A Solution Architecture to Support the C.A.R.S Conceptual Model for Strategic Sourcing

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Abstract: Many companies face challenges in obtaining the benefits associated with effective strategic sourcing. From an organizational perspective, procurement data management is a core organizational challenge for chief procurement officers (CPOs) for fact-based strategic sourcing decision-making. This paper demonstrates how a model-based approach can support companies to achieve two key competencies, procurement data management and analytics, which allow moving the company toward fact-based strategic sourcing decision-making. We define a solution architecture for the proposed model based approach according to four views, Business View, Functional View, Data view and Implementation View. In this paper, C.A.R.S has been described as a reference model in the business view of the solution. Accordingly, in the functional view, a business function model (BFM) has been developed in order to build a complete and consistent set of required process blocks for strategic sourcing decision-making based on C.A.R.S. To support the data view of the solution, a conceptual Entity-Relationship data model to clarify functional and performance entities has been designed and finally, a logical data model has been proposed for procurement Data Mart with snowflake schema by abstract key structure as a way of implementation of the IT solution architecture with Top-Down approach.

Keywords: functional model, data model, data mart, procurement, strategic sourcing, procurement functional dimension, procurement performance dimension
1 Introduction:

Procurement has gained importance in supply chain management due to factors such as globalization, increased added value in the supply chain, and accelerated technological change. Vice versa, the growing importance of supply chain management has led to an increasing recognition of the strategic role of procurement [1]. Procurement has evolved from mere buying into strategic sourcing [2], [3] and has recently been recognized as a critical driving force in the strategic management of supply chains [4], [5], [6]. Strategic sourcing recognizes that procurement is not just a cost function, but supports the firm’s effort to achieve its long-term objectives [7]. Strategic sourcing has become a critical area of strategic management that is centered on decision-making regarding an organization’s procurement activities such as spend analysis, capability sourcing, supplier selection and evaluation, contract management and relationship management. Because of the increasing significance of procurement, strategic sourcing decisions become more important. Sourcing decisions are strategic decisions at the management level about finding opportunities for and delivering sustainable savings; choosing the right sourcing alternatives like outsourcing, insourcing and co-sourcing (i.e., the typical make-versus-buy decisions) to achieve (sustained) competitive advantage; selecting the right suppliers and evaluate their strategic and performance dimension for long-term and short-term partnerships; identifying solutions for mitigating supplier risk, improving supplier governance and enforcing supplier compliance. These decisions are critical for various procurement decision-makers such as chief procurement officers (CPOs), chief strategic officers (CSOs), strategic sourcing managers, category managers, product managers, purchasing managers, contract managers and supplier/customer relationship managers. This paper demonstrates how a model-based approach can support companies to achieve two key competencies, procurement data management and analytics, which allow moving the company toward fact-based strategic sourcing decision-making.

The paper is organized as follows: Section 2 describes the results of our literature review on fact-based decision-making in strategic sourcing and subsequently elaborates on our research objective; Section 3 introduces the proposed approach to achieve this research objective; Sections 4, 5 and 6 discuss the solution architecture of proposed approach in four views, business, functional, data and implementation. Finally, Section 7 concludes the paper.

2 Procurement Data Management and Analytics

To drive fact-based decision-making, organizations require two critical competencies, data management and data analytics. The data management competency is the ability to address issues of data architecture, extraction, transformation, movement, storage, integration, and governance. The data analytics competency is the ability to analyze data for answering key business questions through applying advanced techniques such as modeling (e.g. statistical, contextual, quantitative, predictive, cognitive, other emerging models), deep computing, simulation, data mining, and optimization. Procurement analytics uses procurement data systematically through techniques from applied analytical disciplines to drive strategic sourcing decision-making for planning, management, measurement and learning. Advanced procurement analytics provides the fuel for an organization to make better sourcing decisions faster [8], [9]. Many companies face challenges in obtaining the benefits associated with effective strategic sourcing. From an organizational perspective, procurement data management is a core organizational challenge for CPOs and CSOs [10], [11]. A number of businesses have insufficient accurate and timely information about their spending patterns and suppliers. Most businesses are challenged with spend analysis and need to manage vast volumes of internal and external supplier data due to the disparate nature of systems and data sources [10], [11]. With a large and increasingly global supply base and scattered data, most companies are overwhelmed with supplier information management and challenged to apply that information for procurement analytics to drive fact-based decision-making [12], [13].

To address the above organizational challenge and enable companies to obtain competencies with respect to procurement data management and procurement analytics, our research objective is developing a model-based strategic sourcing approach (C.A.R.S) for enabling 1) the centralization of procurement data; and 2) the systemic exploration and evaluation of strategic sourcing alternatives that supports companies to achieve procurement data management and analytics competencies for fact-based decision-making. The next section introduces the proposed approach (C.A.R.S) to achieve this research objective.
3 C.A.R.S: a model based strategic sourcing approach

First, we propose the construction of a conceptualization of strategic sourcing that can be used as a language for modeling procurement data. Different kinds of procurement data (e.g. spend cost data, sourcing data, supplier data, contract data and relational data) can be identified based on the core procurement concepts and their attributes and relations. Second, we propose conceptual modeling as a technique for exploring strategic sourcing alternatives. We introduce conceptual models as schematic descriptions [1] of sourcing alternatives and apply the proposed conceptualization as a common language for describing these models. Therefore, we introduce the C.A.R.S (Capability – Actor – Resource – Service) conceptualization as a language for strategic sourcing modeling Figure 1. The C.A.R.S concepts are defined as follows:

- **Capability** is ‘What the actor Can do’ for competitiveness and survivability. The capability notion can illustrate the abilities of firm, buyer and supplier to achieve long-term objectives. The capability of an actor represents its potential long-term effects on the achievement of sourcing objectives.
- **Actor** is ‘Who is the Resource Integrator’ that provides service, proposes value, creates value and captures value.
- **Resource base** is ‘What the actor Has’ that is capable to create value. The resource base notion includes tangible and static resources (e.g. goods), as well as intangible and dynamic resources (e.g. competencies and skills), hence both resources and competencies are included in the resource base.
- **Service** is ‘What the actor Does’ that is exchanged with other actors for competitiveness and survivability. The service notion can illustrate the performance dimension of actors to achieve operational objectives (bottom-line results). Performance of an actor represents short-term effects on the achievement of sourcing objectives.

![C.A.R.S conceptualization and viewpoints](image)

Figure 1. C.A.R.S conceptualization and viewpoints

The next section explains the solution architecture of C.A.R.S based on four views, Business View, Functional View, Data view and Implementation View.

4 Solution Architecture_ Business View

The purpose of the C.A.R.S conceptualization and its viewpoints is to support strategic-sourcing decision-makers by offering a common language to model procurement data such as spend data, sourcing data, supplier data, contract data and relational data that reside in disparate systems and data sources. The capability notion, its attributes and other supplementary concepts defined in the capability sourcing viewpoint can be used to model the (strategic) sourcing data about outsourced, insourced and co-sourced capabilities, operational, organizational and technical capabilities and also data about capacities to leverage the existing resource base, to reconfigure the existing resource base, to integrate the resources, to develop new products and capabilities, to absorb the external resource base and to take advantage of market opportunities (adapting). The service notion, its attributes and other supplementary concepts defined in the value creation viewpoint can be used: a) to model the performance (operational) data about the spend cost, the total cost of ownership, the transaction cost, the captured value (profit) and the perceived value; b) to model the contract (operational) data about the quality of service, the service level agreements and the service delivery time, the contract’s clauses, RFx (e.g. RFI, RFQ, RFP) and
KPIs for evaluating supplier performance. The actor notion, its attributes and other supplementary concepts of the supply base viewpoint can be used to model the relational data about the suppliers and their classification such as registered, approved, active, partner, strategic partner, undesirable and blocked and also data about the (strategic and non-strategic) customers. The resource notion, its attributes and other supplementary concepts defined in the resource-based viewpoint can be used to model sourcing data about the internal and external resource base, interconnected resources, composite resources, threshold and distinctive competencies and VRIN resources.

We propose a model driven approach based C.A.R.S conceptualization to explore strategic sourcing alternatives for three distinct purposes: descriptive, predictive or prescriptive in three executive steps:

i. **Spend exploration**: to determine how much cost is being spent, with whom, and for what.

ii. **Sourcing exploration**: to identify sourcing objectives and choose the right sourcing model alternatives (e.g. outsourcing, co-sourcing and insourcing) to achieve objectives through capability sourcing.

iii. **Supply base exploration**: to identify, evaluate and qualify suppliers for long time or short time partnership.

5 Solution Architecture_ Functional View

In order to build a complete and consistent set of measurable requirements for strategic sourcing modeling based on C.A.R.S, we used Functional Modelling to generate new requirements and elucidate existing requirements of the conceptual model. The functional model graphically illustrates system functions and the sequence and interrelationships of the functions. The purpose of this part of our solution is to describe the functions and processes represented in our reference model, and establish a basis for fact-base decision making for strategic (out)sourcing management. The result of our modeling is a Business Function Model (BFM) of the strategic sourcing decision making that emphasizes the functional and operational aspects of the (out)sourcing and procurement activities. Our Business Function Model (BFM) is a general description of operations that help the organization to carry out their strategic procurement and (out) sourcing mission and "provide a conceptual structure for the identification of general business functions" [15]. It can show the critical processes in the context of the strategic (out)sourcing. The processes in the represented function model are consistent with the processes for procurement and supply management based on C.A.R.S. Processes are a group of related activities performed to select the strategic supplier for the service in demand by considering both functional and operational aspects. The Main Stream diagram represents the main steps of analyzing demand and supplier for strategic fact based decision making for procurement activities and (out)sourcing projects Figure 2.

![Main Stream of the CARS functional flow diagram](image)

**Figure 2. Main Stream of the CARS functional flow diagram**

5.1 **Demand Analysis, which has two sub-processes as “As Is Analysis and To Be Analysis”**

This step aims at developing a profile to understand the demand side of the market to assess opportunities for determining the best sourcing strategies. In order to have better understanding of the service in demand, we propose sub-processes to achieve this goal. At first, in the As Is Process both aspects of current situation of the demanded service should be analyzed which needs the historical data of procurement activities of the organization. Out sourcing Validation is a sub-process for this process, and contains filtering and feed-backing stages to verifying demanded service as a capable out sourcing project. In this sub-process, we can analyze our services in demand to check them from strategical and operational view. In Capability stage we want to know if
the service is related to our core capabilities and strategic resources? If yes, due to the strategic risk, it’s better to revise the demand. While operational analysis, we are able to find the Total Cost of Ownership (TCO), Production Cost (PC), Transactional Costs (TC) and related benefits such as Net Perceived Value (NPV) of the service to validate it for being an outsourcing project. The required data for this block are the functional data of the demanded service, the resource data, the actor data, the operational data of the demanded service, the spend data and the market data.

Furthermore, we need to establish and concrete our demand to recognize what capability and performance are in desire for the service. In order to answer this question we should analyze the resources in demand to predict the possible capability of the demanded service. Beside, we can calculate and investigate our desired performance based on the determined capabilities. The final result of the demand analysis function could be a “To Be Strategic Canvas” which represents our perspective of the capability and performance of our demanded service. The perceived output of this step is a generated dataset of demand analysis Figure 3.

5.2 Supplier Analysis

This step aims at developing a profile to understand the supply side of the market to assess opportunities for determining the best sourcing strategies. In this step we need to analyze suppliers to recognize and rate them based on how much their capabilities- resources and also performance profiles are fitted to our determined capability and performance for the service in demand. In this step, we need suppliers profile with functional and operational data and also generated demand dataset as input data for our process block. The perceived output of this step is a generated dataset of the rated suppliers and their profiles Figure 3.

5.3 Dependency Analysis

This step aims at developing a portfolio for positioning buyer-supplier dependency for setting relationship strategies in supply market. In this step, we need the generated demand and supplier datasets and their profiles data as input of our process block. The relational capability-performance dependency matrix of demand-supplier is our perceived result for this functional stage Figure 3.

5.4 Strategic Decision Making

This step aims at developing a portfolio for classifying capability sourcing and setting sourcing strategies. At the end, CPO’s or other related managers are able to make a fact-based and strategic decision by integrating and visualizing our generated results as an (out)sourcing portfolio for the demanded services.

6 Solution Architecture _ Data View

6.1 Conceptual Data Model: Entity-Relationship Diagram

The conceptual data model may be used to form commonality relationships among Entity–Relationship (ER) models as a basis for data model integration. The conceptual means the high-level business solution to a business process or application effort frequently defining scope and important terminology [16]; [17].

In this study, we represented the ER model as a data model for describing the data and information aspects of strategic sourcing and procurement process requirements, in an abstract way. The main components of our ER model are entities, attributes and the relationships that can exist among them. An entity is an abstraction from the complex objects of a domain. “When we speak of an entity, we normally speak of some aspect of the real world that can be distinguished from other aspects of the real world” [18]. This model pays particular attention to relationships and the interactions among entities and their attributes. In the development of databases, relationships require special treatment, because they are the glue that holds information together and because their realization in relational databases is particularly important [19].
Figure 3. Logical Process Flow Diagram of the Model
6.2 Conceptual Design

Conceptual design is the highest level of ER modeling in that it contains the least granularity of detail but founds the overall view of what is to be included within the model set [19]. This conceptual ER model will be used as the foundation to create our logical data models. In this study, an abstraction of Functionality and Performance objects is represented as two complex and critical entities and their possible attributes are shown. We believe, by developing and clarifying these objects in the sourcing domain, the efficiency of the process of decision-making could be highly improved. Represented high-level data model shows attributes related to these high-level entities, which are involved in procurement and strategic sourcing decision-making relation. Regarding to the complexity of these objects we just present their main attributes without considering the possibility of these requirements from demand (buyer) side, supply (supplier) side and their dependency Figure 4.

![Conceptual data model](image)

Figure 4. Conceptual data model

7 Solution Architecture Implementation View

In this part, we propose a procurement data mart as a way of implementation of the model. Regarding to the complexity of the required entities for strategic sourcing decision making we need a fast and agile data repository with low time of response. Also in this process, we would need some summarized external data, which could be added to the procurement data mart. Whether a company has a data warehouse system (DW) or not this solution could be implemented. Our proposal is based on the assumption of a hypothetical firm without DW system and in this case, this departmental data mart could be integrated with other departmental data marts to build a data warehouse system for the firm in future. Using procurement data mart as a platform to consolidate and integrate scattered procurement data from disparate operational procurement applications and also some other required data from other units mostly regarding to the functional dimension such as summarized data from marketing, accounting and technical departments, is important to accelerate the ability to ingest and analyze procurement data and translate them into insights that can inform decision-making. However, the data warehouse system provides a solution that is closer to the "single version of the truth", but they do take a huge amount of effort, and an ability to coordinate across the entire organization. Therefore, Kimball's top-down approach is
more appropriate for small-to-medium firms [20]; [21]. The schematic design of the main steps of building the procurement data mart is presented in Figure 5. Staging area is a temporary storage zone used for data processing in the extract, transform and load (ETL) process [22].

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Application Layer</th>
<th>Staging</th>
<th>Data Mart (Two dimensional)</th>
<th>Report and Process</th>
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![Figure 5. Main steps of building the procurement data mart](image)

To build the procurement department data mart based on our entity-relationship data model, we present part of our logical data model with abstract key structure in snowflake schema to represent the operational possibility of supporting both functional and operational primary dimensions of our fact table Figure 6.

![Figure 6. Logical data model with abstract key structure in snowflake schema](image)

8 Conclusion

Strategic sourcing has become a critical area of strategic management that is centered on decision-making regarding an organization’s procurement activities such as spend analysis, capability sourcing, supplier selection and evaluation, contract management and relationship management. Companies are acting in an increasingly
volatile, uncertain, complex and ambiguous world. Hence, more and more they expect from the chief procurement officers (CPOs) to develop long-term and short-term plans in supply chain management. Leading companies need to transform their supply network from static, isolated and internally focused to externally collaborative to achieve the today’s procurement objectives and priorities. To create a new business model of supply network, organizations should adopt a strategic sourcing approach that includes initiatives designed to drive above priorities. C.A.R.S as a model driven approach has been defined to explore sourcing alternatives based on a common language that enables fact-based decision-making through procurement data management and analytics competencies. We defined the solution architecture for the proposed model based approach according to four views, Business View, Functional View, Data view and Implementation View. As the future works, we develop the logical key structure of functional and performance dimensions of procurement fact table to propose the physical data model for procurement data mart.

References