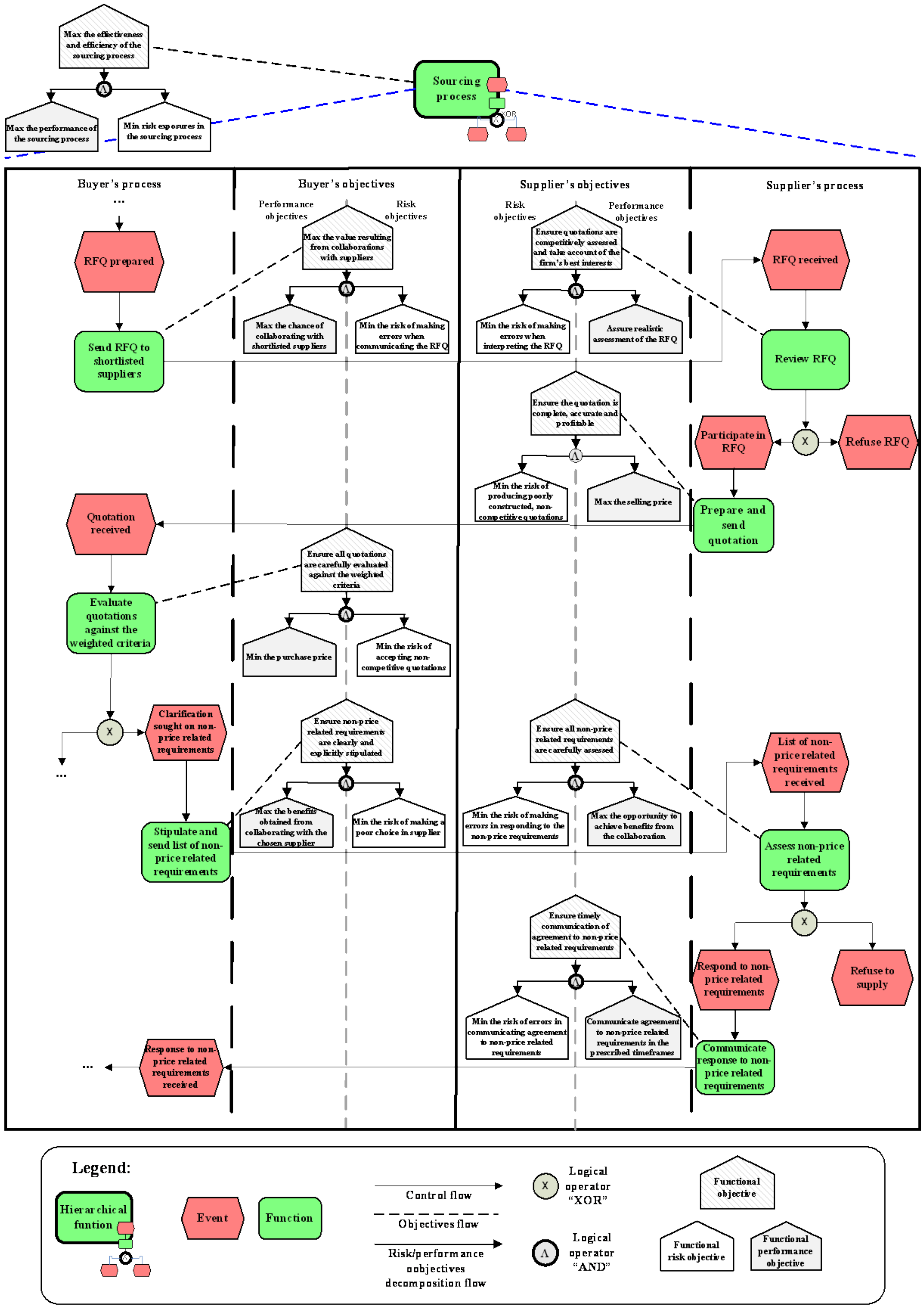

Figure 3: The value generation interface, and decomposition of risk and performance objectives in the high-level cross-organizational *'Sourcing Process'*

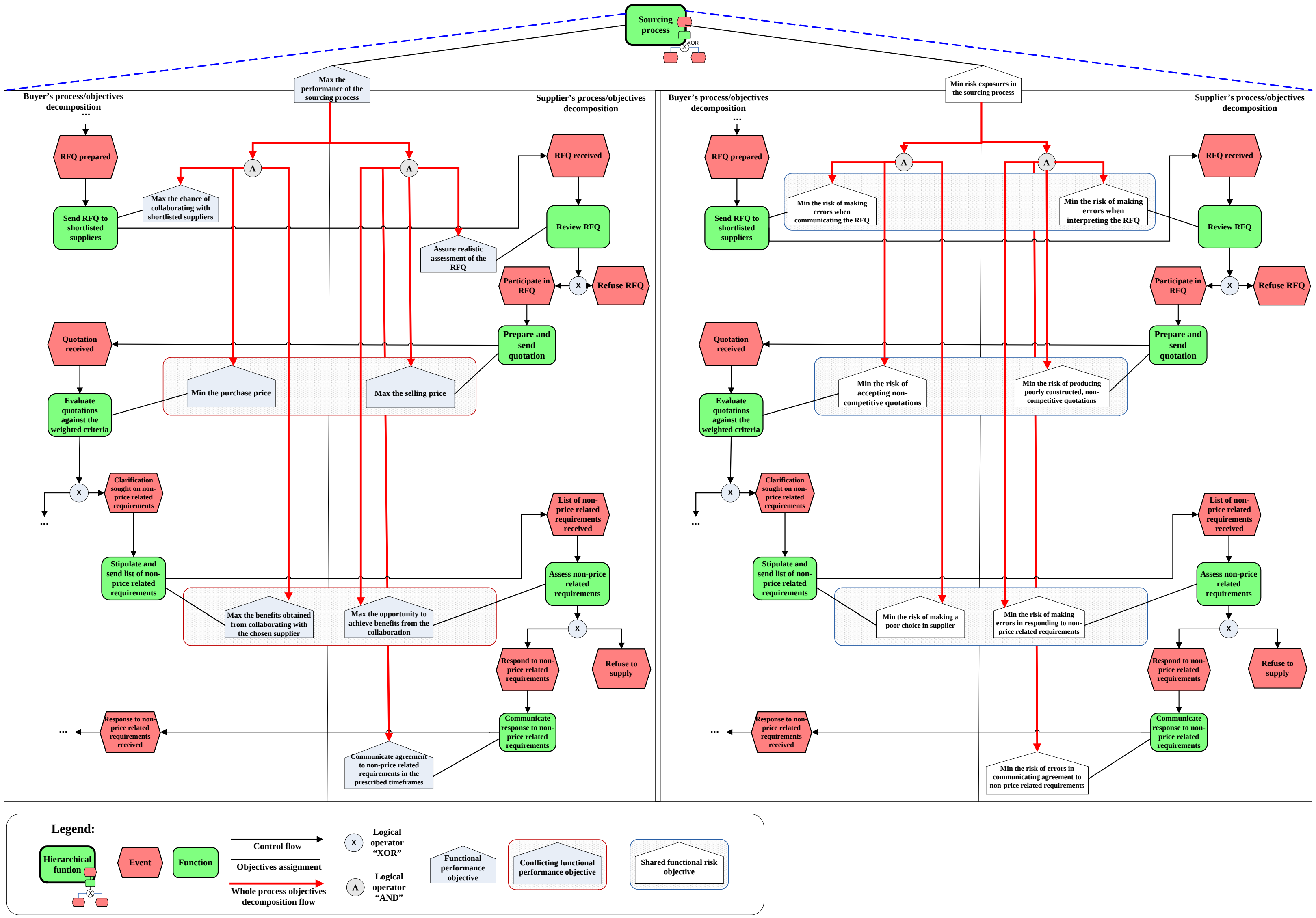

Figure 4: Synchronized decomposition of both the performance (left hand side) and risk (right hand side) objectives and corresponding processes at the buyer-supplier interface

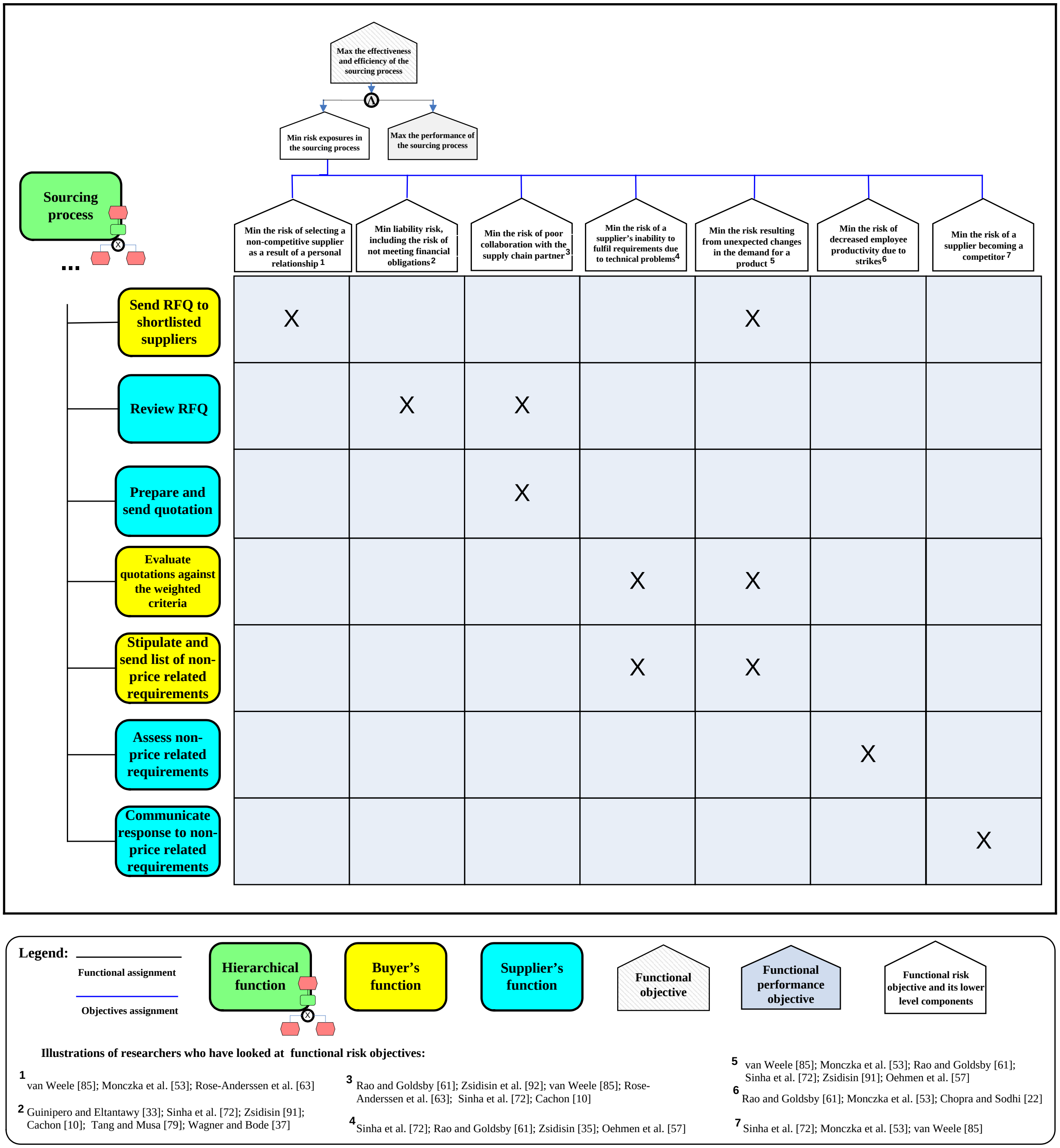

Figure 5: Component decomposition of risk objectives

Notes:
(a) the column structure is defined by the functional risk objectives identified in prior research;
(b) to enhance clarity, as articulated in the legend presented above, functions related to the buyer and supplier sides of the collaborative supply chain process were color coded; and
(c) Figure 4 should not be considered as a definitive statement of risk exposures of the collaborative souring process. Rather the figure provides a decision support tool that facilitates better understanding of the relationship between individual process activities and risk (or performance) objectives.

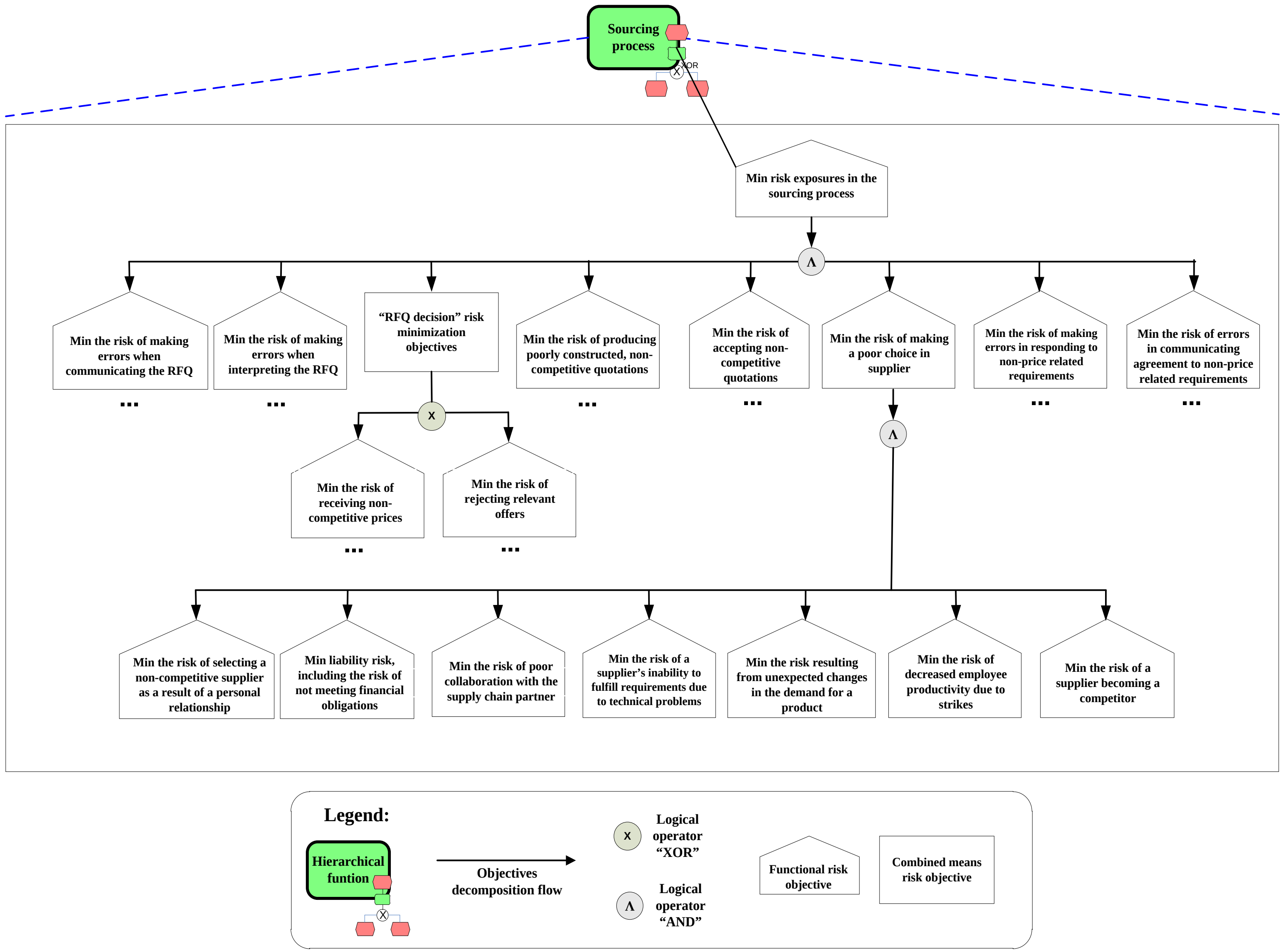

Figure 6: An integrated risk objectives structure

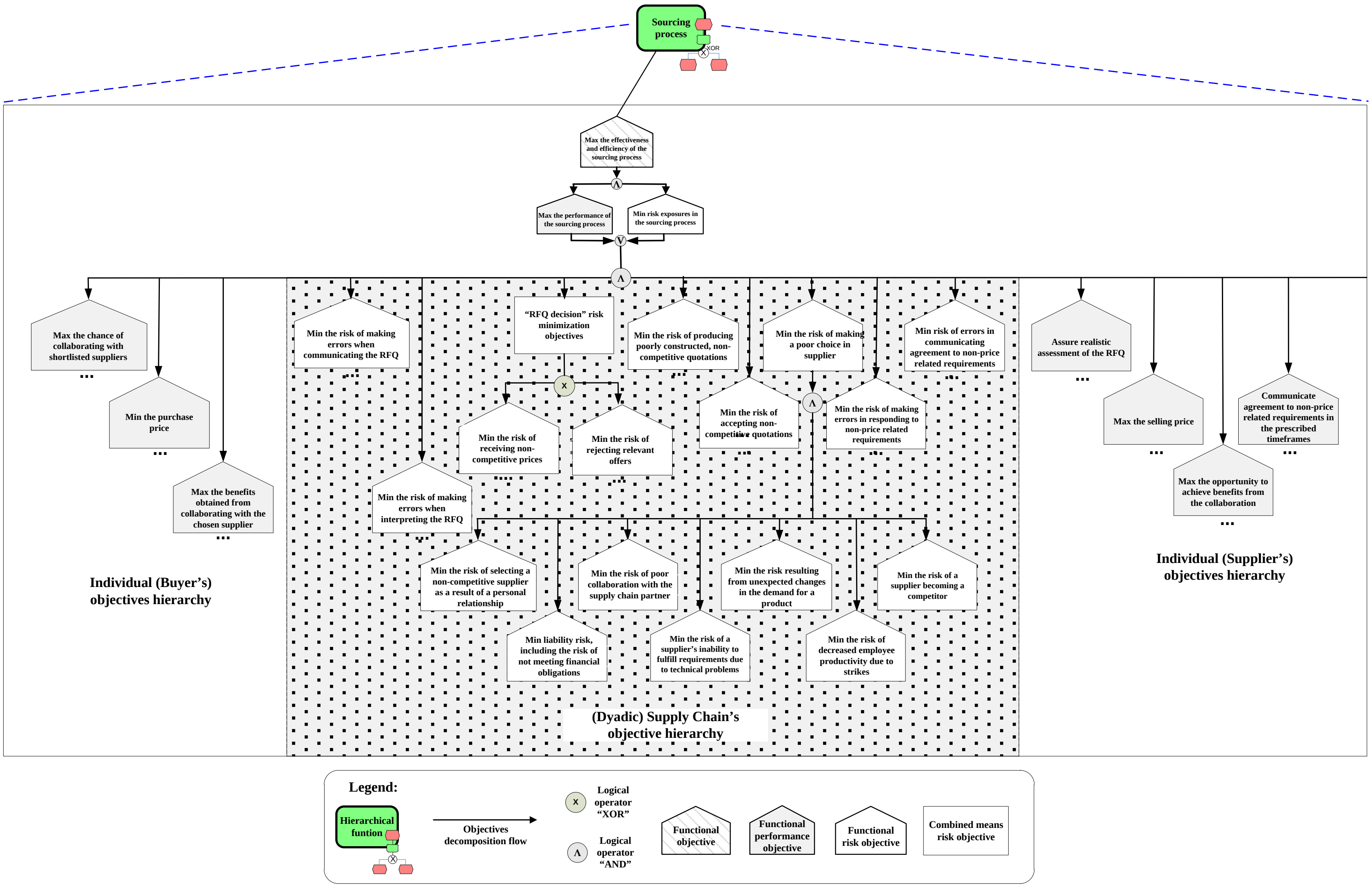

Figure 7: Synchronization of individual and supply chain risk and performance objective structure

Step 4: Aggregation of individual and shared objectives

Figure 7 demonstrates how individual and supply chain risk/performance objectives structures associated with the high level functional objective "*Max the effectiveness and efficiency of the sourcing process*" are synchronized. Analysis of the value generation buyer-supplier interface depicted in Figure 7 demonstrates the systemic role that dyadic risk objectives play in the cross-organizational supply chain processes. As often evidenced in the collaborative supply chain management literature (see Section 2), when attention is solely focused on the performance aspect of the value generation interface, it becomes apparent that each partner in the buyer-supplier dyad aims to achieve individual performance objectives that may conflict with those of the other party (see the left-hand side of Figure 3). Given that sustainability of the supply chain as a whole depends on whether the shared high-level functional objective "*Max effectiveness and efficiency of sourcing process*" is successfully achieved, the ability to explicitly represent individual performance and individual risk objectives (see Figure 7 for individual risk/performance objectives structures of the buyer and supplier), facilitates buyer and supplier organizations in deriving solutions that are acceptable and profitable for both parties. At the level of objectives this means a directed focus in making *conflicting objectives* congruent. To achieve this buyers and suppliers require additional incentives in order to compromise their individual potential value-creating opportunities. The prospective of performance creation for the whole supply chain is, on its own, insufficient to assure a sustainable partnership between collaborating supply chain members (Kampstra et al. 2006).

CONCLUSIONS

In this research paper we have addressed a number of knowledge gaps concerned with the formalized representation of objectives-driven value generation mechanisms in dyadic supply chains and the ability to synchronously integrate such mechanisms into the collaborative business processes of dyadic supply chain partnerships. In doing so, based on the guiding principles of the design science approach, we have achieved the following research outcomes:

- Built a formal modeling approach of RaVFPE, which details the relationship between individual and dyadic risk and performance objectives. This model supports identification of the individual objectives of distinct supply chain partners, as well as the emergent objectives of the dyadic relationship. Further, it allows differentiation between the conflicting and shared objectives of supply chain partners and the linking of objectives of individual supply chain partners with the emergent objectives of the dyadic relationship; and
- Through extension of RaVFPE, formulated an explicit mechanism by which to synchronize the objectives/processes in dyadic supply chains.

The novelty of this approach lies in its explicit emphasis on risk minimization as an effective mechanism for value creation in dyadic relationships and in representation of the dyadic objectives (predominantly risk-aware objectives) as emergent properties brought by the naturally induced collaborative efforts of distinct supply chain partners.

Whilst the Collaborative RaVFPE modeling methodology suggested in this paper requires further work to connect it to analytical methods and approaches, including decision criteria methods, it provides a necessary toolset for decision support at all phases of the collaborative decision making life-cycle. This includes: (1) problem assessment; (2) collection and verification of information; (3) anticipation of consequences of decisions; (4) decision making using sound and logical judgement based on available information; (5) decision evaluation; and (6) informing supply chain partner(s) of decision and rationale. The need for empirical validation is a limitation of the research. Another limitation is the focus on the most elementary form of the supply chain partnership, the dyadic supply chain. This focus limits the generalizability of the model to three- and more-echelon supply chains, thereby creating another opportunity for future research.

These limitations serve as potential directions for future research. Firstly, there is an opportunity to extend the classes of modeling objects (i.e. resource types, such as organizational units, environmental data, etc.) covered by the dyadic supply chain model in the Collaborative RaVFPE modeling methodology. Herein, a guiding principle is the formal representation of these classes introduced by Rotaru et al. (2011). Such an extension may enhance the ability of Collaborative RaVFPE to explicitly consider the available information, the uncertainties involved and the relevant preferences associated with collaborative decision making. Another direction for future research concerns extension and operationalization of the Collaborative RaVFPE model by developing evaluation scales useful in assessing risk and performance at the level of collaborative supply chains. This can be achieved by applying multi-criteria evaluation methods. Moreover, Collaborative RaVFPE could be extended and applied as a decision support tool for modeling and evaluating the value creation mechanisms of three-echelon supply chains, i.e. the so-called supply chain triads (Choi and Wu 2009).

In summary, by addressing the important problem of alignment between business objectives and corresponding activities in cross-organizational supply chain processes, and by providing an explicit formalized representation of shared and individual risk and performance objectives that drive competition and cooperation between supply chain partners, we make a contribution towards appreciation of risk-awareness in cross-organizational business processes.

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