A Domain-specific Modeling Technique for Value-driven Strategic Sourcing

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Abstract. *Strategic sourcing recognizes that procurement should support a firm's effort to achieve its long-term objectives. In particular, procurement needs to be a cross-functional end-to-end process inside the organization that is oriented towards value creation within the company and between the company and its partners in the value chain. The main challenge to the implementation of value-driven strategic sourcing is the lack of instruments that are characterized by analytical rigor and robustness in the identification of strategic sourcing options to achieve strategic goals. Therefore, this research aims to develop a domain-specific modeling technique founded on the Service-Dominant Logic which focuses on the systemic exploration of sourcing alternatives and emphasizes the delivery of value to achieve desired outcomes. This paper reports on a first cycle of Design Science Research which includes the demonstration and the evaluation of the value and utility of the modeling artefacts by means of a case study about IT outsourcing in the healthcare industry.*

Keywords. Strategic sourcing • Value • Domain-Specific Modeling Language • Service-Dominant Logic

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1 Introduction

Strategic sourcing recognizes that procurement is not a mere cost function, but that it should support the long-term objectives of a company. In this respect, organizations expect from their Chief Procurement Officer to develop both long-term and short-term procurement plans. Therefore, strategic sourcing should employ value-driven management approaches which are able to represent and analyze strategic options and alternatives that enable an organization to achieve its strategic objectives (David 2011). More specifically, the organization has to understand that a cross-functional end-to-end process should be implemented which goes beyond tactical cost savings and focuses on the 'value for money' of those assets that are critical for the value chain of the organization to manage the flow of value within the company and between the company and its suppliers and customers (Cox and Ireland 2015). A value chain connects the supply and demand bases of an organization. In this context, the supply base includes all processes that are necessary

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to fulfill the organizational demand by focusing on an efficient supply (i. e., determining what the suppliers propose as value). In contrast, the demand base comprises all the processes that are needed to create demand by identifying what the customer perceives as value (Jüttner et al. 2007). A thorough understanding of the entire value chain is needed to sustain the strategic goals of an organization.

Although value-driven strategic sourcing is fairly well recognized, managers are still challenged by many barriers to its implementation (Kocabasoglu and Suresh 2006). The main challenge is the lack of practical instruments to implement value-driven strategic sourcing. In particular, currently available instruments lack analytical rigor and robustness in the identification of strategic sourcing options to achieve strategic goals (Cox and Ireland 2015).

This problem can be tackled by the design of a conceptual modeling technique that allows a systematic analysis of strategic sourcing alternatives and an evaluation of these alternatives by using value-driven metrics. Such a modeling technique contributes to the implementation of value-driven strategic sourcing in different ways. First, conceptual models support the identification, formalization, and visualization of the relevant value-driven management concepts. Furthermore, the development of conceptual models can support the design of techniques for generating and assessing strategic sourcing alternatives. Finally, conceptual models provide the basis for developing computer-aided design tools which assist in automating the process of designing strategic sourcing alternatives (Osterwalder and Pigneur 2013). A conceptual modeling technique consists of two components: (i) a modeling language, and (ii) a modeling procedure. While the modeling language provides the constructs that can be part of a model, the modeling procedure describes the steps that are needed to construct a model (Karagiannis and Kühn 2002).

More specifically, we have opted to design a domain-specific modeling technique. In comparison with the use of general-purpose modeling techniques, a domain-specific modeling technique is particular useful for offering a rigorous and robust approach for value-driven strategic sourcing because it improves the productivity of modeling as technical terms not have to be reconstructed by the end-user (Frank 2013). Furthermore, a domain-specific modeling technique also preserves the quality of models as their integrity is ensured by preventing the construction of non-sensical models (Frank 2013). The specific choice of developing a new modeling technique implies that end-users are required to work with a new modeling technique which could be potentially harmful for the adoption of the technique in practice. However, the main rationale for designing a new technique instead of implementing value-driven strategic sourcing by means of an existing Enterprise Modeling (EM) language, e. g., ArchiMate (The Open Group 2016) or MEMO (Frank 2014), is that the theoretical foundation of the language's underlying conceptualization which we found most suitable for describing value-driven strategic sourcing, has not been previously used as theory for developing EM languages. As the prospective users of the modeling technique are managerial decision makers (e. g., chief procurement officers, chief strategic officers and strategic sourcing managers), our modeling technique should provide an abstraction and representation of the aspects that are relevant for value-driven strategic sourcing (Frank 2013). To allow model-based exploration and analysis of strategic sourcing options, the intended modeling technique should operationalize a theoretically-founded conceptualization of the enterprise that is in line with the value-driven modeling paradigm. To avoid possible inconsistencies between the underlying conceptualization and the abstract syntax and semantics of existing EM languages, we have opted to create a new domain-specific modeling language. Whereas constructs of our new domain-specific language can also be found in other EM languages, their particular combination might be unique and their semantics related to value co-creation might not be consistent with that of existing EM languages. As integration in an existing EM language is certainly preferred for organizations that use such

language, we suggest this topic as future research and outside the scope of the current paper.

Therefore, this paper focuses on realizing the research objective of designing a new domain-specific modeling technique which (i) provides an analytically rigorous modeling approach for strategic sourcing, and (ii) allows the model user to focus on the systemic exploration of strategic sourcing alternatives to achieve strategic goals.

In previous research (Rafati and Poels 2016), we found that the Service-Dominant (S-D) Logic (Lusch and Vargo 2006) allows for a theoretical description of enterprises that is in line with value-driven management thinking and we subsequently designed a conceptualization of the enterprise by mapping the S-D Logic concepts onto concepts relevant to strategic sourcing that we derived from three related Strategic Management theories: The Resource-Based View Theory (Barney 1991), the Relational View Theory (Dyer and Singh 1998), and the Dynamic Capability Theory (Helfat et al. 2007). This mapping led to the identification of the conceptual principles that underlie value-driven strategic sourcing: (i) An orientation towards modeling the organization's capabilities to (re)configure resources (e. g., assets and competencies) to deliver value and achieve strategic goals (Rafati and Poels 2014a,b, 2015, 2016); (ii) Providing a stable and overarching view on strategic sourcing for fostering dialogue amongst managerial decision makers (e. g., chief procurement officer, chief strategic officer and strategic sourcing manager) about strategic sourcing (Peeters 2016); (iii) Considering capability sourcing as a strategic process for organizing and fine-tuning the firm's value chain to ensure competitive advantage or survivability (Bain & Company 2018; Loftin et al. 2010).

The contribution of this paper is the introduction of the C.A.R.S. (i. e., `capability` – `actor` – `resource` – `service`) modeling technique as an analytically rigorous modeling technique to implement value-driven strategic sourcing. More specifically, we focus on the design of the C.A.R.S. modeling technique by the development of a modeling language (see Sect. 4.1) (i. e., a meta-model, semantic definitions, and a notation) and a modeling procedure (see Sect. 4.2), based on the conceptualization provided by the S-D logic. As we aim to contribute new knowledge on how to explore in an analytical rigorous and systemic way strategic sourcing alternatives according to the value-driven management paradigm, our research methodology was Design Science Research (DSR) (Hevner et al. 2004). This new knowledge was acquired through the building and evaluation of the C.A.R.S. artefacts (i. e., modeling language and modeling procedure). For the demonstration of C.A.R.S. modeling and the evaluation of the value and utility of the artefacts, a case study was employed which involved IT outsourcing in the healthcare industry.

The remainder of this paper is structured as follows. Section 2 describes our previous work which provides a theory-based conceptual foundation for the design of the envisioned modeling technique. The DSR methodology we employed for building and evaluating our research artifact is explained in Sect. 3. The C.A.R.S. modeling technique resulting from the design research is presented in Sect. 4, while Sect. 5 presents the case study of IT outsourcing in the healthcare industry as a proof-of-concept demonstration and evaluation of how our approach helped exploring strategic sourcing alternatives. Section 6 positions the C.A.R.S. modeling technique in different disciplines by comparing it with related conceptual modeling techniques. Finally, Sect. 7 summarizes the conclusions of this paper and outlines opportunities for future research.

2 Previous Work

2.1 C.A.R.S. Conceptual Basis

To help implementing the new paradigm of value-driven management in sourcing, we previously designed the C.A.R.S. conceptualization (Rafati and Poels 2016) (see Fig. 1) using the S-D Logic (Lusch and Vargo 2006) as its theoretical foundation. The S-D Logic is especially suited as a foundation for conceptualizing value-driven strategic sourcing as it views a company as a service

system which is a dynamic value co-creating configuration of resources that is connected internally and externally to other service systems by value propositions through service exchanges (Vargo and Akaka 2009). Moreover, the S-D Logic provides a framework for thinking more clearly about the service system and how it competes (Lusch et al. 2007) and survives (Vargo et al. 2008) in its environment. The S-D Logic defines a service which is the fundamental basis of value creation, as the application of operant resources for the benefit of another party (Vargo and Akaka 2009). While the traditional view on sourcing was a more 'goods-dominant' worldview of suppliers and buyers as senders and receivers of goods (hence the procurement's focus is on realizing cost savings), the value-driven view on strategic sourcing better matches the value co-creation interpretation of provider-customer relationships as in the S-D Logic (Eltantawy et al. 2014).

The C.A.R.S. conceptualization interprets the S-D Logic by applying it to the context of strategic sourcing (Rafati and Poels 2016). Consequently, the core C.A.R.S. concepts (i. e., capability, actor, resource (asset and competency) and service) are a direct mapping from their corresponding S-D Logic concepts (i. e., service system, actor, resource (operand resource and operant resource) and service). In constructing the C.A.R.S. conceptualization, we chose to retain some specific strategic sourcing terminology instead of employing more general S-D Logic concepts. The different C.A.R.S. concepts are defined as follows (Rafati and Poels 2016):

Capability. A capability describes what an actor can do to ensure organizational competitiveness and survivability. More specifically, a capability is the capacity and ability of an actor to create value through service exchanges. In this context, a capability can be considered as the result of a specific configuration of resources which need to be sourced. As the capability of an actor represents a potential long-term effect on the achievement of strategic objectives,value-driven Key Performance Indicators (KPIs) can be defined based on the capabilities of actors in the demand and supply side of the value chain. These KPIs are related to functional abilities like the organizational, managerial, and technical ability to measure long-term effects in achieving strategic goals such as establishing long-term partnerships or developing a sustainable competitive advantage (Ellram 1990). For example, the documentation and self-audit capability, the quality management capability and the design and development capability of the supplier can be used as soft or difficult-to-quantify criteria (i. e., value-driven KPIs), particularly in the context of strategic buyer-supplier partnerships (Narasimhan et al. 2001; Sarkis and Talluri 2002).

Actor. An actor is seen as a resource integrator that provides services, proposes value, creates value and captures value (Vargo and Lusch 2011b; Wieland et al. 2012). This actor notion is used to describe the role of the focal firm, its suppliers and its customers in a value network. Within this network, the following sourcing relationships are common: suppliers offer value propositions to the focal firm, the focal firm (as a buyer) is served by suppliers, the focal firm (as a provider) serves the customers, customers perceive and use value, and the focal firm captures value from both the demand and supply sides. These relationships imply that all actors are co-creators of value.

Resource. The resource base describes what an actor has which can be configured to provide capabilities and to support the creation of value (Vargo and Akaka 2009). As such, the resource base includes tangible and static resources (e. g., goods), as well as intangible and dynamic resources (e. g., competencies and skills). In Fig. 1, we distinguish between assets (i. e., operand resources in S-D Logic) and competencies (i. e., operant resources in S-D Logic).

Service. A service is the application of resources by an actor (Vargo and Akaka 2009). Services can be exchanged with other actors to co-create value and to ensure organizational competitiveness (Lusch et al. 2007) and survivability (Vargo et al. 2008). We use this notion in C.A.R.S. to capture the performance of actors

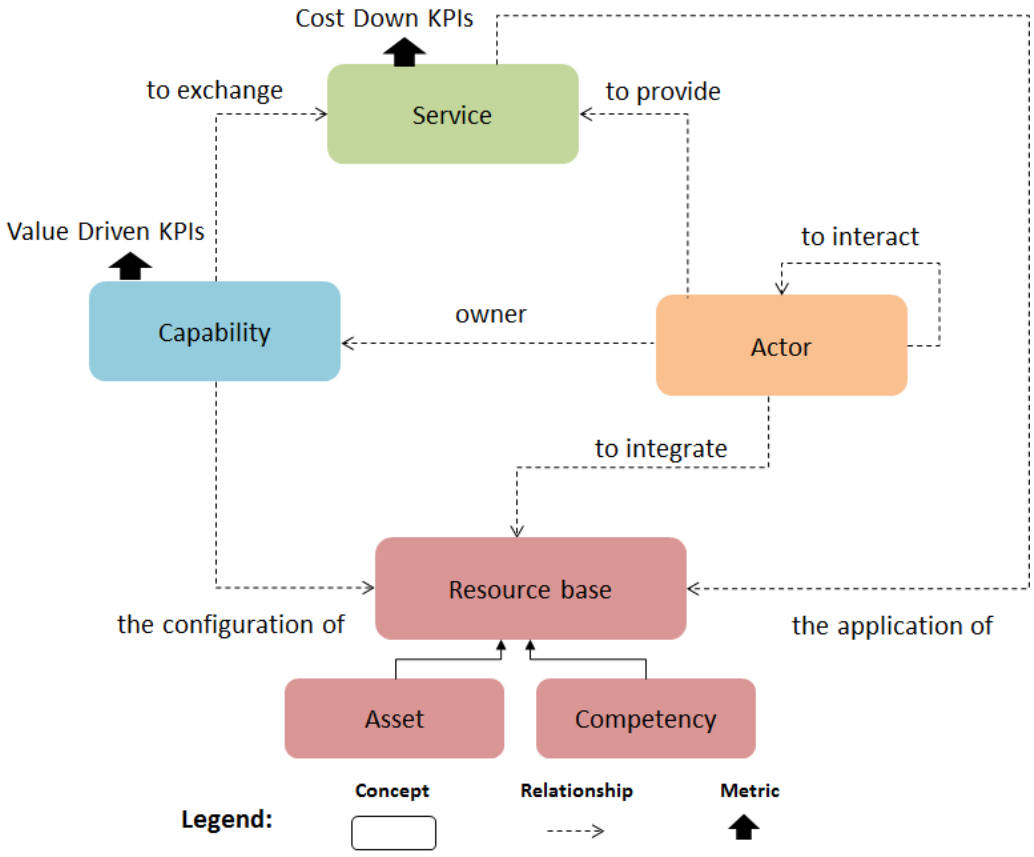

Figure 1: C.A.R.S. conceptualization

in achieving sourcing objectives (i. e., bottom-line results). Therefore, we define `cost-saving KPIs` for strategic sourcing which are based on the performance of an `actor` in `service exchanges`. `Cost-saving KPIs` are quantifiable performance metrics to measure short-term effects in achieving strategic goals. Examples of these metrics are the cost of a service, the quality of a service, the delivery time of a service, etc. (Ellram 1990).

The C.A.R.S. conceptual basis is summarized by four viewpoints that are associated with its main constructs (i. e., `capability`, `actor`, `resource`, and `service`). These viewpoints specify conventions for the construction and the use of the different sourcing views which represent a system from the perspective of one or more decision-makers to address specific concerns (IEEE 2000). An overview of the C.A.R.S. viewpoints, their focus and supported sourcing decisions is given in Tab. 1.

2.2 Preliminary Modeling Procedure

The current techniques for strategic sourcing (e. g., the Purchasing Category Portfolio (Kraljic 1983), the Power Portfolio Model (Cox 2001), the Purchasing Chessboard Approach (Schuh et al. 2009), etc.) strongly focus on cost savings through performing spend analyses, supply market analyses and positioning techniques. These techniques have been criticized as sourcing is considered as a tactical process rather than having a strategic importance to the organization (Cox 2014; Cox and Ireland 2015). Furthermore, the techniques do not consider the variables that are required to assess and evaluate the complexity of the supply market, the value of purchasing categories, the

Table 1: Summary of C.A.R.S. viewpoints

C.A.R.S. viewpoints	Focus	Sourcing decision
Capability-based Viewpoint	focuses on the abilities and capacities of the focal firm, its suppliers, and its customers to internally and externally configure the firm's resources and competencies with the aim of achieving a competitive advantage and surviving in a rapidly changing environment	choosing the right sourcing alternatives (e. g., outsourcing, insourcing, or co-sourcing)
Resource-based Viewpoint	focuses on the firm-specific strengths (i. e., superior resources and core competencies) that are capable of creating value and allow a firm to gain a competitive advantage	integrating superior resources and turning them into a specific benefit
Actor-based Viewpoint	focuses on the firm's interactions with suppliers and internal and external customers to achieve short-term or long-term partnerships	(a) selecting the right suppliers and evaluating their strategic and performance dimensions for short-term and long-term partnerships; (b) finding new customers to increase the value-creating potential
Service-based Viewpoint	focuses on the firm's competitiveness and survivability that is determined by the participation of its network members (e. g., buyers, suppliers, customers) to co-create value	(a) determining how much money is spent at different suppliers, (b) determining how much value is perceived or captured by customers

power of suppliers against buyers, and the suitability of strategic sourcing alternatives (Cox 2014; Cox and Ireland 2015).

To solve this issue, we proposed a preliminary modeling procedure based on the C.A.R.S. conceptualization for the systemic exploration of strategic sourcing alternatives (Rafati and Poels 2016). This procedure consists of three steps: (i) Determine the organization's capability positioning to find opportunities for cost savings and value creation; (ii) Determine its buyer-supplier dependency positioning for setting relationship strategies in the supply market; (iii) Identify sourcing strategies towards classifying capability sourcing and setting sourcing strategies.

In this paper, the preliminary modeling procedure is further extended and refined by connecting it to the developed meta-model of the C.A.R.S. modeling language.

3 Research Methodology

In terms of DSR artefacts (Hevner et al. 2004), the C.A.R.S. meta-model and its semantic definition can be considered as a model, where the constructs are defined by the earlier developed C.A.R.S. conceptualization (see Sect. 2.1). The C.A.R.S. modeling procedure is a method and the C.A.R.S. models obtained through application of the modeling technique in the case study are instantiations. In performing our research, we followed the DSR methodology process (Peffers et al. 2007) (Fig. 2).

3.1 Problem Identification and Motivation

The research problem about the lack of analytically rigorous instruments to help implementing value-driven strategic sourcing is discussed in the introduction (see Sect. 1). Such instruments should help strategic sourcing managers to systematically explore and evaluate strategic sourcing alternatives.

3.2 Definition of Solution Objectives

As a solution to the identified problem, we propose the design of a new conceptual modeling technique for strategic sourcing. Based on the three earlier

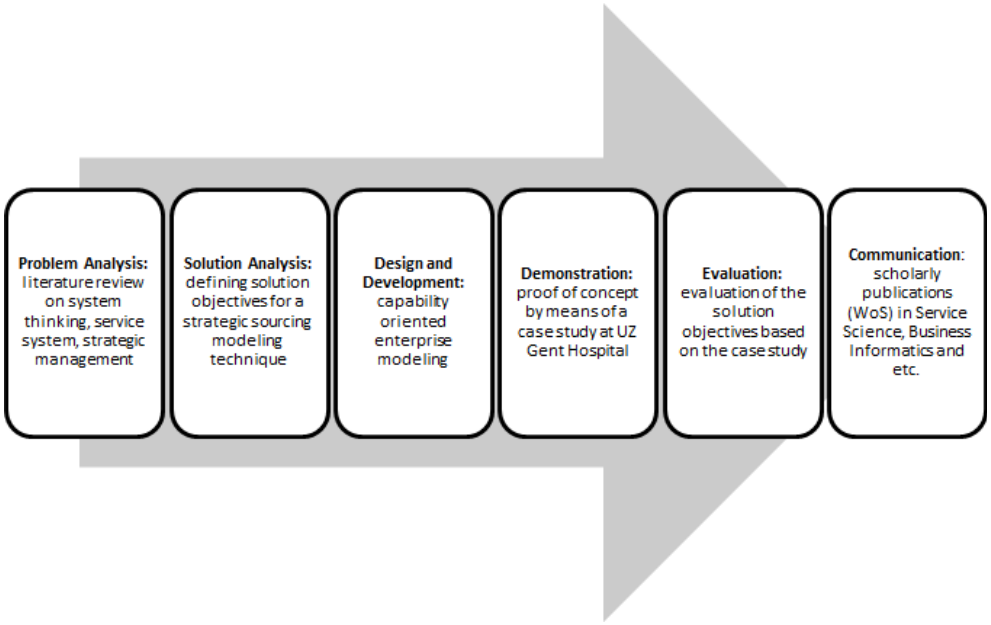

Figure 2: DSR Methodology process (Peffers et al. 2007)

identified principles (see Sect. 1), we define four requirements for such a modeling technique.

Req. 1: The approach must focus on strategic sourcing and the procurement process.

An explicit focus on procurement and strategic sourcing is needed to support the creation of sourcing models, diagrams and views such as the Strategic Canvas (Kim and Mauborgne 2002), the 5-forces model (Porter 1979), the Spend Cube (Bartels et al. 2008), the Core Competencies Model (Campbell and Luchs 1997; Drejer 2002), the Sourcing Canvas (Loftin et al. 2010), Value Chain Models (Porter 2011), Cost Models (e. g., total cost of ownership), Purchasing Models (Cox 2001; Kraljic 1983), etc. These models can help the decision-making of stakeholders at the strategic level such as the chief procurement officer, the chief strategic officer, the strategic sourcing manager, the procurement manager, the purchasing manager, the category manager, and the supply chain manager.

Req. 2: The approach must enable companies to support procurement data management and analytics competencies for fact-based decision-making.

Strategic sourcing has become a critical area of strategic management that is focused on decision-making regarding an organization's procurement activities such as spend analysis, capability sourcing, supplier selection and evaluation. However, many companies face challenges in obtaining the benefits associated with effective strategic sourcing. In this respect, managing the right procurement data for fact-based strategic sourcing decision-making is a core organizational challenge (Berger 2014; Butner 2009; Dhawan et al. 2011; Finch et al. 2014; IBM 2013; LaValle et al. 2010). Therefore, we need an approach that enables the centralization of procurement data and the systemic exploration of sourcing alternatives to support procurement data management and analytics competencies (Rafati and Poels 2015).

Req. 3: The approach must provide a rigorous analysis considering both cost-saving KPIs and value-driven KPIs in strategic sourcing.

Cox (2014) introduces the need for a paradigm shift from a tactical to a strategic way of thinking about sourcing by focusing on value-driven targets. According to this strategic sourcing paradigm,

there is need for a modeling approach to systemically explore sourcing alternatives by considering both cost-saving KPIs (e. g., total cost of ownership, switching cost, searching cost, etc.) and value-driven KPIs (e. g., organizational ability, technical ability, managerial ability, etc.) (Rafati and Poels 2016).

Req. 4: The approach must model both performance-related and functional dimensions of value chain actors to achieve long-term and short-term sourcing objectives.

According to Talluri and Narasimhan (2004), sourcing decisions are not just operational decisions about the supplier and buyer's performance in a short-term relationship, but also strategic decisions about the supplier and buyer's capabilities for developing long-term relationships. Therefore, an approach is needed for modeling the performance and functional (i. e., strategy-related) ability of actors (e. g., buyer, supplier, and focal firm) with respect to achieving sourcing objectives. The performance-related dimension of an actor (e. g., with respect to cost, quality, or delivery) represents short-term effects on the achievement of sourcing objectives. In contrast to this, the functional ability (e. g., technical capability, managerial capability, organizational capability) of an actor represents potential long-term effects on these objectives.

3.3 Design & Development

Section 2 presented the C.A.R.S. conceptualization for strategic sourcing which was founded on the S-D Logic as main theoretical basis. The design of the C.A.R.S. modeling technique starts from this conceptualization. This design (see Sect. 4) includes the specification of a meta-model that defines the language constructs and their relationships. For formulating the intended semantics of these meta-model elements, we use SBVR (i. e., Semantics of Business Vocabulary and Business Rules). Using SBVR, the C.A.R.S. constructs are characterized as `Object Types` and `Roles`. In this respect, an `Object Type` is a noun concept that classifies things on the basis of their common properties, while a `Role` is defined as a noun concept that corresponds to things based on playing a part, assuming a function or being used in some situation (OMG 2015a). The C.A.R.S. relationships between constructs are considered as `Fact Types` which are concepts that have the meaning of a verb phrase that involve one or more noun concepts (OMG 2015a). Besides the meta-model and its semantics, a concrete syntax is proposed for the core concepts. In Sect. 4.2, the C.A.R.S. modeling technique is further completed by the specification of a supporting modeling procedure which also includes guidance on the use of specific modeling viewpoints that can be constructed as instantiations of the C.A.R.S. modeling language.

3.4 Demonstration

We used a case study in the healthcare domain to demonstrate the use of our modeling approach for conceptualizing, designing, exploring, and analyzing strategic sourcing alternatives regarding IT outsourcing (see Sect. 5.1).

3.5 Evaluation

The goal of this phase is to observe and measure how well the proposed modeling technique supports the implementation of value-driven strategic sourcing. We reflect upon the case study demonstration to evaluate the four solution requirements that were defined in the current section (see Sect. 5.2).

3.6 Communication

The results of the first two steps of the DSR process (i. e., problem and solution analysis) were disseminated in peer-reviewed conference publications within domains such as System Thinking (Rafati and Poels 2013), Service Science (Rafati and Poels 2016) and Strategic Management (Rafati and Poels 2015). The current paper presents the design & development, demonstration, and evaluation of the C.A.R.S. modeling technique.

4 C.A.R.S. Modeling Technique

4.1 Modeling Language

Meta-model. Section 4.1 introduces the meta-model of the C.A.R.S. modeling technique (see

Fig. 3) which is compliant with the MOF (i. e., Meta Object Facility) specification (OMG 2016). This meta-model identifies the key concepts (i. e., capability, actor, resource, and service) and their interrelationships of the C.A.R.S. conceptualization. Value-driven KPIs and cost-driven KPIs are included as respectively strategic metrics and performance metrics. The meta-model also includes a number of classifications of the key C.A.R.S. concepts.

The meta-model further shows how services aim at delivering value and that this value is intended to result in desired outcomes. According to the meta-model, competitiveness and survivability are defined as two distinct desired outcomes of value creation through two functions, surviving and competition. While surviving is a function of how the firm exchanges its services to survive and thrive in its surrounding environment (Vargo et al. 2008), competition is a function of how one firm exchanges its services to meet the needs of the customer relative to how another firm exchanges its services (Lusch et al. 2007). Possible competitiveness outcomes are obtaining a sustainable competitive advantage, a temporary competitive advantage, competitive parity, etc. (Hill and Jones 1991). To achieve these desired outcomes, a company possesses a set of capabilities which refer to the capacity and ability of an actor to internally and externally (re)configure resources (i. e., assets and competencies) which can be classified in either a core or a non-core category. Core capabilities are required to achieve competitiveness or survivability. Besides this, non-core capabilities support the firm's core capabilities to achieve desired outcomes. Moreover, capabilities are able to deliver value through service exchanges in both the supply and the demand market which can be measured by strategic indicators (i. e., using value-driven KPIs). Service provisioning is the fundamental basis of value delivery by the application of resources for the benefit of another party (i. e., who requested the service) (Vargo and Akaka 2009). Resources can be classified as valuable, rare, inimitable, and non-substitutable as in the Resource-Based View of the firm (Barney 1991, 2002). The actual result of a service exchange can be measured through performance metrics (i. e., using cost-driven KPIs). Actors are engaged in these service exchanges as value co-creator and can play different roles as supplier, buyer, provider, customer or competitor. An actor can propose, perceive and capture the value to and from the market. Therefore, after value proposition, value creation and value capture functions, the value can be interpreted as the proposed value, the perceived value or the captured value in the market. Note that when different constellations of actors co-create value that is perceived as equal by customers, the value created by each of these constellations is a different instance of the value concept.

Semantics. The semantics of the meta-model is formalized by means of SBVR in Tab. 2 and Tab. 3. To increase the understanding for the reader, clarifying examples are provided which are inspired by our case study in the healthcare domain (Sect. 5).

The meta-model relationships (i. e., verb concepts) are formalized by SBVR in the Fact Table of Tab. 4.

Notation For instantiating the meta-model, a concrete syntax is needed. In Tab. 5, we present the notation that we used when instantiating the meta-model for the case study (see Sect. 5).

4.2 Extended Modeling Procedure

The C.A.R.S. modeling procedure which extends the preliminary modeling procedure presented in Sect. 2.2, now includes five different modeling steps (see Fig. 4): (i) Conduct a demand analysis (new); (ii) Conduct a supply analysis (new); (iii) Determine the capability positioning; (iv) Determine the dependency positioning; (v) Identify capability sourcing options.

Furthermore, an accompanying meta-model instantiation is proposed for each of these modeling steps which is a further refinement of the preliminary modeling procedure presented before. The

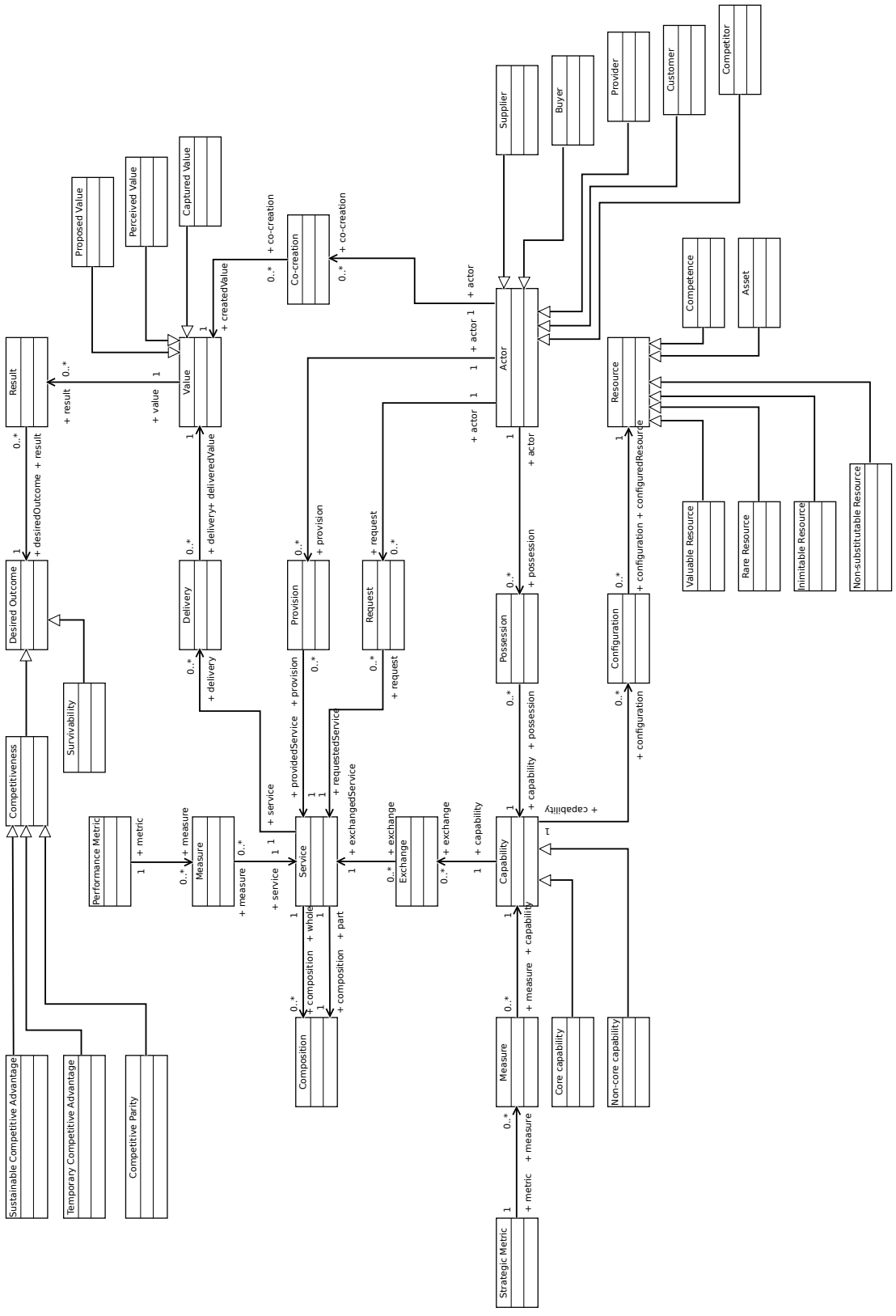

Figure 3: C.A.R.S. meta-model

Table 2: C.A.R.S. concepts

Noun concept	Definition
Resource (object type)	An asset or competency that an actor has or can call upon (Barney 1991, 2002). *Examples: skills, software and devices*
Competency (object type)	An active resource that acts upon other resource(s) to create value (Lusch et al. 2007; Poels 2010; Vargo and Akaka 2009). *Examples: skills, systems*
Asset (object type)	A passive resource that must be acted on to become a valuable resource (Lusch et al. 2007; Poels 2010; Vargo and Akaka 2009). *Examples: standards, technologies*
Valuable resource (role)	A resource that is capable of creating value (Barney 1991, 2002). *Example: healthcare information systems*
Rare resource (role)	A valuable resource that is possessed uniquely by one actor or by only a few others (Barney 1991, 2002). *Example: business intelligence tools*
Inimitable resource (role)	A valuable resource that competitors find difficult to imitate or obtain (Barney 1991, 2002). *Example: specialized health standard*
Non-substitutable resource (role)	A valuable resource that does not have a strategic equivalent (Barney 1991, 2002). *Example: integrated health system*
Capability (object type)	The capacity and ability of an actor to internally and externally (re)configure resources which is able to deliver value through service exchanges and which is needed to achieve a desired outcome (Helfat et al. 2007). *Examples: healthcare core management, healthcare information management, hospital infrastructure management, hospital business management*
Core capability (role)	A capability that is required to achieve competitiveness or survivability and cannot be imitated or obtained by competitor(s) (Helfat et al. 2007). *Examples: healthcare core management, healthcare information management*
Non-core capability (role)	A capability that supports the firm's core capabilities but is not essential to the firm to achieve competitiveness or survivability or can easily be imitated by competitor(s) (Helfat et al. 2007). *Examples: hospital infrastructure management, business information management*
Desired outcome (object type)	A desired state of the firm in its environment (Azevedo et al. 2015; U.S. Department of Defense 2010). *Example: gaining profit or a sustainable position in the healthcare sector*
Survivability (role)	A desired outcome that results in the survival and prosperity of the firm (Vargo et al. 2008). *Example: a sustainable position in the healthcare sector*
Competitiveness (role)	A desired outcome that results in more economic value in competition market (Hill and Jones 1991). *Example: gaining profit in the healthcare sector*
Sustainable competitive advantage (role)	A desired outcome that results in maintaining a profit that is above average during a prolonged period (Hill and Jones 1991). *Example: achieving high profitability for a number of years in the healthcare market*
Temporary competitive advantage (role)	A desired outcome that results in maintaining a profit that is on average to above average during a limited time (Hill and Jones 1991). *Example: achieving a profitability in the healthcare market which is slightly above average*
Competitive parity (role)	A desired outcome that results in maintaining an average profit (Hill and Jones 1991). *Example: achieving average profit in the healthcare market*
Service (object type)	An application of resources for the benefit of another party which is the fundamental basis of value creation through economic exchange (Vargo and Akaka 2009). *Example: healthcare core service and healthcare supporting services*

Table 3: C.A.R.S. concepts continued

Noun concept	Definition
Value (object type)	An increase in the viability of an actor that only can be co-created by the participation of other actors (Cardoso et al. 2014; Vargo and Lusch 2011a). *Examples: differentiation of healthcare core services, low costs of healthcare supporting services*
Captured value (role)	What the actor captures after perceiving value by the beneficiary actor (Bowman and Ambrosini 2000; Golnam et al. 2013; Vargo and Lusch 2011a). *Example: profit*
Perceived value (role)	The value as defined by the beneficiary actor, based on its perceptions of the usefulness of the product on offer (Vargo and Lusch 2011a). *Example: a care service with a high-level quality that results in a high perceived value*
Proposed value (role)	The value that is promised by an actor to be delivered in a service exchange (Vargo and Lusch 2011a). *Example: enabling the hospital to deliver quality of care while capturing efficiency gains*
Performance metric (object type)	A quantifiable or "hard" criterion to measure the performance of an actor to exchange services and to deliver value (Ellram 1990; Talluri and Narasimhan 2004). *Example: quality, cost, delivery time of service*
Strategic metric (object type)	A soft or difficult-to-quantify criterion to measure the capability of an actor to integrate resources which is needed to achieve a desired outcome (Ellram 1990; Talluri and Narasimhan 2004). *Example: documentation and self-audit capability, quality management capability, design and development capability*
Actor (object type)	A party which is engaged in a service exchange as a value co-creator (Vargo and Lusch 2011b). *Examples: hospital, patients, clinical staff, hospital staff, other users of the hospital systems, and other hospitals, vendors*
Supplier (role)	An actor who proposes value to be delivered to a beneficiary actor in a service exchange (Eltantawy et al. 2014). *Examples: healthcare IT solution providers, healthcare technology vendors*
Buyer (role)	An actor who purchases services from supply market (Eltantawy et al. 2014; Golnam et al. 2013). *Examples: general hospitals, university hospitals*
Provider (role)	An actor who provides services to beneficiary actor and who captures value (Eltantawy et al. 2014; Golnam et al. 2013). *Example: a specific hospital (as a service provider)*
Customer (role)	An actor who requests services from demand market and who perceives and uses value (Eltantawy et al. 2014; Golnam et al. 2013). *Examples: patients, healthcare laboratories*
Competitor (role)	An actor who provides the same services to the same group of beneficiary actors (Eltantawy et al. 2014; Golnam et al. 2013). *Example: other university hospitals than UZ Gent*

Table 4: C.A.R.S. facts

Relationship (Fact type)	Definition
Configuration	A capability configures resources (Helfat et al. 2007).
Exchange	A capability exchanges services (Lusch et al. 2007; Vargo and Akaka 2009).
Measure	A capability is measured by strategic metrics (Talluri and Narasimhan 2004).
Possession	An actor possesses capabilities (Eltantawy et al. 2014).
Provision	An actor provides services (Eltantawy et al. 2014).
Request	An actor requests services (Eltantawy et al. 2014).
Co-creation	An actor co-creates value (Vargo and Lusch 2011a).
Delivery	A service delivers value (Lusch et al. 2007; Vargo and Akaka 2009).
Measured	A service is measured by performance metrics (Talluri and Narasimhan 2004).
Composition	A service is composed of subservices.
Result	Value creation results in a desired outcome (Lusch et al. 2007).

Table 5: C.A.R.S. concrete syntax

Modeling element	Concrete syntax
Capability	
Actor	
Resource	
Service	
Value	
Desired outcome	
Metric	
Relationship	

C.A.R.S. viewpoints provide an overall image of the models that result from meta-model instantiation when applying the C.A.R.S. modeling procedure. A viewpoint is a representation of a whole system from the perspective of one or more decision-makers to address specific concerns (IEEE 2000). In accordance with the viewpoints defined for the C.A.R.S. conceptualization (see Tab. 1 in Sect. 2.1), we define several viewpoints to address specific needs of strategic sourcing decision-makers:

1. An overall viewpoint on the demand market and supply market to find opportunities for sourcing which is solved by the introduction of *demand-side and supply-side profile models*; 2. A positioning viewpoint on different classifications of capabilities, resources, services and actors (e. g., suppliers, customers and buyers) for setting strategies which is realized by the *capability positioning portfolio model*; 3. A relational viewpoint on the relationship among suppliers, buyers, and customers for assessing dependencies which is given by *the dependency model and the actor positioning portfolio model*; 4. A sourcing viewpoint on various strategic sourcing alternatives and options of capabilities toward cost-saving and value-driven targets which is shown by *the capability sourcing portfolio analysis model*. These meta-model instantiations are demonstrated in Sect. 5, where the

procedure is applied through a case study. However, we first explain the five steps of the modeling procedure.

Step 1: Conduct Demand Analysis. This step aims to increase the understanding of the demand side of the customer market to better assess opportunities for strategic sourcing. Our approach analyzes demand based on two dimensions of the focal firm: a functional dimension that is measured by strategic metrics and a performance dimension that is measured by performance metrics. These dimensions can be analyzed within C.A.R.S. by the development of *a demand-side profile model* (see Fig. 5 for an example). This type of model is constructed by instantiating the `desired outcome`, `value`, `service`, `capability`, and `resource` meta-classes. The instances are related through the following relationships: `configure`, `exchange`, `deliver`, and `results in`.

Step 2: Conduct Supply Analysis. This step is oriented towards improving the understanding of the supplier market. Comparable to the demand side, the supply market can be analyzed based on a functional dimension and a performance-related dimension which are analyzed in *a supply-side profile model* (see Fig. 6 for an example). This type of model is constructed by instantiating the `value`, `service`, `actor`, and `capability` meta-classes. The instances are related through `possess`, `co-create`, and `provide` relationships.

Step 3: Determine Capability Positioning. This step aims to position the capabilities of the focal firm by considering both the demand and supply side of the value chain to find opportunities for cost savings and value creation. Inspired by Cox's criticality analysis (Cox 2014), we introduce *the capability positioning portfolio model* (see Fig. 7 for an example) as a C.A.R.S. meta-model instantiation which is based on two capability dimensions: (i) the potential to create more economic value (i. e., competitiveness) or the potential to survive (i. e., survivability), and (ii) the available resource base to achieve the desired outcome. This results in a 2 x 2 matrix with four capability categories: (i) critical-strategic, (ii) strategic, (iii) critical-tactical, and (iv) tactical. For this type of model, only the `capability` meta-class needs to be instantiated.

Step 4: Determine Dependency Positioning. The purpose of this step is to position the dependency between buyers and suppliers to shape relationship strategies in the supply market. The C.A.R.S. modeling approach classifies this dependency based on the power of both the supplier and the buyer which is measured by (i) the essentiality and substitutability of the exchanged service (Jacobs 1974), and (ii) the capability to exchange services. The essentiality of a service is determined by the relative financial magnitude of the service which refers to the impact of a service on the organizational profit. In contrast to this, the criticality of a service refers to the degree in which the focal firm is able to continue its operations in case of absence of the service. The substitutability of a service is determined by the availability of alternative sources and the level of relation-specific investments (i. e., the costs that result from switching between suppliers or buyers). This results in four possible categories to position the relationship between a buyer and a supplier: (i) buyer dominance, (ii) supplier dominance, (iii) interdependence, and (iv) independence. C.A.R.S. categorizes the dependencies between *a supplier and a buyer by a dependency model* (see Fig. 8 for an example) and illustrates the suppliers' dependency positioning by a 2 x 2 portfolio matrix, called the *actor positioning portfolio model* (see Fig. 9 for an example). The *dependency model* is constructed by instantiating the `resource`, `service`, `actor`, and `capability` meta-classes. The instances are related through `configure`, `possess`, `provide`, `request`, and `composition` relationships. For the *actor positioning portfolio model* only the `actor` meta-class needs to be instantiated.

Step 5: Identify capability sourcing strategies. The goal of the last step in the modeling procedure is to develop *a capability sourcing portfolio analysis model* (see Fig. 10 for an example) for classifying and setting capability sourcing strategies. The proposed model makes use of a 4 x 4 matrix to classify 16 capability sourcing categories based on the outcomes of the previous steps:

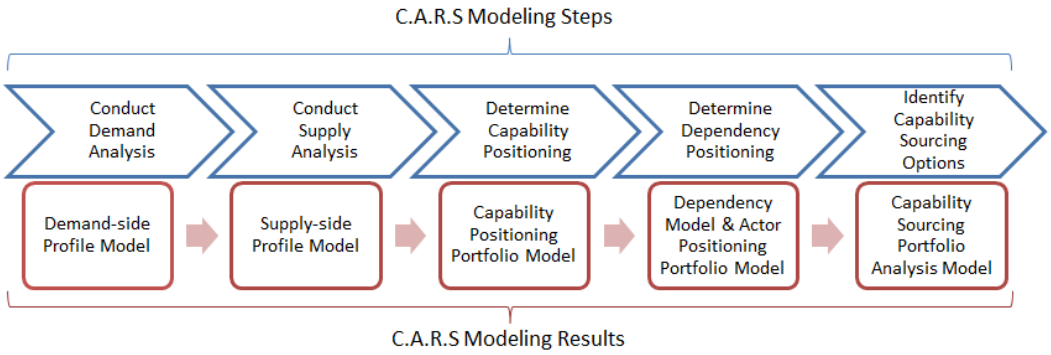

Figure 4: C.A.R.S. modeling procedure

the capability positioning and the buyer-supplier dependency positioning. The *capability sourcing portfolio analysis* is inspired by the sourcing portfolio analysis of Cox (2014) which is an existing approach to set supply strategies based on two leverage principles for exploring sourcing options: (i) moving into supply markets with low complexity, and (ii) understanding the current position and search for ways to exploit or balance the existing relationships. This type of model does not require instantiating any of the meta-classes of the meta-model, and is thus strictly spoken not a meta-model instantiation.

5 Case Study

Section 5 presents a proof-of-concept demonstration and evaluation of the C.A.R.S. modeling technique for exploring value-driven strategic sourcing by using an IT sourcing case study in UZ Gent which is one of the largest hospitals in Belgium. More specifically, we illustrate how a strategic sourcing decision maker can apply the C.A.R.S. modeling technique to explore strategies and recommendations about sourcing IT capabilities in the hospital (see Sect. 5.1). Furthermore, the C.A.R.S. modeling technique is evaluated based on the insights that we gained from the case study (see Sect. 5.2).

5.1 Demonstration

We describe the IT sourcing scenario based on existing information about the healthcare IT contracts and agreements of UZ Gent. Furthermore, we did a reality check about the obtained results with the Chief Information Officer (CIO) of UZ Gent for a proof-of-concept evaluation of the proposed modeling approach. In the remainder of this paragraph, we illustrate how a strategic sourcing decision maker can apply the C.A.R.S. modeling technique to explore strategies and recommendations about sourcing IT capabilities in the hospital. As explained in Sect. 4.2, this application is guided by the 5-step C.A.R.S. modeling procedure (see Fig. 4).

Step 1: Conduct Demand Analysis. Fig. 5 shows *the demand-side profile model* of UZ Gent which shows the exchange of two services with internal and external customers like patients, clinical staff, hospital staff, and other hospitals. These services are healthcare core services (i. e., including clinical services and care services) and healthcare supporting services (i. e., including business administration services and ICT communication services). For these services, the associated value that is offered to the customers is differentiation (i. e., healthcare core services) and low costs (i. e.., healthcare supporting services). The exchange of these services is supported by four IT capabilities: (i) healthcare core management, (ii) healthcare information management, (iii) hospital infrastructure management, and (iv) hospital business management. The definitions of these capabilities can be found in Tab. 6.

The IT capabilities are based on various healthcare IT resources, such as skills (e. g., clinical

Table 6: IT capability definitions

Capability	Definition
Healthcare core management	The ability and capacity to deliver integrated healthcare core services supported by information and communication technologies
Healthcare information management	The ability and capacity to acquire, analyze and act on digital and traditional healthcare information (e. g., hospital information, clinical information, radiology information, and laboratory information) to provide high-quality patient care
Hospital infrastructure management	The ability and capacity to simplify communication and to speed up access to information with the aim of enhancing the clinical efficiency, increasing the productivity and improving the patient well-being
Hospital business management	The ability and capacity to acquire, analyze and act on administrative data (e. g., accounting, billing, purchasing, logistics, and catering data) to increase the hospital management performance and to decrease the overall costs

skills, business skills, ICT skills, technical skills, and organizational skills), technologies (e. g., displays, monitors, workstations, projectors, and video walls), software (e. g., image processing software and ERP software), systems (e. g., healthcare information system, reporting system, decision support system, and hospital-wide management information systems such as accounting, billing, and procurement management systems) and standards (e. g., information systems such as accounting, billing, and procurement management systems) and standards (e. g., Health Level-7 and DICOM). According to the hospital spend analysis, 40 % of the total IT budget is spent on core services and 25% on supporting services.

Step 2: Conduct Supply Analysis. The *supply side profile model* (see Fig. 6) shows that two technical capabilities (i. e., the integrated healthcare solution development capability and the integrated business-ICT solution development capability) are needed for a supplier to provide both the healthcare core services and the supporting services. For the healthcare core services, potential suppliers are companies such as Cerner, Xperthis, Agfa Healthcare, Barco, Infohos, Carestream Healthcare, GE Healthcare, and Nexuz Healthcare. These parties can all co-create equal (but not the same) value which include the delivery of quality of care while capturing efficiency gains, providing timely access to the right information and intelligence, and offering integrated care. On the other hand, companies as SAP, Oracle, Microsoft, EMC, Dimension Data, Realdolmen, HP, PHILIPS, Fujifilm, Dell and Siemens are potential suppliers of healthcare supporting services. They co-create value by: (i) supporting UZ Gent towards interdisciplinary collaboration, (ii) increasing business management performance, (iii) supporting UZ Gent towards integrated business operations, (iv) simplifying the hospital IT infrastructure to help save money, and (v) reducing the complexity of the hospital IT infrastructure through consolidation and virtualization.

Step 3: Determine Capability Positioning. The *capability positioning portfolio model* of UZ Gent, (see Fig. 7) shows that the healthcare core management capability is considered as a configuration of VRIN (i. e., valuable, rare, inimitable, and non-substitutable) resources and competencies (e. g., specialized healthcare skills, technologies, systems and standards) which is a critical-strategic capability that is able to achieve a sustainable competitive advantage in the demand market. The healthcare information management capability (i. e., a configuration of valuable resources and competencies such as healthcare skills, technologies, systems and standards), is a strategic capability that is able to achieve competitive advantage in the demand market. The hospital infrastructure management capability as a configuration of VRIN resources and competencies (e. g., hospital technologies, networks, and websites and data

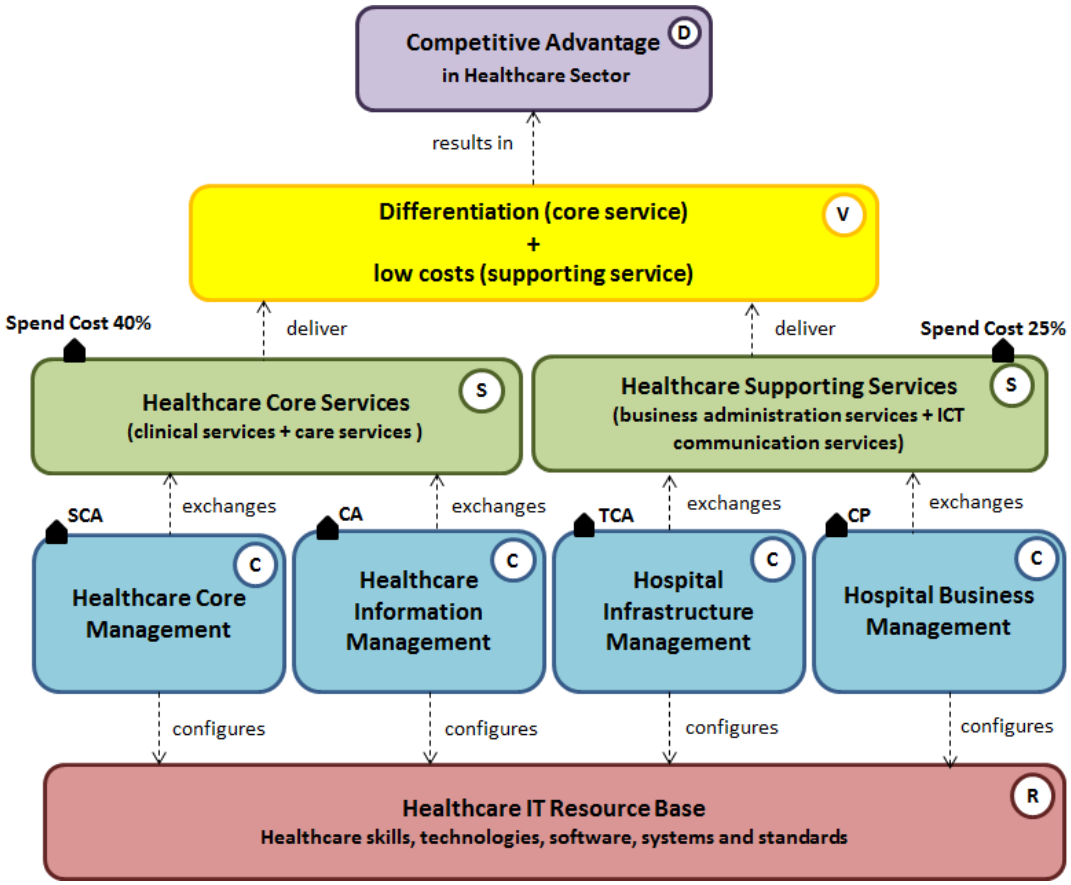

Figure 5: Demand side profile model of UZ Gent

centers) is a critical-tactical capability that is able to achieve temporary competitive advantage in the demand market. Finally, the hospital business management capability is a tactical capability that is based on valuable resources and competencies (e. g., management information systems, business managerial skills and competencies) which results in parity competition in the demand market.

Step 4: Determine Dependency Positioning. The *dependency model* in Fig. 8 focuses on the picture archiving service that is provided to UZ Gent's by Agfa Healthcare which is a specialized healthcare IT solution provider. This service supports a seamless linkage of digital images with information from clinical information systems and other databases in the hospital. This service is part of the healthcare core services that are exchanged by the healthcare information management capability of UZ Gent. The buyer-supplier dependency analysis shows that the studied service is a common healthcare information system for UZ Gent with low-level criticality and low-level financial impact. On the other hand, this service is a core service of Agfa Healthcare with high-level criticality and high-level financial impact. There are seven alternative suppliers (i. e., Xperthis, Barco, Infohos, Carestream Healthcare, GE Healthcare, Nexuz Healthcare, and IBM Healthcare) to provide this service with low-level switching costs. Moreover, there are only three alternative buyers (i. e., one university hospital and two general hospitals) to request this service with high-level searching costs. Therefore, the relationship between UZ Gent and Agfa Healthcare is positioned as a "buyer dominance" relationship. Similarly,

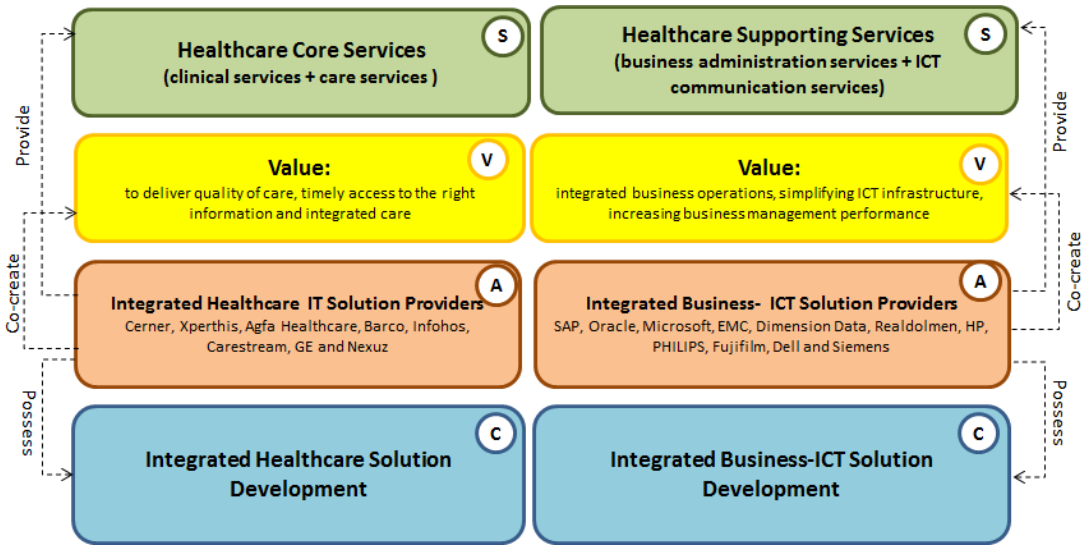

Figure 6: Supply side profile model of UZ Gent

we can create dependency models for other suppliers in the market which are required to develop a complete *actor positioning portfolio model)* (see Fig. 9).

Fig. 9 shows the results of the actor positioning portfolio analysis of all UZ Gent suppliers. The findings of this analysis can be summarized as follows:

(i) Buyer dominance: Agfa, Barco, Infohos, Nexuz and Carestream are alternative suppliers to provide healthcare information systems through a buyer-dominant relationship with UZ Gent

(ii) Interdependence: (a) Xperthis is classified in the interdependence cell as a supplier for hospital information management services; (b) Cerner is the only supplier in the market to provide an integrated healthcare solution to UZ Gent, hence it can be positioned in the interdependence cell; (c) Realdolmen is classified in the interdependence cell for providing hospital infrastructure management services.

(iii) Supplier dominance: Dimension Data and EMC are two dominant suppliers for hospital infrastructure management.

(iv) Independence: (a) two suppliers are classified in the independence cell for infrastructure management: HP and Dell; (b) to support the business administration in UZ Gent, SAP, Oracle and Microsoft are all classified as having independence buyer-supplier relationships with UZ Gent.

Step 5: Identify capability sourcing strategies. Fig. 10 shows the modeling result of the last step of the C.A.R.S. modeling procedure which aims to develop appropriate sourcing strategies based on *the capability positioning portfolio model* (Fig. 7) and *the actor positioning portfolio model* (Fig. 9). More specifically, *the capability sourcing portfolio model* classifies capability sourcing options into 16 categories based on the outcomes of the capability positioning (i. e., tactical capability, tactical-critical capability, strategic capability, and strategic-critical capability in Fig. 7) and the actor positioning (i. e., interdependence, dependence, buyer dominance and supplier dominance in Fig. 9). Fig. 10 shows the results of applying the capability sourcing portfolio analysis in UZ Gent. In the following, we explain the possible and available options and strategies for sourcing UZ Gent's capabilities according to the capability sourcing portfolio analysis and its leverage principles.

Possible strategies for the healthcare core management capability (i. e., a critical-strategic capability) are: (i) Develop an integrated IT system

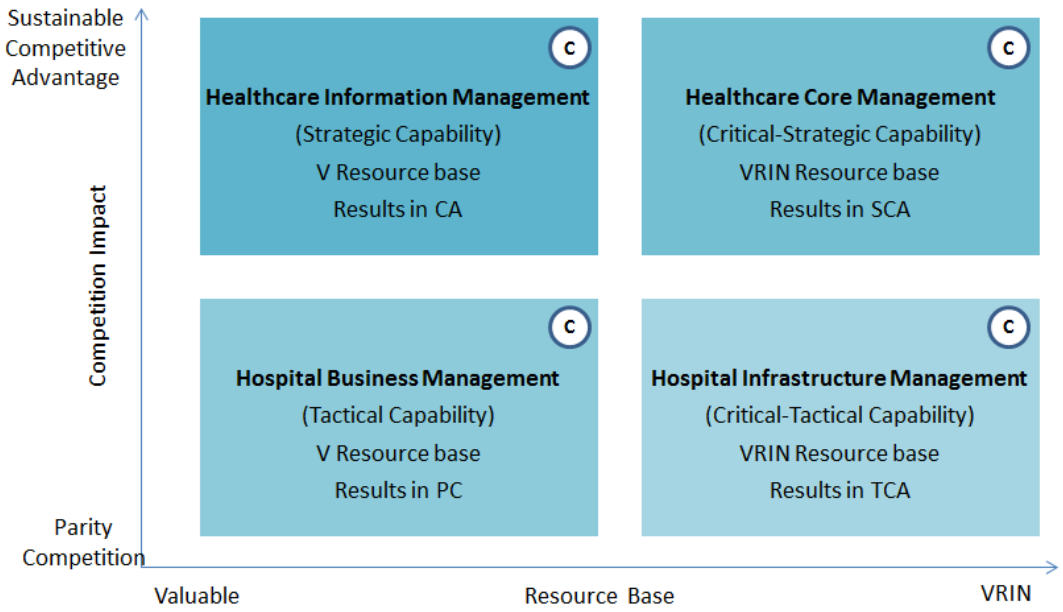

Figure 7: Capability positioning portfolio model of UZ Gent

in-house (i. e., insourcing) which can be sold to other hospitals in the market. The main advantage of this strategy is the development of an innovative platform that generates extra revenues by improving the internal IT capabilities and internal IT resource base. However, this will also result in high development costs. (ii) Choose for outsourcing to realize cost reductions. However, this option comes at the expense of value creation and is only viable if there exist potential suppliers in the market. (iii) Maintain the strategic partnership with Cerner through long-term agreements for value creation (e. g., by the development of a tailored healthcare system to realize differentiation) and reduce risk through master data management.

The healthcare information management capability is sourced within a supply market which is characterized by many suppliers and relatively low switching costs. Therefore, UZ Gent has the following options: (i) Exploit the buying power through market competition and short-term agreements with suppliers to realize cost reductions. (ii) Develop a strategic partnership with Xperthis through long-term collaborations to foster innovation. A possible disadvantage of this option is the emergence of a lock-in partnership.

Sourcing the healthcare infrastructure management capability is difficult for UZ Gent as their suppliers determine both the price and the quality, while the hospital has limited buyer power. Hence, possible sourcing strategies include: (i) Exploit market competition through short-term agreements with HP and Dell. However, this can have a negative impact on the creation of value. (ii) Develop a strategic partnership with Realdolmen through moving into an alliance position. Although this can increase the creation of value, a risk of choosing this option is entering in a lock-in partnership. (iii) Accept the hospital's dependency on Dimension Data and EMC and the existence of a locked-in partnership.

Finally, many options exist for sourcing the business information management capability as the supply market has many buyers and searching costs are relatively low. Therefore, the best sourcing option is realizing market competition through short-term agreements.

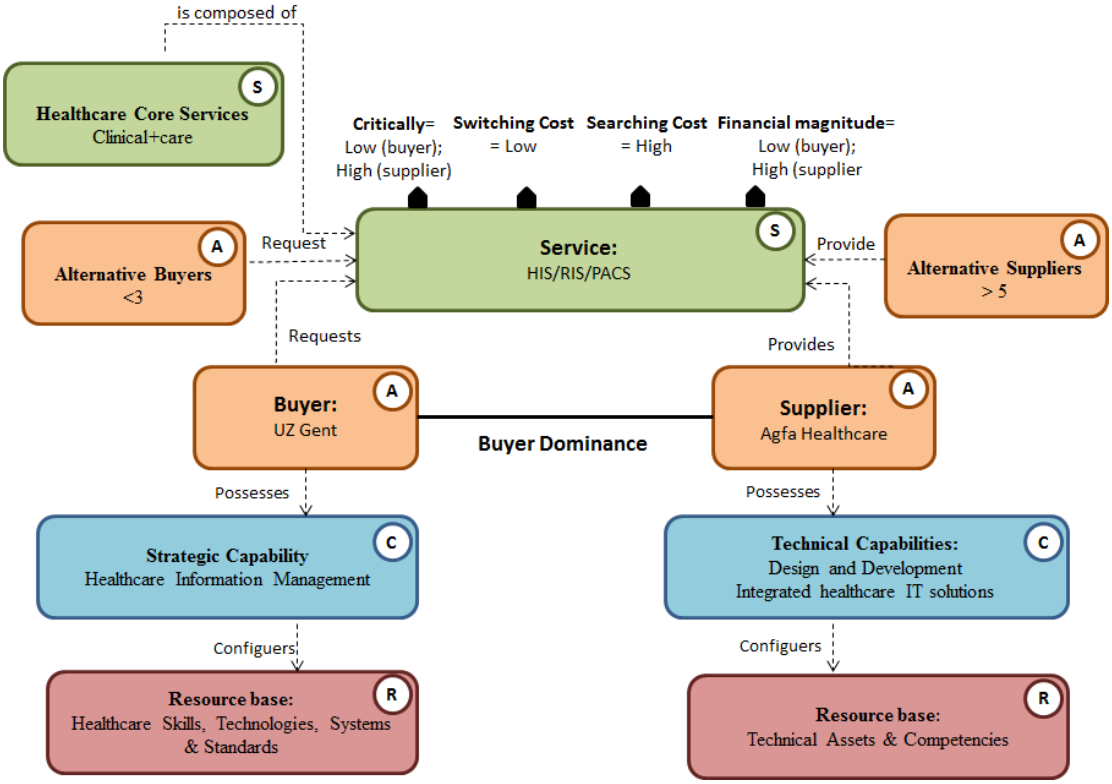

Figure 8: Buyer-supplier dependency model of UZ Gent and Agfa Healthcare

5.2 Evaluation

The CIO of UZ Gent realized that its sourcing strategy was mainly focused on cost-saving metrics (e. g., total cost of ownership, quality, and delivery time) rather than value-creating factors (e. g., capabilities, competencies and resources). In this respect, he believes that the C.A.R.S. modeling approach can support strategic sourcing decision makers to achieve value-related targets (e. g., innovation and long-term partnerships) through providing an IT capability portfolio, an analysis of both the demand and supply side of the hospital's capabilities, and a buyer-supplier dependency portfolio. In the remainder of Sect. 5.2, we evaluate the C.A.R.S. modeling approach against the solution requirements (see Sect. 3.2) based on the insights gained from the case study at UZ Gent.

The C.A.R.S. modeling approach provides a set of viewpoints that are useful for decision makers at the strategic management level (i. e., requirement 1). More specifically, capability-oriented viewpoints are proposed to represent architectural descriptions that address specific concerns such as demand profiling, supply profiling, category positioning, dependency-power positioning, and sourcing portfolio management. For example, *profile models* (see Fig. 5 and Fig. 6) represent the demand and the supply profile of the IT market of UZ Gent. Furthermore, *a capability-based dependency model* (see Fig. 8) illustrates the relationship between the hospital and its suppliers. Finally, *positioning models* (see Fig. 7 and Fig. 9) are able to model capability and actor portfolios. According to the CIO's feedback, these models are able to provide a stable view and a common language to support the discussion about IT sourcing options between the different decision makers at UZ Gent.

The proposed modeling technique enables companies to achieve procurement data management and analytics competencies for fact-based

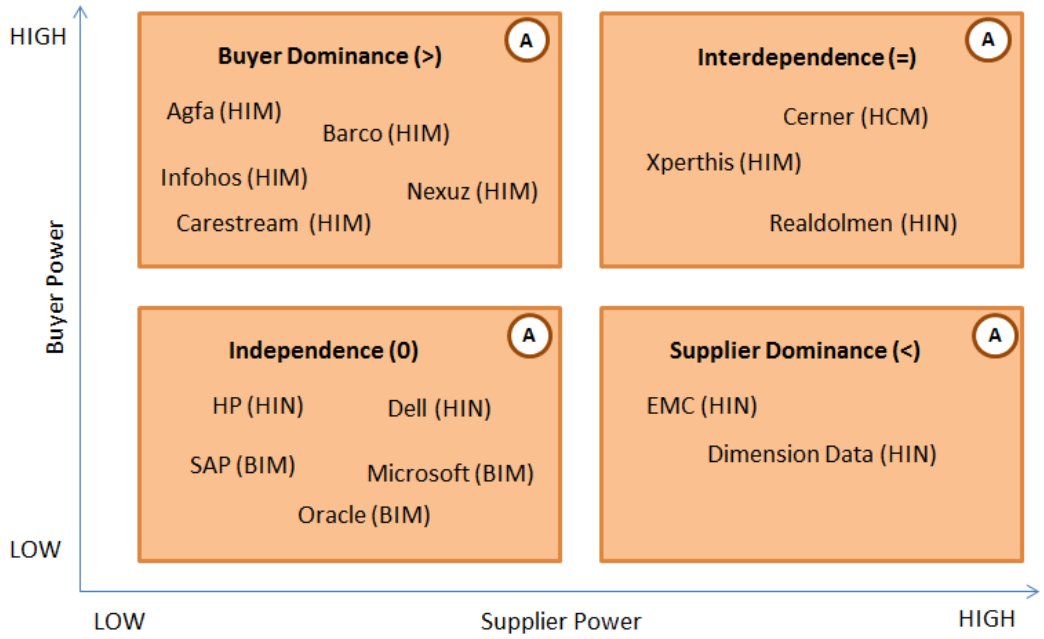

Figure 9: Actor positioning portfolio model of UZ Gent

decision-making (i. e., requirement 2). The meta-model and the semantics of C.A.R.S. have the potential to be used as a conceptual data model which could be further extended into a logical data model. In order to do so, more technical information and attributes need to be added to the current meta-model. Afterwards, this logical data model could be converted into a physical data model by applying implementation attributes, constraints, security roles, and by generating XML schema descriptions.

In this respect, the `capability` notion of the C.A.R.S. meta-model can be used to model strategic sourcing data about the capabilities of actors (e. g., supplier, buyer, competitor, customer, etc.) in both the supply and demand markets. In the case study, this resulted in an overview of the capabilities in the healthcare demand market and the required capabilities from the IT supply market of UZ Gent. Furthermore, the `service` notion can be used to model operational sourcing data about the cost of a service (e. g., spending, total cost of ownership, transaction costs, switching costs, and searching costs), the quality of a service, and the delivery time of a service. In the case study, this provided us more insights about services in the demand market, services that are exchanged between UZ Gent and its IT suppliers, searching costs, switching costs, and the financial impact of exchanged services (e. g., the picture archiving service). The `actor` notion can be used to model relational sourcing data about supplier-buyer relationships as illustrated by *the dependency models* between UZ Gent and its IT suppliers. Finally, the `resource` notion is useful to model sourcing data about the available resource base. For UZ Gent, this resource base includes skills, systems, technologies and standards.

C.A.R.S. provides a rigorous analysis of sourcing options by considering both cost-saving and value-driven KPIs (i. e., requirement 3). In the case study, value-driven KPIs were used to evaluate the technical capabilities of IT solution providers with the aim of identifying options for long-term partnerships and to determine the operational capabilities of UZ Gent and their competitors to achieve a sustainable competitive advantage. Furthermore, cost-saving KPIs were considered

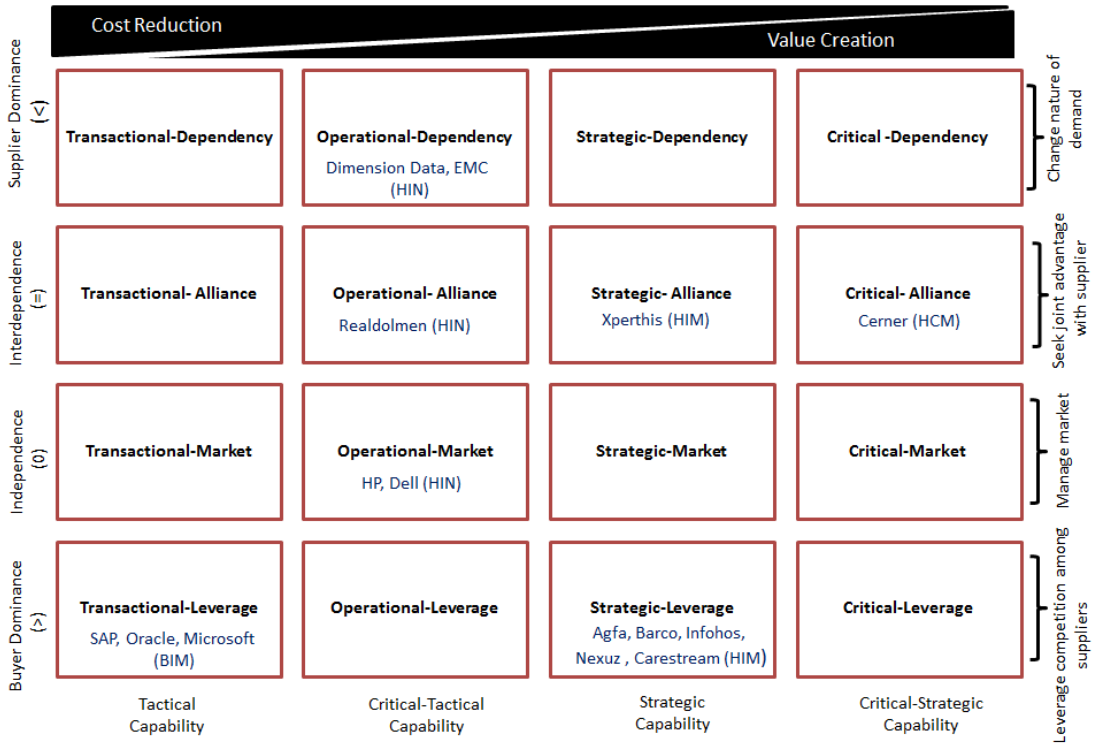

Figure 10: Capability sourcing portfolio analysis model of UZ Gent

to evaluate the current performance of IT-solution vendors in the provision of their services. This was realized through metrics such as the cost and quality of a short-term relationship.

The C.A.R.S. modeling approach is able to demonstrate both operational (i. e., performance-related) and functional (i. e., strategy-related) dimensions of the actors in the value chain (i. e., buyers, suppliers, and the focal firm) to achieve both long-term and short-term sourcing objectives (i. e., requirement 4). C.A.R.S. proposes a service-dominant logic for modeling the performance dimension of actors (e. g., buyer, supplier and focal firm) to achieve sourcing operational objectives (i. e., bottom-line results). On the other hand, C.A.R.S. proposes a capability-dominant logic for modeling the functional abilities and capacities of actors to achieve long-term objectives. In the case study, we used the C.A.R.S. service concepts and related operational metrics to model the performance dimensions of UZ Gent and Agfa Healthcare in exchanging the picture archiving service. These dimensions include the criticality and financial magnitude of the service, the searching costs, and the switching costs. Furthermore, we applied the C.A.R.S. capability concepts and related strategic metrics to illustrate the functional dimension of UZ Gent and Agfa Healthcare in exchanging the picture archiving service by the technical capabilities of Agfa Healthcare and the strategic capabilities of UZ Gent.

6 Related Work

`Capabilities` do not only play an essential role within the C.A.R.S. modeling technique, but the concept is often employed in EM to connect strategic objectives and high-level organizational information to the requirements of individual technological artifacts (Loucopoulos et al. 2015). The use of a capability as the representative of 'what' the business does and needs without describing the technical implementation (i. e., 'how') serves

as a powerful abstraction tool to ensure the communication between technology and business specialists (Loucopoulos et al. 2015). The notion has been used for representing investment profiles for IT (Iacob et al. 2012; Keller 2009), realizing business/IT alignment (Ulrich and Rosen 2012), reasoning about alternatives of capability development (Danesh and Yu 2014), mapping to operational components and services (U.S. Department of Defense 2010) and realizing a nearly automated transition to software development (Stirna et al. 2012; Zdravkovic et al. 2013).

Different EM techniques use `capabilities` as a construct in their modeling language. These capability-oriented modeling techniques include the Component Business Model (CBM), the Value Delivery Modeling Language (VDML), Enterprise Capability Modeling (ECM), Business Strategy and Valuation Concepts (BSVC), the DoDAF meta-model (DM2), Capability-based planning, Business Capabilities Centric Enterprise Architecture (BCCE) and Capability-Driven Development (CDD). An overview of the scope of these modeling techniques is given in Tab. 7.

CBM focuses on the realization of business change and the transformation of enterprises. The technique makes use of a componentization approach that is based on a process of deconstruction/reconstruction through business components (i. e., a part of an enterprise that has the potential to operate independently). In other words, business components represent a logical grouping of the work that is done within the enterprise which contains people, activities, and supporting technology (Cherbakov et al. 2005; Ernest and Nisavic 2007).

VDML links capability offerings to the organizational value network as the concept is considered as being fundamental for the delivery of a product or service and the realization of a company's business model. In this context, VDML defines a `capability` as the ability of an organization to perform a particular type of work and may involve people with particular skills and knowledge, intellectual property, defined practices, operating facilities, tools and equipment (OMG 2015b).

ECM is a modeling approach to meet organizational challenges such as alignment, agility and sustainability in the context of dynamic enterprise requirements. ECM makes use of five interrelated viewpoints, in which capability modeling acts as a conduit to integrate the different views. This will offer enterprises the opportunity to analyze the effects of a changing environment on the strategic alignment among digital services and organizational objectives (Loucopoulos et al. 2015).

BSVC is an extension to the ArchiMate modeling language that aims to capture the business value of IT artifacts and projects in order to achieve a better alignment with the business strategy. BSVC defines a capability as the ability of a static structure element, (e. g., actor, application component, etc.) to employ resources to achieve some goal. BSVC uses this `capability` construct to facilitate the strategic alignment between business and IT (Azevedo et al. 2015).

DM2 supports a modeling technique which emphasizes the importance of describing capabilities by a viewpoint that facilitates capability deployment planning, implementation, monitoring and preservation. DM2 defines a `capability` as the ability to achieve a desired effect under specified performance standards and conditions through combinations of ways and means (i. e., activities and resources) to perform a set of activities. DM2 explicitly facilitates the mapping of capabilities to both operational components which illustrates the functional scope and organizational span of a capability, and services to illustrate how various capabilities can support a service-oriented implementation (U.S. Department of Defense 2010).

CBP is a versatile business planning approach that focuses on the planning, engineering, and delivery of strategic business capabilities to the enterprise. As such, CBP assists in aligning IT with the business by focusing on the continuous creation of business value. Within this approach which is used as an extension of the TOGAF framework and the ArchiMate modeling language, a `capability` is defined as an ability, capacity or

Table 7: Capability-oriented modeling approaches

Approach	Discipline	Definition	Application Domain
CBM	Business Architecture	A modeling approach to support the componentization and service- orientation of a business	Business development at the strategic level (Cherbakov et al. 2005; Ernest and Nisavic 2007)
VDML	Value Modeling	A modeling approach for value-driven enterprise design and the management of business transformation	Analysis and design of the operation of an enterprise, support for strategic transformation of enterprises (OMG 2015b)
ECM	Requirements Engineering	A capability-centric modeling approach to achieve business/IT alignment	Business/IT alignment (Loucopoulos et al. 2015)
BSVC (ArchiMate)	Enterprise Architecture	An approach to model the organization's core capabilities and key resources to focus on capturing the business value of IT artifacts and projects in order to achieve a better alignment with business strategy	Strategic alignment of project portfolios (Azevedo et al. 2015)
DM2	Enterprise Architecture	A modeling approach which facilitates architectural alignment by mapping capabilities to a service-oriented implementation	Service-oriented architecture and development, Business/IT alignment (U.S. Department of Defense 2010)
Capability-based Planning (TOGAF/ ArchiMate)	Enterprise Architecture	A modeling approach for capability analysis, development and delivery	Enterprise planning and engineering, Business/IT alignment (Papazoglou 2014)
BCCE (TOGAF)	Enterprise Architecture	A modeling approach based on the component business model for the modularization of IT architectures	Business development, IT architecture, EA integration (Barroero et al. 2010)
CDD	Model-driven Development	A holistic approach to model-oriented information system development and to allow the run-time adaptation of alternatives	Information system development (Zdravkovic et al. 2013)

potential that an organization, person or system possesses (Papazoglou 2014).

BCCE integrates the IBM business component approach into the TOGAF framework. BCCE defines a `capability` as the power or the ability to describe what a business component can do to create value for customers (Barroero et al. 2010). BCCE uses capability and business component maps to support the modularization of the architecture of a business component which are considered as IT clusters that provide and consume services.

CDD aims to facilitate a nearly automated transition to software development by modeling capabilities and the contexts in which they operate. CDD defines a `capability` as the ability and capacity that enable an enterprise to achieve a business goal in a certain context. As such, a capability formulates the requirements for accomplishing a business goal which can be realized by applying a capability delivery pattern. Consequently, CDD facilitates run-time adjustments to changing requirements by the implementation of contextualized patterns of capability execution (Zdravkovic et al. 2013).

In summary, existing EM approaches use `capabilities` in a wide variety of application

contexts like strategic alignment, business development and transformation, enterprise architecture integration, requirement and change management, service-oriented architecture, information system developments, and project and portfolio management. Hence, we introduce C.A.R.S. as a modeling technique to realize a more rigorous exploration and analysis of strategic sourcing alternatives. As a domain-specific modeling language, C.A.R.S., explicitly focuses on procurement and strategic sourcing as a specific application domain.

7 Conclusion

In this paper, we propose the C.A.R.S. modeling technique as an instrument to implement value-driven strategic sourcing. This modeling technique is a capability-oriented modeling approach founded on the S-D Logic which focuses on the systemic exploration of strategic sourcing alternatives to achieve strategic goals. Furthermore, C.A.R.S. enables a rigorous analysis of strategic sourcing options. In this context, the modeling technique is designed by defining both a modeling language and a supporting modeling procedure. Furthermore, we used a case study to demonstrate the application of the C.A.R.S. modeling technique in a real-world scenario (i. e., IT outsourcing in UZ Ghent). This case study supports the evaluation of the C.A.R.S. modeling approach with respect to the identified solution requirements.

Although the evaluation enables us to demonstrate the potential applicability of the C.A.R.S. technique, we acknowledge that this needs to be repeated by future case studies. Therefore, we will investigate the application scope of the modeling approach by targeting different domains (e. g., commercial and non-commercial domains), different levels (i. e., micro (e. g., local), meso (e. g., international), and macro (e. g., global)), and different sourcing trends (e. g., shared service centers, business process outsourcing, IT outsourcing, offshoring and global sourcing, etc.). This could potentially result in small adaptations to the modeling technique.

Besides a practical evaluation of the usefulness of the modeling technique, a formal evaluation of its syntax and semantics is needed in the future to detect and resolve possible language deficiencies. This could be realized by applying the C.A.R.S. modeling technique in case studies with diverse contexts which enables to compare different instantiations of the modeling constructs to identify language flaws.

As C.A.R.S. is designed as a new domain-specific modeling technique which does not originate from existing EM languages, it is important that future research is oriented towards the integration of our modeling technique with languages as MEMO (Frank 2014) and ArchiMate (The Open Group 2016) (e. g., as a new viewpoint specifically tailored to the Chief Procurement Officer). This will ensure that value-driven strategic sourcing becomes a new EM perspective that is clearly integrated with the existing perspectives.

Finally, future research includes the development of a way-of-working to implement value-driven strategic sourcing. This research will be focused on model-driven analytical techniques to support data management (e. g., master data and reference data), data analysis (e. g., statistical, contextual, quantitative, descriptive, predictive and cognitive analyses), and visual data tools (e. g., SAS and SPSS) with the aim of realizing fact-based decision-making. Besides this, we will develop a computer-aided design tool to support the way-of-supporting. This can be realized by an assessment of the ability of existing EA modeling tools (e. g., Archi, Sparx Enterprise Architect, IBM Rational Enterprise Architect, and ADOIT for strategic management) to support the C.A.R.S. technique.

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