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Design and Implementation of a Framework for Performance Measurement in Service Oriented Virtual Organizations

By

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In the name of God,

the compassionate, the merciful

ABSTRACT

Management of Virtual Organizations faces new challenges that traditional approaches cannot address. This research proposes a performance measurement framework for service oriented virtual organizations including a *structural* and a *procedural* component. The *structural* framework aligns the activities of partners in a virtual organization at three different layers. The first layer is designed for partners' strategic alignment through coordination of the value creation network. In the second layer, performance dimensions of partners' collaboration are defined and mapped to the service choreography model. The third layer focuses on assessing effectiveness and efficiency of partners' domain specific services, which is designed based on ITIL V3 service level management guidelines. In order to consolidate the structural framework, these three layers are integrated using a method for extracting service choreography model and SLA aggregation patterns from the value network. The *procedural* framework, on the other side, defines the processes required to design the KPI structure, implement the solution, communicate the results, and derive improvements. We propose an implementation architecture that enables inter-organizational performance management in collaborative environments. Then, the IBM products for business process and performance management (IBM BPM, Business Monitor, and Cognos BI) are employed to implement the proposed architecture. The conceptual framework along with the implementation architecture provides an integrated solution for decentralized performance measurement without the need for a central authority. We demonstrate that the proposed solution enhances flexibility, scalability, and interoperability, and supports transparency of partners' performance information at an agreed-upon level as a basis for mutual trust.

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Acronyms and Definitions:

Table 1-1: Acronyms and Their Definitions

BPM (Business Process Management)	BPM includes methods, techniques, and tools to support the design, enactment, management, and analysis of operational business processes. It can be considered as an extension of classical Workflow Management (WFM) systems and approaches. A business process management system (BPMS) is a generic software system that is driven by explicit process designs to enact and manage operational business processes (Aalst et al., 2003).
CNO (Collaborative Networked Organization)	A collaborative network (CN) is a network consisting of a variety of entities (e.g. organizations and people) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals, thus jointly generating value, and whose interactions are supported by computer network. Although not all, most forms of collaborative networks imply some kind of organization over the activities of their constituents, identifying roles for the participants, and some governance rules. Therefore, these can be called manifestations of collaborative networked organizations (CNOs) (Camarinha-Matos et al., 2009)
ESB (Enterprise Service Bus)	An Enterprise Service Bus is a software component that facilitates web service transaction and enforces policies and quality measures within a SOA infrastructure. It can also act as integration middleware for information systems.
SOA (Service Oriented Architecture)	SOA is an architecture for building business applications as a set of loosely coupled black box components orchestrated to deliver a well-defined level of service by linking together business processes" (Hurwitz et al., 2006).
SOA Infrastructure	SOA Infrastructure is a set of software solutions which facilitate web service choreography, orchestration and execution. A SOA infrastructure does not only allow web services to be reused and composed but facilitates dynamic agile changes in business processes. Therefore it is said that BPM and SOA together will facilitate the next phase of business process evolution from merely "automated" to "managed flexibility" (Fiammante, 2009).
VO (Virtual	A dynamic, temporal consortium of autonomous legally independent organizations which corporate with each other to attend a business

Organization)	opportunity or cope with a specific need, where partners share risks, costs and benefits, and whose operation is achieved by a coordinating sharing of skills, resources and competencies (Karvonen et al., 2005).
VO Management	VO management denotes the organization, allocation and coordination of resources and their activities, as well as their inter-organizational dependencies to achieve the objectives within the required time; cost and quality frame (Karvonen et al., 2005).
WAS (WebSphere Application Server)	Stands for IBM WebSphere Application Server product. This product is IBM's web application server and most IBM SOA Infrastructure components are hosted on this application server.
Performance Measure/ Performance Indicator	The term "Performance Measure" is used along with "Performance Indicator" in this document, however it should be noted that they are not technically the same. Indeed any value which reflects a fact in the system is called a measure which may not be necessarily meaningful. When a set of these facts come into a specific context and get combined in a formula to make meaningful information it will be called a Performance Indicator.
VN (Value Network)	A value network is any set of roles and interactions that generates a specific kind of business, economic, or social good (Allee and Schwabe, 2011).
VNA (Value Network Analysis)	A methodology provided by Allee and Schwabe, (2011) *that "seeks insights into the question of exactly how purposeful networks (such as organizations, cross-boundary task networks, public agency collaborations, and societal change networks) can more effectively create value, achieve business outcomes, and generate sustainable success"*.
E3-Value	A comprehensive method for modeling a business as a value network is e3value (Gordijn et al., 2000). The e3value ontology provides modeling constructs for representing and analyzing a network of enterprises exchanging things of economic value with each other.
ECOLEAD	European Collaborative networked Organizations Leadership initiative (Rabelo et al., 2006)
SCOR (Supply Chains Operations Reference)	The SCOR model was developed by Supply Chain Council in order to model the operations of the partner organizations within a supply chain (Supply Chain Council, 2010).

CHAPTER 1 INTRODUCTION

In a developing global economy, business is becoming more competitive as a result of worldwide, boundary-less markets. Consequently, organizations must operate with great flexibility and rapid adaptation to new demands. To survive in this intense competition, companies need to improve competencies in terms of dealing with new business models, strategies, organizational and governance principles, processes and technological capabilities (Camarinha-Matos et al., 2009). As a result, organizations started to share their resources and skills by cooperation and outsourcing some components of their products and services. This cooperation was originally formed in relatively stable, static and classic associations with well-defined roles and responsibilities. However, facing further complicated and more dynamic markets, new forms of collaboration over networks of entities are engendered which are information/knowledge driven instead of data driven, like collaborative networks (CNs). In the context of independent organizations, each of which having information privacy considerations, a new subtype of CN was engendered, called Virtual Organization (VO). VO partners create value added products and services through collaboration and sharing their resources and skills, to better respond to business opportunities (Camarinha-Matos et al., 2009).

Nevertheless, collaboration does not guarantee the VO's success. Deficit in collaborative management is an identified reason of VO's failure (Westphal et al., 2007). An essential pre-requisite for an effective VO management is a sound information basis. Therefore, performance measurement (PM), as an important source for this information, plays a critical role in success of VOs. Furthermore, traditional PM approaches do not meet specific requirements and characteristics of VOs (Westphal et al., 2007). The purpose of this research is to develop a performance measurement framework for virtual organizations that extracts key performance indicators from their SOA-based collaboration infrastructure.

1.1 Research Motivations

In less than ten years, most enterprises will be part of some sustainable collaborative networks for the formation of dynamic virtual organizations in response to the fast changing market conditions (Rabelo et al., 2006). In addition, the planned usage rates of SOA infrastructures were extremely high in 2006. Ninety three percent of wireless technology companies projected use of SOA. The retail firms, financial, manufacturing and government usage rates projected to be 92%, 89%, 76% and 75%, respectively. The estimated value of the business support systems middleware market was $870 million in 2008 (DATAMONITOR, 2006). SOA infrastructure is being widely used in Europe. Almost 70% of the Europeans were using SOA in 2007. North America is following up with 55% and Asia with 25% (Gartner, 2008). Furthermore, it was reported in OASIS conference on SOA (2007) that the Japanese government is taking initiative to use SOA to boost the number of SMEs that conduct direct B2B e-commerce ("Bringing SOA to small enterprises," 2007). Based on these two facts (growth of B2B collaborations and SOA adoption) facilitating VO management with SOA infrastructure (SOVO) is becoming more important in the business environment. Therefore, Performance management of VO - as a part of its overall management - is drawing business and the academic attention.

Additionally, it is critically important to recognize why organizations decide to adopt SOA. The empirical studies show that one of the main reasons for SOA becoming attractive for firms is the diversity of technologies they use (Randy Heffner, 2008). Based on these findings, there is a positive correlation between the number of platforms being used in enterprises, and their intention to adopt SOA. As the technology diversity is always an issue in case of B2B collaborations, SOA infrastructure seems to be the best candidate for implementing VO.

Furthermore, current solutions for VO performance management (Such as Extended ERP, etc.) are not flexible enough to adapt to rapid changes in VOs. For instance, the goal of extended ERP has been to consolidate the functions through different systems of the business partners. Studies show that incorporation of SOA based BPM with ERP systems enables more standardized and flexible integration and management of different components of ERP systems (Shu and Chuang, 2010). BPM provides the standardized business process modeling and management, while SOA enables flexible integration with the other systems components. Therefore, a more dynamic solution can be provided based on SOA infrastructure, using services as foundation for building business processes. As a result of these observations, in this thesis a performance measurement framework for VO is designed based on SOA infrastructure.

1.2 Problem Definition

Companies have been changing their way of managing their business, increasingly partnering with other companies in complex value chains and business ecosystems that extend globally (Camarinha-Matos, 2009).

Traditional performance measurement methodologies are designed to assess efficiency of intra-organizational processes. Some of traditional approaches are Benchmarking, Six Sigma, EFQM, SCOR and BSC (Graser et al., 2005a).

Among traditional approaches for PM, Benchmarking, Six Sigma, and EFQM are only appropriate for intra-organizational processes (Graser et al., 2005a). SCOR model was developed by Supply Chain Council, addressing the interactions among organizations within a supply chain, but just supporting static and stable interactions. All of the above approaches mostly focus on financial perspectives (Graser et al., 2005a). To address this, another framework was introduced by Kaplan and Norton named Balanced Scorecards (BSC) (Kaplan and Norton, 2007). Providing a balanced approach which considers non-financial aspects, as well as financial ones, this framework introduces a methodology for translation of strategies to appropriate actions. This approach does not address inter-organizational interactions. In summary, the current well-known frameworks for performance measurement have various gaps in meeting the requirements of a VO. As such, we are focusing on designing a brand new PM framework in this project based on the requirements of service oriented virtual organizations.

Table 1-1: Framing Research Problem

Steps	***Description***
Observation	• The number of Collaborative Networked Organizations (CNOs) is increasing and by 2020 most of organizations specially small and medium sized enterprises (SMEs) will participate in some kind of CNO (Camarinha-Matos et al., 2009) • Virtual Organization's success depends on high level of collaboration performance of dependent partner organizations (Graser et al., 2005b)

Steps	Description
Thesis	VO real-time performance measurement is challenging because of the fact that the partners have heterogeneous management cultures, operations environments, performance measurement conventions, and infrastructures.
Enthymeme	A framework is needed for collaborative performance measurement that evaluates VO partners' collaborations in both strategic and operational layers.
Problem Statement	Conceptualize VO partners' interactions and collaborations, and provide a solution for the integration of partners' performance information, in order to effectively enhance collaborative performance measurement, in a way that preserves the VO partners' privacy of information.
Objective	Design and implement a framework for collaborative performance measurement (PM) in service oriented virtual organizations (SOVOs), with consideration of the existing PM frameworks and the SOVO characteristics.
Research Questions	1. How to measure the overall performance of the VO, and contributing performance of the partners? 2. How to measure performance of the VO partners' collaboration? 3. How to establish the connection between the VO operations and strategies? 4. What BI architecture will facilitate collaborative performance measurement and monitoring, and how it can be implemented?

1.3 Objectives

The Objective of this project is to design a framework for performance measurement (PM) in service oriented virtual organizations (SOVOs), with consideration of the existing PM frameworks, the SOVO characteristics and requirements of stakeholders. The designed framework will be implemented using IBM tools in order to be validated.

1.3.1 Key Benefits

Some of the key benefits of this project are as follows:

- Enhancing the evaluation of collaboration performance between VO partners (e.g. a particular VO business partners, Healthcare system and government, etc.)
- Aligning and coordinating the partner organizations with various strategies and goals, using value network analysis methods at the VO's strategic level
- Addressing interdependencies among services offered by partners in a VO according to collaborative business processes
- Realizing distributed performance measurement of the VO with no necessity of a central authority
- Providing transparency at an agreed level within VO to facilitate mutual trust among partners
- Propose an implementation architecture that enables collaborative performance measurement and monitoring by the integration of IBM tools (Websphere business process manager, Websphere business monitor, and Cognos BI)

1.4 Methodology

1.4.1 Design Science Research methodology for Information Systems

The Design Science Research (DSR) in the information System (IS) field is defined as design, creation, and evaluation of IT artifacts intended to solve identified organizational problems (Peffers et al., 2007) and to change the current situation into the preferred one (March and Storey, 2008). The main challenges of DSR in the IS discipline are to build and evaluate IT artifacts, in order to (1) enable managers and IT professionals to identify the desired information processing capabilities and its relation with the current and desired organizational situations and (2) provide actions and required infrastructure specifications that enable them to implement those capabilities to move the organization toward the desired situation (March and Storey, 2008). Therefore DSR is a problem centric approach that tries to identify the gap (problem) between the current situation and the desired one and then provide a solution to help filling this gap.

After about two decades of history of conducting DS research in IS, the methodology might be still evolving, however most researches in this discipline follow almost the same procedures. A formalized method is provided by Peffers et al, (2007) which is shown in Figure 1-1. The first step is problem identification and motivation. In this step the problem is defined and the value of a potential solution is justified. The second step is to define the objectives for a solution. The objectives are inferred from the problem definition and the knowledge of what is possible and feasible. These objectives can be either quantitative (terms in which a desired solution would be better than the current one), or qualitative (descriptions of how the designed artifact will support the solution to the current problem).

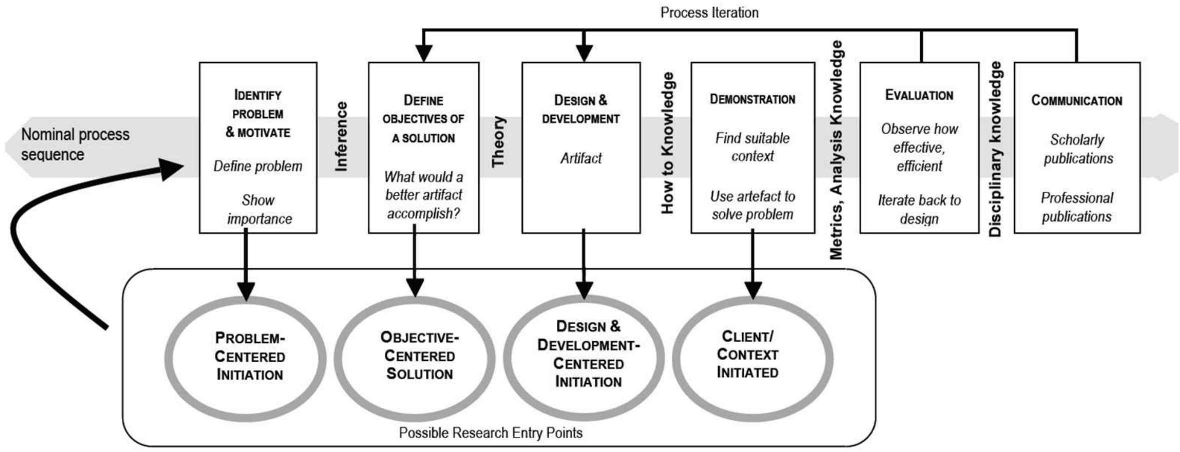


Figure 1-1: DSR methodology in IS discipline (Peffers et al., 2007)

The third step is to design and develop the IT artifact as the solution. This artifact can be any designed object in which a research contribution is embedded in the design. This includes identifying required functionality and its architecture and then building the actual artifact. The fourth step is to demonstrate the use of the artifact in solving one or more instances of the problem. This may include its use for experimentation, simulation, proof, case study, or any other kind of appropriate activity. The fifth step is to evaluate and measure how well the artifact contributes to solving the problem. This can be performed by comparing between the objectives of the solution and the actual observed results from use of the artifact in the demonstration step. The researcher may decide after this step whether iterate back to step three to improve the design specifications of the solution, or continue to the next step. The six and final step is to communicate the results, including the solution utility and novelty, rigor of its design, and its effectiveness to researchers and other relevant audiences.

1.4.2 Research Method and Steps

Following the DSR methodology in IS, we have performed the different activities through five different phases. The details are shown in Table 1-2.

We identify the problem through the phase of literature survey. The objectives of the desired solution are discussed in the second phase. In the third phase (Designing a framework for SOVO PM), we propose the framework for performance measurement in SOVO. The demonstration and evaluation of the proposed framework are done in the fourth phase (Modeling, Implementation, and validation). Finally, the communication of the results is performed in the Knowledge Dissemination phase.

Table 1-2: Research phases and detail activities

No	Phase	Activities
1	**Literature Survey**	• Introduction to VOs and their characteristics and challenges • Research on Service Oriented Architecture and its application in VO formation and management • Investigating the traditional performance indicators and measurable organizational values • Review the evolution of performance measurement (PM) and its trend over the time • Study previous practical and academic efforts for PM including existing frameworks (e.g. EFQM[1], Benchmarking, SCOR[2], BSC[3], etc.) • Overview the ITIL V3 Service Level Management concepts in order to use it in KPI definition and documentation. • Finding the existing roles in SOVO related to performance data (Creators, Brokers, and Customers/Users) in order to develop the requirements from the perspective of each user group.

[1] The European Foundation for Quality Management
[2] Supply Chain Operations Reference Model
[3] Balanced Scorecard

No	Phase	Activities

2	**Define Objectives of the Solution**	• Specify SOVO characteristics and the challenges of SOVO performance measurement in two categories of:
		  o *Inter-organizational issues*
		  o *Impermanence and time restrictions of VO*
		• Identify the shortcomings in the current PM approaches for SOVO environment

3	**Designing a framework for SOVO PM**	• Specify the requirements of SOVO PM, considering the existing challenges from the perspective of each related stakeholder or user group. • Designing a framework for SOVO PM considering the SOVO characteristics, existing PM frameworks, ITIL V3 guidelines, and requirements of users.
4	**Modeling, Implementation, and validation**	• Modeling a prototype for SOVOPM based on the proposed framework, using the designed structure and procedure. • Learn to work with IBM BPM, and Cognos BI • Integration of IBM BPM, Websphere Business Monitor, and Cognos BI and Configuring these tools • Implementation of the modeled SOVOPM framework using IBM tools and verification of the solution. • Testing, Evaluating, analyzing, improving and validating the results. • Finalizing the designed framework
5	**Knowledge Dissemination**	• Disclosing the resulted knowledge in conferences, workshops, journals, etc. • Summarization and writing the thesis

1.5 Contributions of the Thesis

In this research, we proposed a framework for performance measurement in service oriented virtual organizations. The structural component of this framework defines the key performance indicators in three layers of value network, collaboration performance, and service performance. In order to consolidate the three layers we proposed a method for deriving service choreography model, and SLA aggregation pattern from the value network. This method is validated by various prototype implementations.

The SLA aggregation pattern is modified with respect to ITIL V3 guidelines, to support the concept of drilling down through the multi-level SLA structure. We have also defined responsibility zone that supplements the SLA aggregation pattern, with identification of the responsible parties for each out of threshold SLA term.

Current studies on virtual organizations do not provide concrete definition of KPIs. Therefore, we need to define and formulate them based on VO’s needs. In order to do so, basic definition of performance indicators are derived from the richest studies and best practices in the related fields (such as E3-Value, ValueNet, SCOR, ECOLEAD, and ITIL), and are customized to meet the specific requirements of service oriented virtual organizations the best. The result is the definition of consistent KPIs in the three layers of value network, collaborative processes, and services.

From an implementation point of view, the current performance measurement solutions mainly support the scope of a single organization, which do not cover inter-organizational relationships. Therefore we propose an implementation architecture that enables collaborative performance measurement and monitoring. This architecture is implemented in KDD[1] lab, by using IBM tools for performance management. The proposed architecture integrates performance information from different data sources into aggregated OLAP cubes. We design the cube dimensions and measures, considering the structure of the collaborative processes and services of the VO, in a way that supports summarization of information based on the structure. This structure enables drilling up/down capabilities through the process breakdown structure.

1.6 Structure of the Thesis

In the next chapter (Chapter 2), we review the literature from four different perspectives related to the objective of the thesis. First of all, we study the current literature about collaborative networks, virtual organizations, their characteristics, and challenges of their management. In the second part, we discuss the ICT infrastructure requirements for

[1] Knowledge Discovery and Data Mining

collaborative environments, and introduce Service Oriented Architecture (SOA) as reference model for creation and integration of business services and processes. In the third part of the literature review, we introduce ITIL V3, as a set of guidelines and best practices for IT service management. The fourth part of the literature review focuses on the state of the art of performance measurement and management. In this section, we introduce different approaches in this field and at the end we discuss their shortcomings in meeting VO's requirements. At the end of the literature review chapter, we discuss different challenges in performance measurement of the virtual organizations. These challenges demonstrate the requirements of the designed solution.

In chapter three, we propose the design specifications of the performance measurement framework based on the reference frameworks, and the identified requirements. This framework includes a *structural* and a *procedural* component. The structural framework provides the structure of performance indicators, their inter-relation, and their dependencies to the process management infrastructure. Then the procedural framework provides a step-by-step procedure to extract the collaboration and operation performance indicators from the strategic layer of PM structural framework (Value Network).

In the fourth chapter, we propose an implementation architecture which enables collaborative performance measurement. This includes the configuration of different IBM products (including IBM BPM, Business Monitor, and Cognos BI tools) and design specifications of an IT artifact that enables integration of performance information coming from local reports into the aggregated global reports.

In the sixth chapter, we apply the proposed method to a VO scenario, and created a prototype implementation. This is followed by analysis of different parameters of the proposed solution against the design requirement specification measures. This way, the solution is evaluated, improved and validated. This leads to the conclusions and a set of recommendations to improve the current solutions provided by IBM, to enhance their capabilities to support inter-organizational performance measurement and monitoring.

The final chapter (Conclusion) wraps up the thesis by providing the summary of the research. This will be followed by highlighting the contributions of the thesis and resulting publications. The ending of this chapter discusses the research limitations and future works.

CHAPTER 2 LITERATURE SURVEY

2.1 CNO and VO

Developing the world economy, markets are getting more and more competitive. Moving towards no border worldwide markets calls for flexibility and rapid adaptation to new demands. The need for collaboration over networks of organizations can be identified in the context of manufacturing businesses as well as in the service industry. Six grand challenges for manufacturers were recognized a few years ago in an exercise to establish a vision for manufacturing in 2020 (Committee on Visionary Manufacturing Challenges, NRC, 1998, page 13):

1. Achieve concurrency in (all) operations.
2. Integrate human and technical resources to enhance workforce performance and satisfaction.
3. "Instantaneously" transform information gathered from a vast array of diverse sources into useful knowledge for making effective decisions.
4. Reduce production waste and product environmental impact to "near zero".
5. Reconfigure manufacturing enterprises rapidly in response to changing needs and opportunities.
6. Develop innovative manufacturing processes and products with a focus on decreasing dimensional scale.

These challenges have forced manufacturing enterprises to change their organizational structures, business models, business processes and technologies to adapt with extremely dynamic changes in their environment. Small and medium sized enterprises (SMEs) with limited resources and skills need to collaborate with others to overcome their individual limitations. In fact, their capability to form temporary, goal driven associations enables dynamic adjustment to the needs of the market. Although collaboration through supply chains has a long history in the manufacturing environment, it assumes relatively stable and well-defined roles, responsibilities and interaction among principals. However, facing further complicated and more dynamic markets, new forms of collaboration over networks of entities are engendered which are information/knowledge driven instead of data driven, called collaborative networks (CNs) (Camarinha-Matos and Afsarmanesh, 2005).

A collaborative network (CN) is a network consisting of a variety of entities (e.g. organizations, people, and even machines) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but collaborate to better achieve common or compatible goals, and whose interactions are supported by computer networks (Camarinha-Matos and Afsarmanesh, 2005). Camarinha-Matos and his colleagues (Camarinha-Matos et al., 2009) have provided a classification of the terms related to inter-organizational interactions including Networking, Coordinated Networking, Cooperation and Collaboration in order to provide a better understanding of Collaboration in CNs. Each of these terms may have common aspects; however they do not comply with a single concept. They have provided their classification as interaction maturity model in Figure 2-1. This figure implies the level of interaction and integration of organization for each of the terms. Based on this model, Collaboration includes all the functionalities related to Networking, Coordinated Networking, and Cooperation. In fact, when some entities have collaboration, they have joint responsibility to follow a joint goal through working together in joint entities.

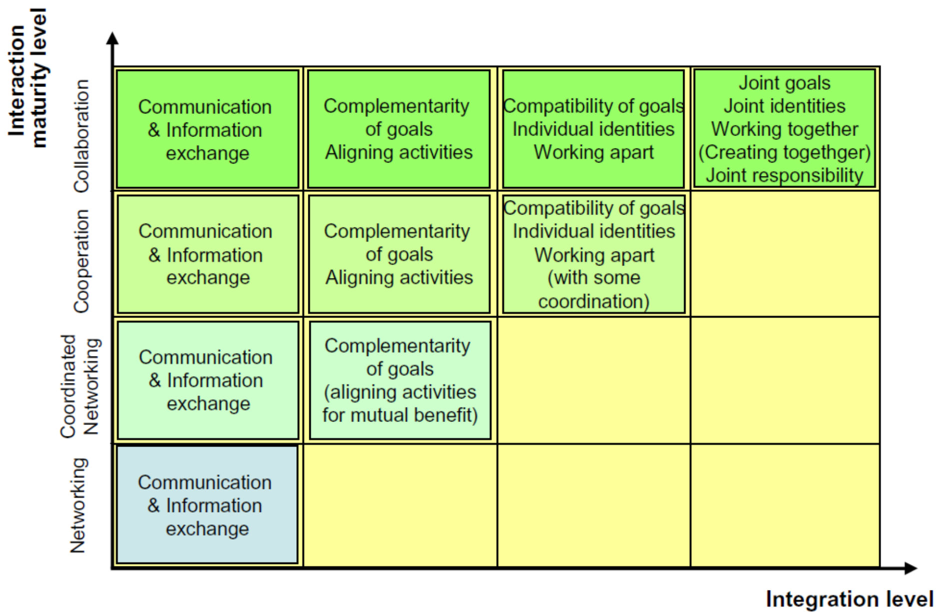


Figure 2-1: Interaction Maturity Model (Camarinha-Matos et al., 2009)

This work also provides a taxonomy classification model for CNs based on their purpose and timeframe. This taxonomy model is shown in Figure 2-2. Most forms of CNs imply some kind of organization over constituents, their roles, activities and some governance rules. These forms of CNs are generally called collaborative networked organizations (CNOs) (Camarinha-Matos, 2009).

CNOs may either work together in a long-term strategic networks (like VO Breeding Environments and Professional Virtual Communities), or work together to follow a common goal (like Opportunity driven networks and Continuous production driven networks).

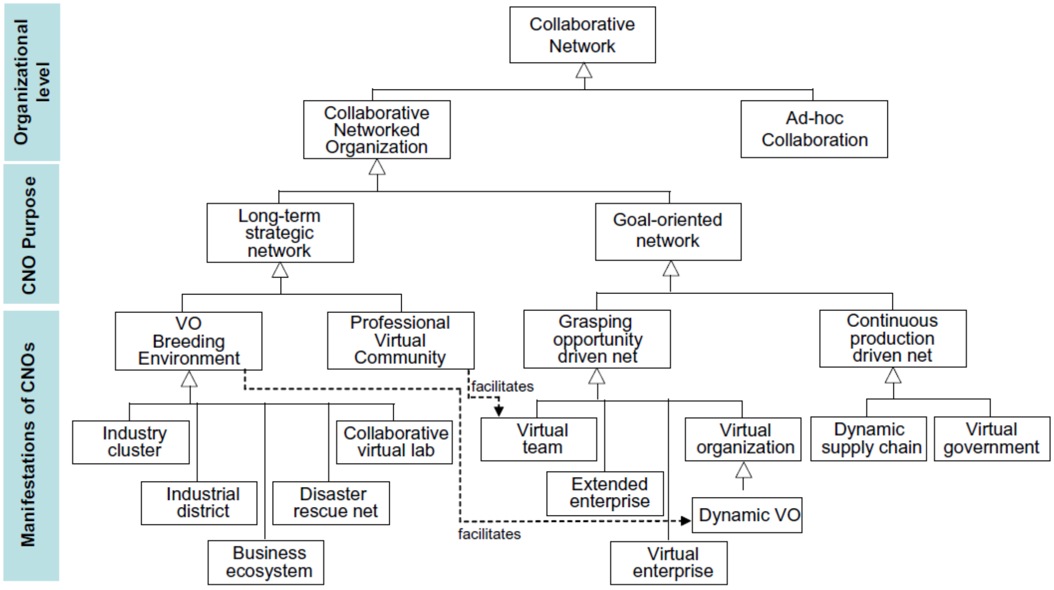


Figure 2-2: Classification of Collaborative Networks (Camarinha-Matos et al., 2009)

2.1.1 Virtual Organizations

Specific sub-type of goal oriented CNO is virtual enterprise (VE). VE represents a temporary alliance of enterprises that come together to share skills or core competencies and resources in order to better respond to business opportunities, and whose cooperation is supported by computer networks. In this research, we intend to cope with goal-oriented, opportunity driven CNOs called Virtual organizations (VO). VO is also similar to VE with this difference that it's comprised from legally independent organizations that are not limited to for profit alliances (Camarinha-Matos et al., 2009).

One of the classification methods of VOs is based on the partners' interaction topologies. Topology here is defined as different structures, in which the VO partners (as the nodes of the network) interact. The interaction between the partners includes exchange of money, information, material, service, control flows, responsibilities, and power relationships. The identified topologies are supply chain, star, and peer-to-peer. In supply chain topology, each partner interacts with its immediate upper and lower neighbors. In star topology there is a central partner that interacts with all of the other partners, but there is no link between the non-central partners. Finally in peer-to-peer topology each partner may interact each of the other partners in a non-hierarchic manner.

Figure 2-3 shows the VO topologies (Karvonen et al., 2005).

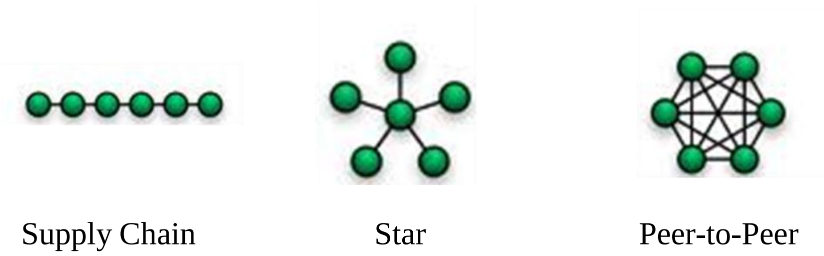


Figure 2-3: VO Interaction and Management Typologies (Karvonen et al., 2005)

2.2 VO Management Life-Cycle

Common organizations spend only a negligible fraction of their lifetime in the creation and dissolution stages, however in VOs these two phases are complex and take up considerable effort (Camarinha-Matos and Afsarmanesh, 2007). So it is essential to identify and define the life cycle of VO from creation to dissolution. A VO passes through different phases in its whole life-cycle, including Creation, Operation, Evolution and Dissolution or Metamorphosis (Camarinha-Matos and Afsarmanesh, 2008). Figure 2-4 shows the sequence of these phases in the whole life-cycle.

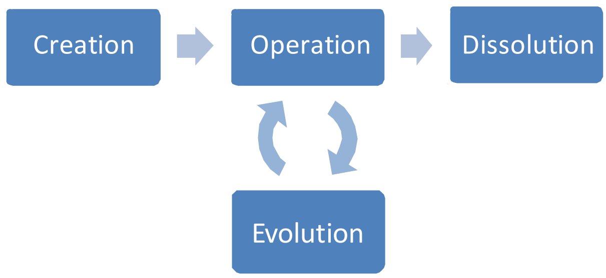


Figure 2-4: VO Life-Cycle phases

In order to manage a VO effectively, it is important to clearly identify activities within these phases. Here we introduce the generic life cycle for CNOs. VO as a specific CNO has a same life cycle with a difference in the last phase.

- **Creation**: The creation stage can be divided into two phases, namely (i) *initiation* and recruiting, dealing with the strategic planning and initial incubation of the CNO; (ii) *foundation*, dealing with the constitution and start up.
- **Operation**: Certainly the most important phase, when the CNO actually operates towards achieving its goals.
- **Evolution**: During the operation of a CNO it might be necessary to make some changes to its membership, structural relationships, and roles of its members. Therefore, the CNO can go through an adjustment or evolution process in parallel with the operation stage.
- **Dissolution or metamorphosis**: A short-term CNO such as a VO will typically dissolve after accomplishing its goal. In the case of a long-term alliance, considering its valuable assets gradually collected during its operation, its dissolution is a very unusual situation. Instead, it is much more probable that this CNO goes through another stage, that we call the metamorphosis stage, where it can evolve by changing its form and purpose.

2.3 VO Collaborative processes

The VO members must be capable of collaborating reliably in most of their processes. Some of the collaborative processes of a VO can be categorized as shown in Figure 2-5 (Ricardo J. Rabelo and Gusmeroli, 2006).

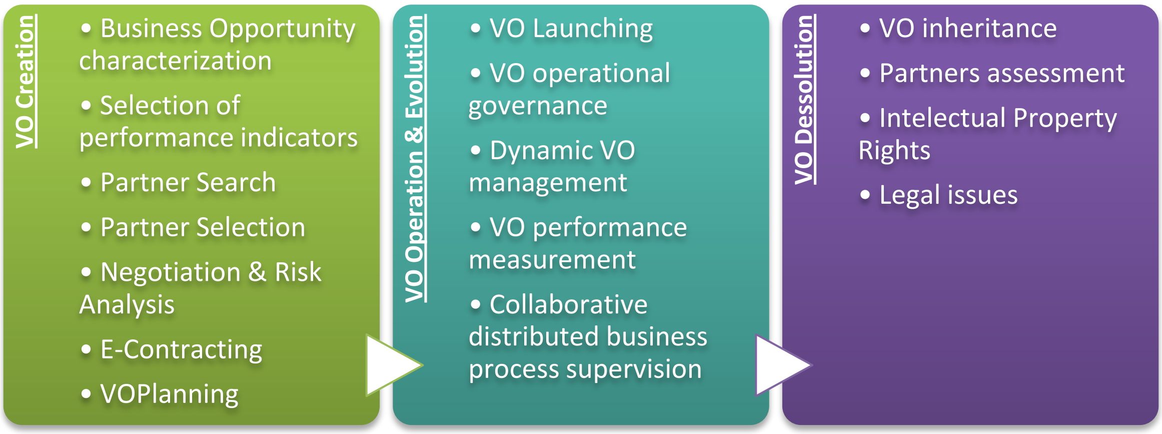


Figure 2-5: Some of the VO Collaborative Processes

In this project, we focus mostly on operation and evolution of VO. The creation and dissolution phases need more efforts and are open for future endeavors. Some of the processes in the Operation and Evolution phases including VO operational governance, performance measurement, and Collaborative distributed business process supervision will be supported by the Performance Measurement framework which is designed, implemented, and validated in this project.

Based on these collaboration needs, which are not traditionally addressed in existing ICT based systems, VO members should benefit from a reliable infrastructure that makes users indeed confident and enthusiastic to use it in the support of their networked businesses.

2.4 ICT-I for supporting VO management

In order to support VO management, a specific kind of information and communication technology infrastructure (ICT-I) is needed. In order to find out the best fit ICT-I for VO, we should first specify the ICT-I requirements of CNOs generally. These characteristics and requirements are inherent to VO as well as other types of CNO.

2.4.1 ICT-I requirements for VO

Basically a VO is formed by SMEs with restricted resources that come together to share their competencies and fill their gaps. As a result, the potential VO members are mostly SMEs. SMEs are mostly aware of the importance of ICT in their competitiveness. So they either buy off-the-shelf products or in some cases develop their own solutions from scratch. In the best-case situation, the ICT tools that SMEs use are transaction based ERPs with the focus on execution efficiency. However the collaboration needs are not considered in most cases. These local systems mostly lack the compatibility and ability to collaborate with the ICT tools of suppliers and customers or other partner organizations. In addition, the flexibility to be changed agilely based on upcoming new requirements is not enough in SMEs ICT systems. Although the VO partners have independent platforms and technologies, they need an infrastructure to support their collaborative business processes that meets the following requirements (Ricardo J. Rabelo and Gusmeroli, 2006):

- very easy deployment and usage (plug & play)
- business processes modeling, synchronization and management
- lean and easy maintenance
- platform users management and logging
- affordable (if not free)
- access data in legacy systems
- technology independence

- full interoperability
- flexible security mechanisms and privacy guarantee
- open / fully based on ICT standards
- transparency
- functional scalability
- platform functionalities on demand
- communication reliability
- support for mobile access / devices information, knowledge and ontology management

An ICT-I architecture should be employed considering these requirements, to better support the distributed management and heterogeneous environment of VO.

2.4.2 ICT Infrastructure for VO

In this research, the Service Oriented Architecture (SOA) is considered as reference to support operation and evolution of VOs. “SOA is an architecture for building business applications as a set of loosely coupled black box components orchestrated to deliver a well-defined level of service by linking together business processes” (Hurwitz et al., 2006).

This architecture meets almost all of the above mentioned requirements. In fact, each organization using whatever infrastructure and systems platform and technology can join a SOA based VO as long as it follows a service oriented approach in systems development. This will boost interoperability and agility needed for VO formation and management. SOA services are loosely coupled which means the interdependencies in their relationship are minimized and they have to interact just in interface layer. In SOA, services can be seen as black boxes. That means their context and inner logic is hidden from the outside world. This feature is called service abstraction which facilitated partners’ security of business advantages. Services are also reusable which means the whole application can be decomposed into units (services) which may be used to compose another functionality. SOA service autonomy provides control over the logic they encapsulate. Services may also be discovered by the communicative Meta-data which are incorporated with them (Hurwitz et al., 2006).

Nowadays, organizations are moving towards reusing resources through using palettes of atomic or composite services that can be easily and dynamically assembled into business processes (Fiammante, 2009). SOA’s loose coupling, policy driven, composable service architecture shows a good degree of alignment to VOs specific needs. SOA's success stories on dynamic business processes implementations make it a suitable candidate for VO business process management (Holley and Arsanjani, 2010).

One of the most common uses of SOA is in organizational process implementations. Each partner in a VO provides services that enable value delivery, these services take the form of processes and therefore, a combination of an SOA and Business Process Management (BPM) approach, with the appropriate management focus, will facilitate a faster path to IT and business alignment. Although SOA BPM approach has known to be successful, failure stories have been reported that were caused by a sole web service implementation and lack of enough focus on governance issues ("The SOA technology war moves on to governance," 2007). SOA principles and best practices need to be used to design services in three different layers and to compose services on those layers to realize dynamic BPM. The first layer is collaborative services, which includes high level business processes defined between enterprises. The second layer is public services which are processes inside an enterprise composed of different business components and orchestrated accordingly. Finally, the private services are internal business activities within a business unit (Fiammante, 2009).

2.5 ITIL V3

In a service oriented virtual organization (SOVO) business processes are executed by different services which are provided by VO partners. So in order to manage the performance of VO at the operational layer, the Service Level Management (SLM) concepts should be considered.

Information Technology Infrastructure Library (ITIL) provides a framework for service management and service life-cycle. On its third version now, ITIL is the most widely adopted guidance for IT service management worldwide. It is non-proprietary best practice that can be adapted for use in all business and organizational environments (Kneller, 2010). In the early 80's, the evolution of computing technology moved from mainframe-centric infrastructure and centralized IT organizations to distributed computing and geographically dispersed resources. While the ability to distribute technology provided more flexibility to organizations, the side effect was inconsistent application of processes for technology delivery and support. The UK's Office of Government Commerce recognized that utilizing consistent practices for all aspects of a service lifecycle could assist in driving organizational effectiveness and efficiency as well as predictable service levels and thus, ITIL was born.

COBIT is another IT management framework that potentially could be used as a reference for this research. However, its latest version (COBIT 5) focuses on the governance issues of the enterprise IT, while ITIL V3 focuses on the service management. The backbone of COBIT is the differentiation between the governance and the management, and focusing more on the governance part. Governance is defined by COBIT as evaluation of stakeholder needs, and setting the directions by prioritization and decision making, as well as monitoring compliance against agreed-on directions. The management, however, is defined as planning, building, running, and monitoring activities, in alignment with the directions set by the governance ("COBIT 5 Framework," 2012). In addition, ITIL guidelines have been recognized as a successful mechanism to drive consistency, efficiency and excellence into the business of managing IT services (Arraj, 2010), which was the main focus of this research. The value of ITIL has been recognized by COBIT and other similar frameworks, and its guidelines have also been widely used by them.

From a business perspective, the adoption of ITIL practices by IT service providers – whether in-house providers or external suppliers – ensures many benefits, including (Kneller, 2010):

- IT services which align better with business priorities and objectives, meaning that the business achieves more in terms of its strategic objectives
- Known and manageable IT costs, ensuring the business better plans its finances
- Increased business productivity, efficiency and effectiveness, because IT services are more reliable and work better for the business users
- Financial savings from improved resource management and reduced rework
- More effective change management, enabling the business to keep pace with change and drive business change to its advantage
- Improved user and customer satisfaction with IT
- Improved end-customer perception and brand image.

ITIL V3 provides a life-cycle for service management. Figure 2-6 shows the lifecycle stages (Long, 2008).

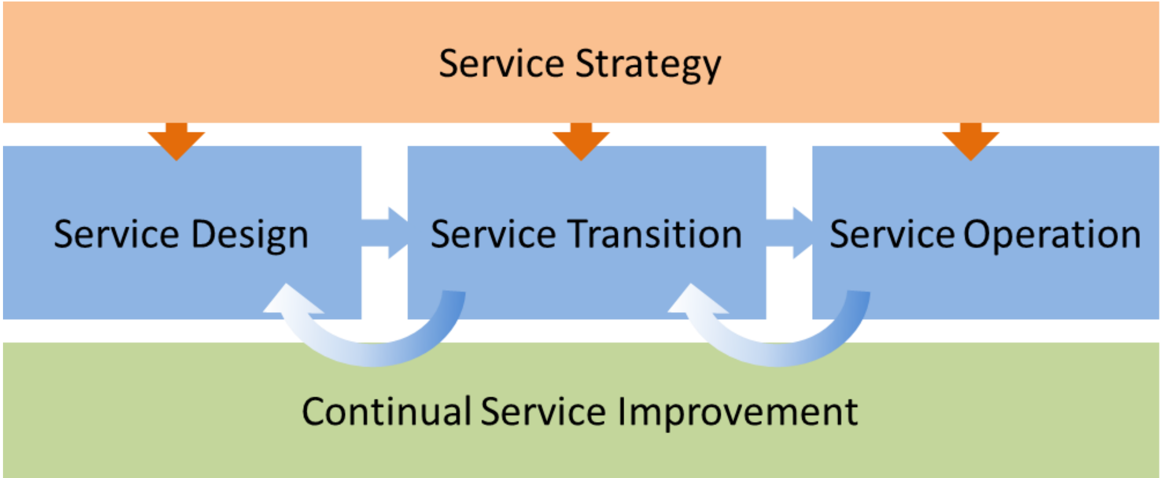


Figure 2-6: ITIL lifecycle for Service Management

2.5.1 Service Life-Cycle

2.5.1.1 Service Strategy

Service Strategy defines high-level approach to providing services. First, the service provider must identify the market for its services. This in turn, drives the identification of services offerings as well as the strategic assets that will constitute those services. Envisioned services will continue to be pursued until they are finally chartered for design (and development), which moves those services into the Service Design stage. Supporting this overall activity is the need to determine the service provider's overall approach to providing services. This may include internal providers, external providers, a shared approach, preferred providers, etc.

2.5.1.2 Service Design

Service Design is a stage in which a new or modified service is developed and made ready for the Service Transition stage. This includes defining service requirements, designing the service solution, evaluating alternate suppliers of the service, and integrating service assets into a service.

Service Level Management provides the interface to IT customers in the collection of requirements. Supporting processes such as Availability Management, Capacity

Management, Information Security Management, and IT Service Continuity Management are consulted to make sure the envisioned service will meet service level targets and expectations.

Supplier Management manages relationships with potential service providers. As the service progresses through this stage, the Service Catalog is updated with new information about the service, including status changes in the service. The Service Catalog is that part of the Service Portfolio that can be viewed by IT customers to discuss about new service requirements or about the initiation of a service level agreement.

2.5.1.3 Service Transition

The primary activity done during this stage is Transition Planning and Support. This process plans all of the activities that must take place to put the service into production. This may involve the creation of a number of RFCs that will carry out all necessary changes (Change Management) and deployments (Release and Deployment Management).

Prior to moving the service into production, there may be a period of testing and validating the service to ensure sufficient quality of the service. An overall evaluation framework is used by transition planning and support to determine if the service is still in an acceptable state to proceed or must be remediated in some manner. As the service is readied for production, various configuration items and assets must be assembled and prepared. Information about all of these CIs and assets, as well as the relationships between all of these elements, must be maintained in order to provide the best support for the service. Knowledge about the services and underlying CIs and service assets is collected during this stage and subsequent stages in order to provide effective support for service faults.

2.5.1.4 Service Operation

In the Service Operation stage, a service is available for IT end users. During execution of the service, it is monitored to determine service levels as well as to look for operational faults. Operational faults may be detected as events from service monitoring. Those events may be resolved within Event Management or may be escalated to Incident Management to be resolved by Service Desk personnel. In either case, the event is recorded as an incident and the service is restored as quickly as possible via either a workaround or some other resolution. Faults may also be detected by users, who may contact the Service Desk to log an incident. The Incident Management process is used by the Service Desk to get the service restored to the user. The Problem Management process supports the Incident Management process by looking for incident trends and resolving root causes of those problems. This process also proactively addresses any faults not yet previously identified. The user may also contact the Service Desk to carry out simple, virtually risk-free actions that cannot be performed by the user or to provide access to services or service assets.

2.5.1.5 Continual Service Improvement

During the Continual Service Improvement (CSI) stage, the service provider collects data and feedback from users, customers, stakeholders, and other sources to enhance services and how they are provided. This involves the use of a 7-step improvement process that collects data, analyzes the data, provides recommendations, and implements those recommendations. In support of the improvement process, Service Level Management collects information from IT users and customers and data from the operation of the services. Service measurement and reporting provides standard vehicles for describing the performance of the services. Finally, all service improvements must be scrutinized according to whether they meet the needs of the business and provide an overall return on investment.

2.5.2 Service Level Management

Service Level Management (SLM) is a Process responsible for negotiating customer requirements and Service Level Agreements (SLA), and ensuring that these agreements are met. This process will be triggered in "Service Design" stage and the outcomes will be used through the following stages. SLM is also responsible for ensuring that Service Management Processes, Operational Level Agreements (OLAs), and Underpinning Contracts, are appropriate for the agreed service level targets. SLA is developed between service providers and customers to describe the service, document service level targets, and specify the responsibilities of each party (OGC-Office of Government Commerce, 2007a). This agreement is made after the customer's requirements are stated in Service Level Requirement (SLR).

In addition, the definition of interdependent relationships among the partners working to support a service level agreement is provided by Operational Level Agreement (OLA).

This agreement describes the responsibilities of each partner toward other partners, including the process and time-frame for delivery of their services. In fact, the OLA defines the goods or Services to be provided and the responsibilities of both parties (OGC-Office of Government Commerce, 2007a). The objective of the OLA is to present a clear, concise and measurable description of the service provider's internal support relationships.

In the operational level of service oriented virtual organization (SOVO), the SLM processes should be used to generate sufficient documentation of service level targets in terms of SLR, SLA and OLA.

2.5.3 Seven Step Improvement Process

ITIL also provides a seven step procedure for measurement, monitoring, and improvement, in its continual service improvement component. The seven steps are as follows (OGC-Office of Government Commerce, 2007b):

1- *Define what you **should** measure*. This information has to be identified in service strategy and service design phases.

2- *Define what you **can** measure*. We have to identify the new service level requirements of the business, the IT capabilities, and the available budget. This will answer the question "Where do we want to be?".

3- *Gathering the Data*. Data should be gathered usually through Service Operation, based on goals and objectives identified. At this point data is raw and no conclusion is drawn.

4- *Processing the data*. The data is processed in alignment with the Critical Success Factors (CSFs) and the KPIs. This means that timeframes are coordinated, unaligned data is made consistent, and gaps in data are identified. The simple goal of this step is to process data from multiple disparate sources into a consistent comparison. We can begin analysis only after we have rationalized the data.

5- *Analyzing the data*. The data is analyzed to identify gaps, trends and the impact on business. The outcome of this process is transformation of data into information.

6- *Presenting and using the information*. An accurate picture of the results of the improvement efforts must be given to stakeholders. The knowledge should be presented to the business in a way that reflects their needs and assists them to identify next steps.

7- *Implementing corrective action*. The resulted knowledge will be used to optimize and improve the services. Managers identify the solutions for the issues. The solutions must be communicated and explained to the organization. At the end of this cycle, organization establishes a new baseline and iterates to the first step.

Figure 2-7 illustrates the seven steps of improvement process.

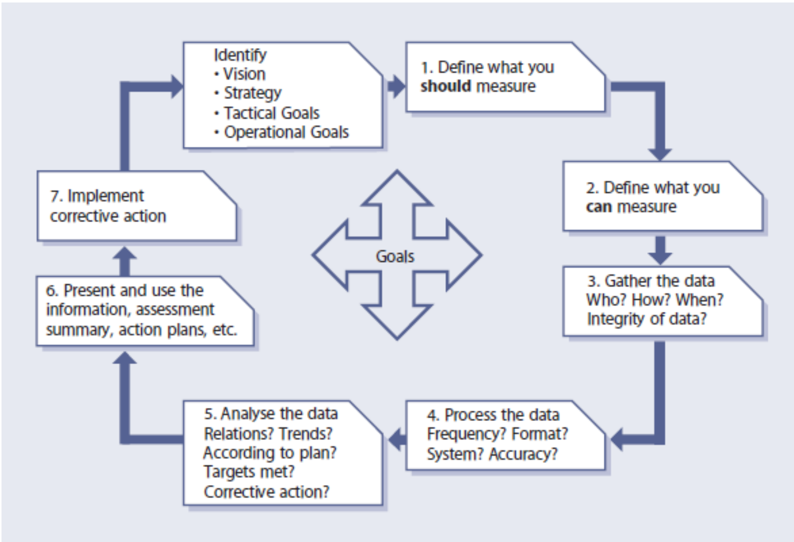


Figure 2-7: ITIL Seven Steps Improvement Process (OGC-Office of Government Commerce, 2007b)

2.6 Performance Measurement and its Evolution

Performance Measurement (PM) is defined as: "The systematic approach to plan and conduct the collection of data regarding the accomplishment of tasks and the corresponding objectives …" (Camarinha-Matos et al., 2008). PM has evolved over the time through different stages. In the following sections this evolution will be discussed based on the work done by Paul Folan and Jim Browne (Folan and Browne, 2005).

The initial starting point of all PM initiatives is called performance measurement recommendation. Afterwards these recommendations, accumulated to form the PM frameworks which can be categorized as structural and procedural ones. The step after was evolving the PM frameworks to support inter-organizational relations as well as intra-organizational ones which led to new concept of PM systems. In the last phase of this evolution process, hiring PM systems to provide information in order to derive positive change in organizational culture, systems and processes is called Performance Management. In following sections each phase of this evolution will be introduced in more details.

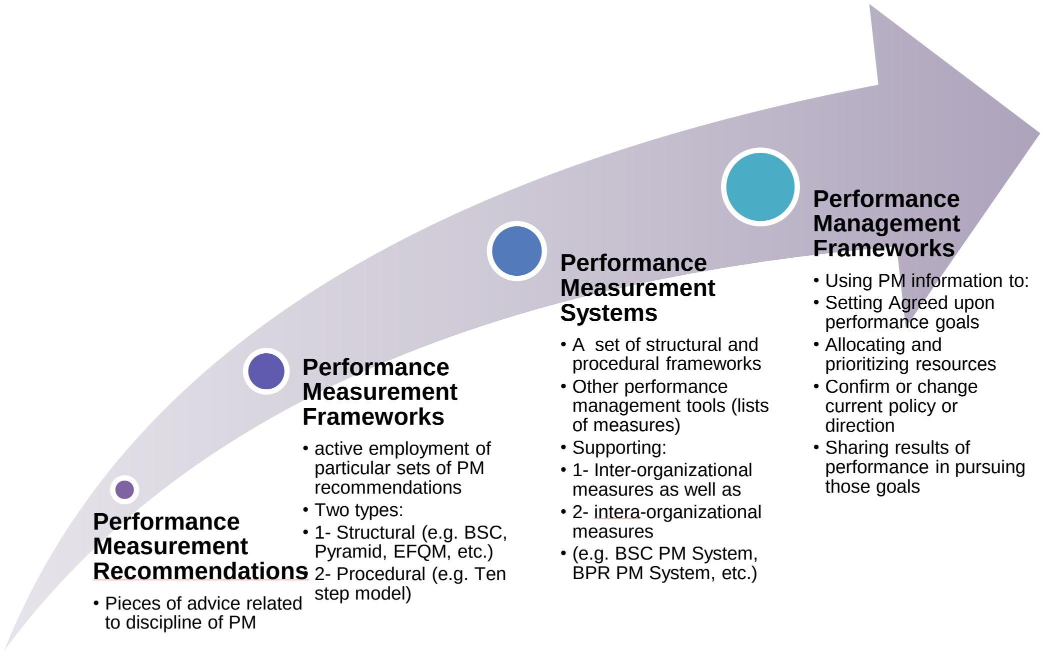


Figure 2-8: Performance Measurement Evolution – Towards Performance Management

2.6.1 Performance Measurement Recommendation

The initial building block of all PM frameworks and systems are pieces of advice relate to discipline of PM which may be termed as PM recommendations. These recommendations can be divided into two main categories:

1. *Recommendations for performance measures;* which emphasize on requirements for good performance measures and subjective procedures for selecting them.

   (e.g. "performance measures must have top management support." Or "employees must be involved in developing the measures.")

2. *Recommendations and issues for PM framework and system design;* which are related to design, development and implementation of successful PM initiatives.

(e.g. "PM frameworks should be based upon the strategic role of the company." Or "Graphs should be the primary method of reporting performance data.")

Many of the researches made concerning PM recommendations (such as: (Azzone et al., 1991), (Crawford, 1988), (Dixon, J. Robb et al., 1990), and (Eccles, 1991)) date from the late eighties to early nineties when PM concepts were initially being formed.

2.6.2 Performance Measurement Framework

The term framework refers to active employment of particular sets of recommendations. So a set of consistent PM recommendations may produce a PM framework. A performance measurement framework assists in the process of developing a PM system, by clarifying PM boundaries, specifying PM dimensions or views and may also provide initial intuitions into relationships among the PM dimensions. In fact PM framework provides more information rather than PM recommendation and less information rather than PM system. A PM framework may be of two kinds:

1. Structural PM frameworks; specifying the categories of the performance measures
   (e.g. BSC (Kaplan and Norton, 1992), Performance Pyramid (RL Lynch, 1992), EFQM ("EFQM," n.d.))
2. Procedural PM frameworks; characterize a step-by-step process for developing performance measures from strategy
   (e.g. Ten steps framework (Lynch and Cross, 1995), SME PM framework (Hudson et al., 2001), Brown framework (Brown, 1996))

Structural PM Frameworks have attracted more attention and effort in the literature. As a result works concerning structural frameworks have outstripped the procedural ones (Folan and Browne, 2005). Both of these views are needed to provide a holistic framework which can address all the requirements of PM. However, such a holistic framework has so far not been realized.

2.6.3 Performance Measurement System

There is not a unique, agreed-upon definition for PM system and there are many definitions provided by different researchers (Franco-Santos et al., 2007). From the strategic control perspective two different aspects of PM system can be identified. Firstly, PM system reflects the procedure used to cascade down those performance metrics used to implement the strategy within the organization. Secondly, PM system provides the information necessary (feedback loop) to challenge the content and validity of the strategy. Correspondingly PM system has two major requirements including PM structural and procedural frameworks (Folan and Browne, 2005). Examples of PM system are Balanced Scorecard PM system (Kaplan and Norton, 1992), Business Process Reengineering PM system (Bradley, 1996), and Medori and Steeple PM System (Medori and Steeple, 2000).

2.6.4 Performance Management Framework

Performance management is defined as "the proactive use of performance measurement information to effect positive change in organizational culture, systems and processes, by helping to set agreed-upon performance goals, allocating and prioritizing resources, informing managers to either confirm or change current policy or programmed directions to meet these goals, and sharing results of performance in pursuing those goals" (Amaratunga and Baldry, 2002). Figure 2-9 shows the most abstract diagram depicting the performance management process provided by Smith and Goddard (2002).

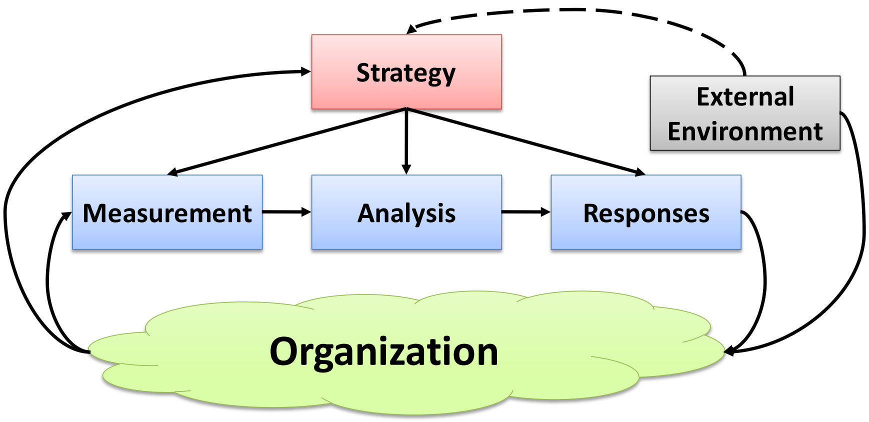


Figure 2-9: Abstract Representation of Performance Management Process (Smith and Goddard, 2002).

This framework should address planning, measurement, monitoring and assessment, improvement and rewarding the performance (Camarinha-Matos et al., 2008). Also the term of "supervision of collaborative processes" is introduced as the planning of performance, the performance measurement and the monitoring and assessment of the obtained performance data. This supervision provides input for performance improvement and rewarding. The supervision process is mapped in the overall performance management process in Figure 2-10 (Camarinha-Matos et al., 2008).

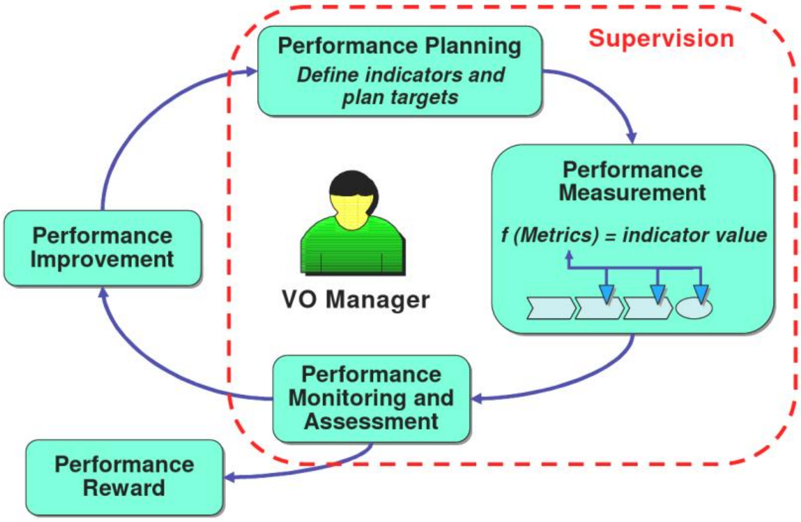


Figure 2-10: Performance Management and Supervision process (Camarinha-Matos et al., 2008)

2.6.5 Collaborative Performance Measurement

The concept of collaborative (inter-organizational) performance measurement is a new but fast growing facet of PM literature. Most of the research being done in this area has focused on supply chain specific requirements. The PM systems for supply chain (such as SCOR model) are mostly focused on traditional logistics performance. In addition, extended enterprise PM system is touched only briefly (Folan and Browne, 2005). So these approaches cannot answer more holistic aspects of inter-organizational relationships. For example, how the efficiency of interactions of the firms can be measured? Or how different alliances can be compared based on their overall performance?

2.7 An Overview of the Existing PM Frameworks

The objective of this chapter is to overview the state of the art of performance measurement and management. There are many frameworks available in this area, which have been widely used in practice. Here we will introduce some of these frameworks, which are relatively more applicable for VOs, including:

- Benchmarking
- 6 Sigma
- Quality Management Systems - EFQM

- Balanced Scorecards (BSC)
- Supply Chain Operation Reference (SCOR) Model

These frameworks will be considered as candidate references and will be evaluated to be used in the new framework which will be designed for performance measurement in VOs.

2.7.1 Benchmarking

Benchmarking is one of the most widely used methods and was initially introduced as a comprehensive approach in the 1980s (Graser et al., 2005b). However various definitions are provided for benchmarking, one of the most definitive definitions is provided by (Vaziri, 1992).

> *"…Benchmarking is the process of continually comparing a company's performance on critical customer requirements against that of the best in the industry (direct competitors) or class (companies recognized for their superiority in performing certain functions) to determine what should be improved."*

The process model for Benchmarking projects depicted in Figure 2-11 is provided by (Camarinha-Matos et al., 2005).

This method allows participants to compare their performance with the average performance of the group and with the performance of the leading firm within the group. Then the operational processes of the subject firm will be improved regarding the processes of the superior firm of the group. In fact the performance level of the best firm will be considered as performance goal for the other participants. This approach guides the firms toward filling the gaps between their actual performance and their potential realizable performance.

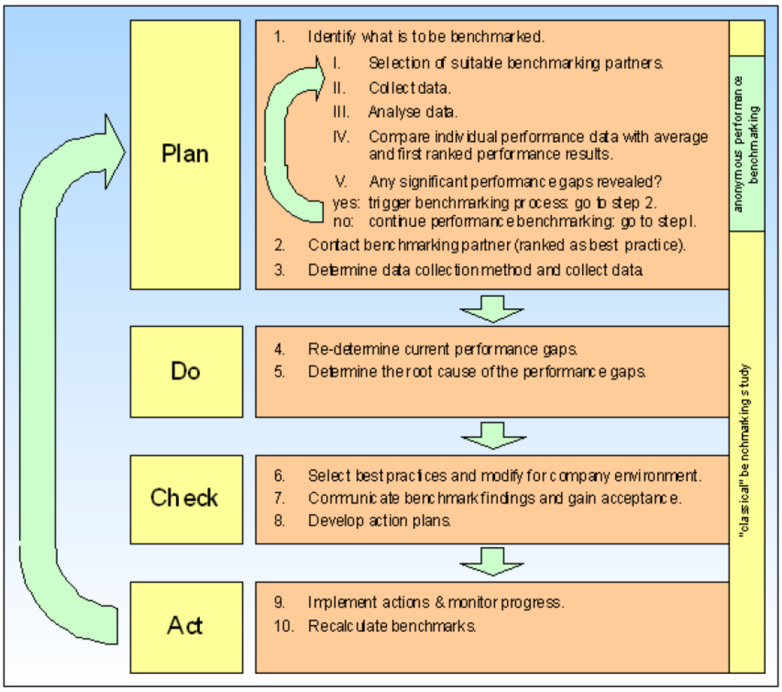


Figure 2-11: Process Model for Benchmarking PM Framework (Camarinha-Matos et al., 2005)

Benchmarking essential characteristics include (Graser et al., 2005b):

- Comparison of different partners.
- Normalization of data.
- Identification of best practices.
- Learning from the best in class.
- Adaptability to a broad range of applications and objects of interest.

Considering these points, benchmarking seems to be quite interesting to be used in VO, because it realizes making normalized comparisons among VO partners in order to rank their performance. This would produce fundamental information to be used in sharing benefits and risks among VO partners. However in order to use benchmarking in VO common definitions of the KPIs are required. Our proposed framework provides this common language, which makes the heterogeneous operation of the VO partners, comparable.

2.7.2 Six Sigma

Six Sigma PM framework first got famous in 1990s through its success at General Electrics. This framework is designed based on statistical quality control principles. A company which is committed to Six Sigma controls each and every critical process defects to be less than 3.4 in one million opportunities. This means that the process must be so accurate at meeting design specifications that almost every opportunity occurs within the control limits. Figure 2-12 shows the logics of using sigma value as a measure for process defects.

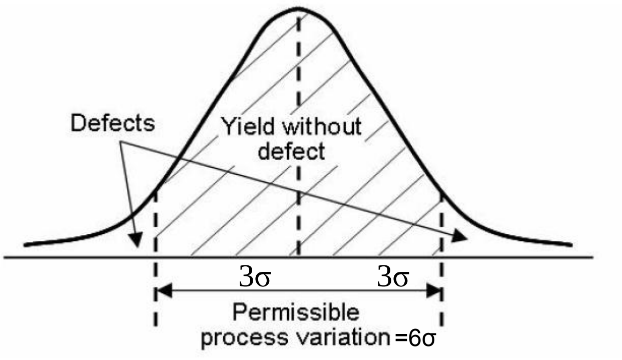


Figure 2-12: Sigma value as a measure for process defects (Graser et al., 2005b)

Contrary to common view, Six Sigma approach assumes that stable processes and good quality reduces costs. In fact, more satisfied customers mean more value produced and thus more revenue gained by the company. So the objective of Six Sigma approach is to improve profitability by reducing waste and increasing customer satisfaction (Graser et al., 2005b).

Six Sigma can be applied regardless of the context of the subject. That means, it should be possible to compare the sigma value of a billing process in a financial service company to a production process in automotive. This facilitates the information exchange and trust issues among companies being surveyed.

In order to implement Six Sigma, Juran Institute suggests a structured course of action called DMAIC. This process includes Define, Measure, Analyze, Improve, and Control (Feo et al., 2003). Figure 3 depicts a descriptive view of this process.

The characteristics of the Six Sigma framework include (Graser et al., 2005b):

- Consequent alignment towards customers.
- Process oriented.
- Concentration on critical to quality characteristics.
- Decisions are based on measured data.
- Structured course of action.
- Universal measures for process quality.

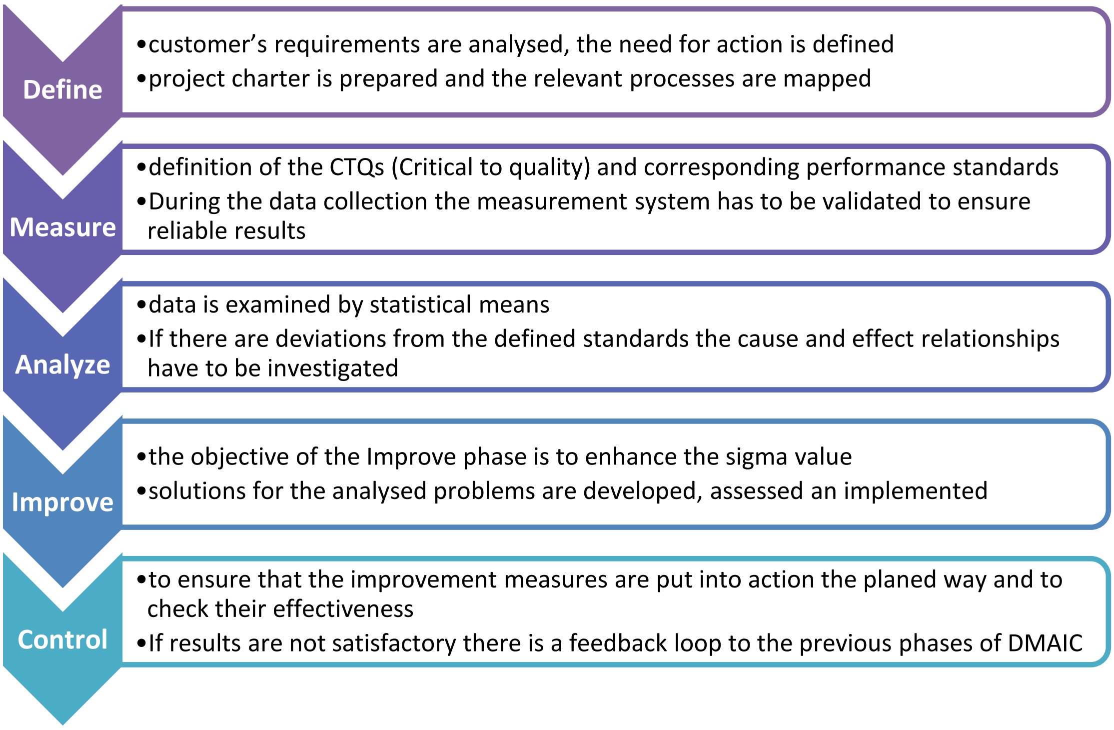


Figure 2-13: DMAIC Process to Implement Six Sigma

In the context of VO, the Six Sigma framework for performance measurement is interesting as it provides universal performance measures that on one hand is context independent and on the other hand reduces trust issues. This may solve the information sharing concerns among VO partners which in some cases may be competitors and so reluctant to share their performance data. However, this method only provides information about the number of deficit processes. Six Sigma is not suitable for cases that the actual value of performance indicators need to be analyzed. In addition, it does not provide insight to the context of the process. In other words an out of threshold performance level will not lead the managers to the performance indicators in the lower layers and corresponding processes. Therefore finding the root cause of a deficit would need a separate investigation through a cause and effect analysis, and can not be identified right away. Therefore in VO environment this method is not sufficient by itself and might be used besides other frameworks.

2.7.3 EFQM

European Foundation for Quality Management (EFQM) is a global non-for-profit membership foundation based in Brussels, Belgium. With more than 500 members covering more than 55 countries and 50 industries, provides a unique platform for organizations to learn from each other and improve performance. EFQM is the custodian of the EFQM Excellence Model, a business model which is helping over 30,000 organizations around the globe to strive for Sustainable Excellence ("EFQM," n.d.). This reference model was lunched first in 1991. EFQM excellence model explicitly focuses on the systematic assessment of a company's performance regarding quality. This model is now widely used for assessment or self-assessment and improvement of company's alignment toward quality (Graser et al., 2005b). The assessment includes nine major categories of criteria which are weighted based on different importance for the overall excellence (Figure 2-14). Each category includes some sub-category of criteria with several defined single criteria.

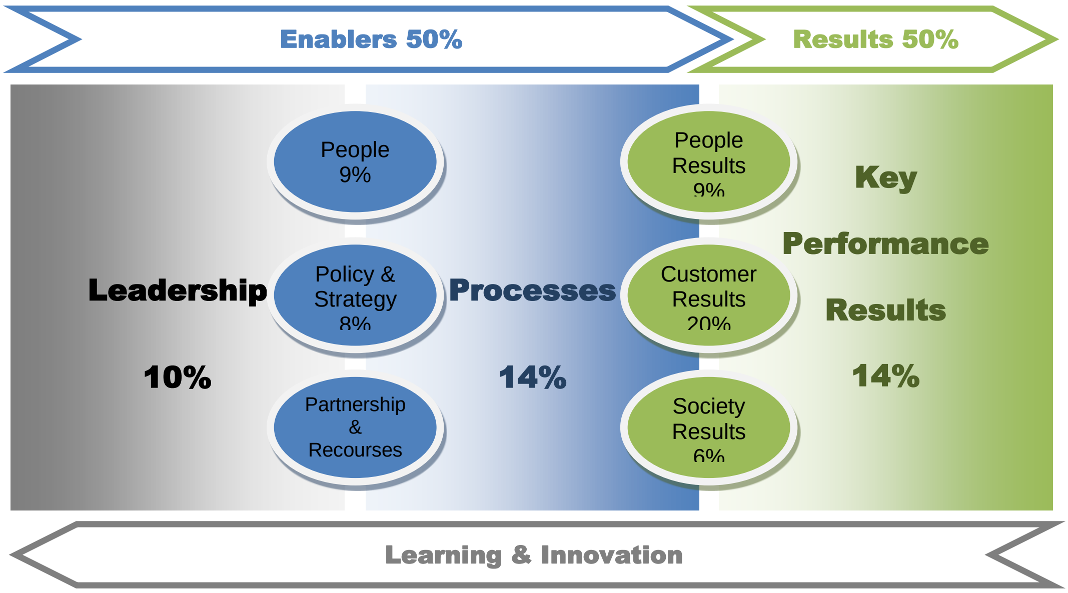


Figure 2-14: The EFQM Excellence Model

In this framework, the enablers for current and future results are considered as well as present results, each with subtotal of 50% importance. In addition, the results are not only focused on financial ones. In fact, people, customer and society results are supposed to be foundation for future financial results.

The EFQM framework can be characterized by following features (Graser et al., 2005b):

- Universal model to assess the capabilities of entire companies to achieve sustainable excellence
- Regarding both the results as well as the enablers for results

- Including financial and nonfinancial aspects, which provide a basis for future financial results; Combination between hard and soft facts
- The categories for assessment are weighted
- Besides shareholder and customers the employees, partners and the society are considered as stakeholders

The characteristic of EFQM which is interesting in case of VO, is considering non-financial aspects as well as financial ones. In fact there are many dimensions in VO which are not limited to financial aspects. However this approach has some downsides when it comes to short-term collaborative environments. As a matter of fact EFQM only dedicates 9% of its indicators to "partnership and recourses". In addition it is meant to support long-term quality excellence which is not of interest in the case of VO.

2.7.4 BSC

In 1992 Kaplan and Norton introduced a new paradigm in performance measurement literature called Balanced Scorecards (BSC) (Kaplan and Norton, 1992). This new framework was basically used to measure the performance of organizations from four perspectives: Financial, Customer, Internal Processes, and Learning and Growth. The financial measures are considered in most of the traditional PM frameworks. But the other three nonfinancial metrics are so valuable mainly because they predict future financial performance rather than simply report what's already happened. Therefore, BSC enabled companies to track financial results while simultaneously monitoring progress in building the capabilities and acquiring the intangible assets they would need for future growth (Kaplan and Norton, 2007).

Despite introducing the new perspectives, this framework supports the idea of linking the firm's strategy and vision to daily operations or actually "translating" the strategy into coherent system of performance measures in four above perspectives (Graser et al., 2005b). The Figure 2-15 shows the main ideas of the Balanced Scorecards in a glance (Brabänder, 2000).

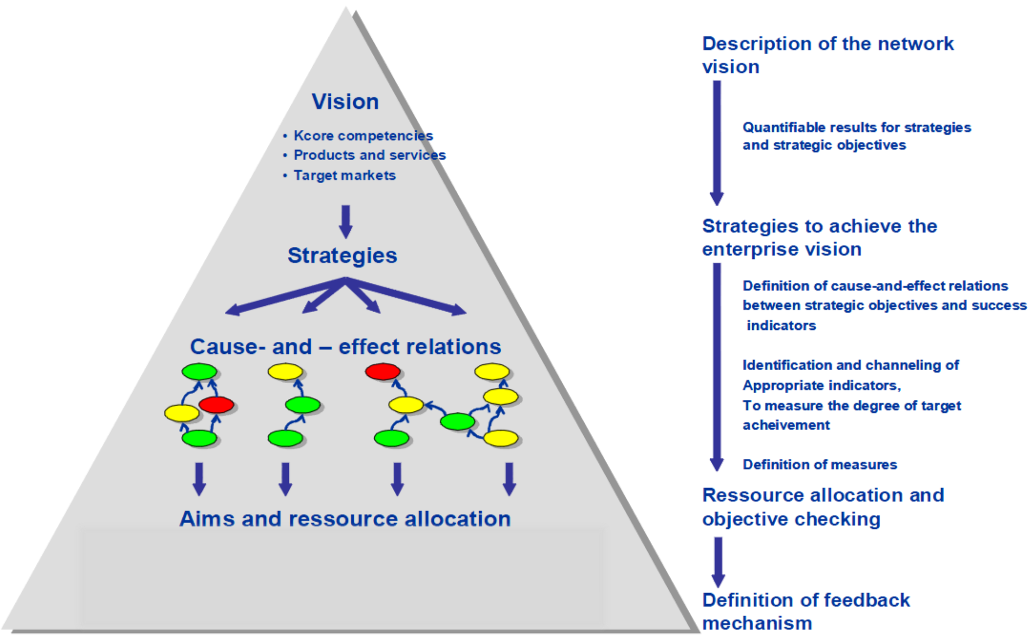


Figure 2-15: Main ideas of Balanced Scorecard (Graser et al., 2005b)

The measures in each of the four perspectives are enablers for other measures in another perspective. In fact, to gain required financial performance in future, in terms of cash flow, quarterly sales growth, operating income by division, increased market share by segment and return on equity, the company must show commitment to its customers by improving their satisfaction. Therefore, the company has to monitor the measures such as lead times, quality, performance and service, and costs. Consequently, the company has to indicate which processes are bringing value to the customers and ensure their improvement. The performance of that processes must be monitored in terms of measures like cycle time, quality, employee skills, and productivity and try to improve them.

Finally to support the continuous improvement of core processes, the company has to learn from its previous experiences and obtain the prerequisites for growth. As a result, the measures for the performance of company's innovativeness, learning and growth must be it has to specified and monitored. These measures may include the ability to launch new products, create more value for customers, and improve operating efficiencies (Kaplan and Norton, 2007).

The distinguishing features of BSC are as follows (Graser et al., 2005b):

- Comprehensive approach.
- Balance between financial and nonfinancial perspectives.
- Translation of vision and strategy into operational business.

- Interactions between measures are analyzed by causal chains.
- Deployment in the entire organization through sub-scorecards.

BSC is designed for single traditional organization and not for a network of organizations. So there are some obstacles to use the BSC in VOs as a PM framework. For example:

- How the strategies of the partner organizations should be translated in to a coherent statement that is accepted by all parties?
- How the performance of partners' collaboration should be measured?
- How should the performance measures be indicated?
- How the performance targets should be set?
- How the performance data should be collected from heterogeneous environments of partner organizations?
- How the benefits should be shared in terms of incentives and compensations?

2.7.5 SCOR

The SCOR model was developed by Supply Chain Council in order to model the operations of the partner organizations within a supply chain. Supply Chain Council (SCC, supply-chain.org), which was founded in 1996 by 69 organizations, is a global nonprofit organization whose framework, improvement methodology, and benchmarking tools help member organizations make dramatic and rapid improvements in supply chain performance (Supply Chain Council, 2010). The SCOR model provides the standard language to describe the performance, configuration, activities, practices and workforce assets of a supply chain. The reference model consists of 4 key pillars ("SCOR Online Access | Supply Chain Council," n.d.):

1. **Processes**; help explain how the supply chain is configured (what activities are taking place)
2. **Performance**; Metrics help to describe the performance of the supply chain
3. **Practices**; are unique ways to configure supply chain processes
4. **People**; Assess needs, availability and gaps of skills in the supply chain workforce

The SCOR model provides a 6 layer hierarchy of process decomposition and in each layer introduces predefined performance metrics. This predefined structure facilitates agile formation of new supply chains and also enables benchmarking within a supply chain or between different supply chains.

The top layer that is introduced by SCOR model includes core processes of each partner of the supply chain. These processes are called process types that include Plan, Source, Make, Deliver and Return. Process types and their interdependencies are depicted in Figure 2-16 ("SCOR Online Access | Supply Chain Council," n.d.).

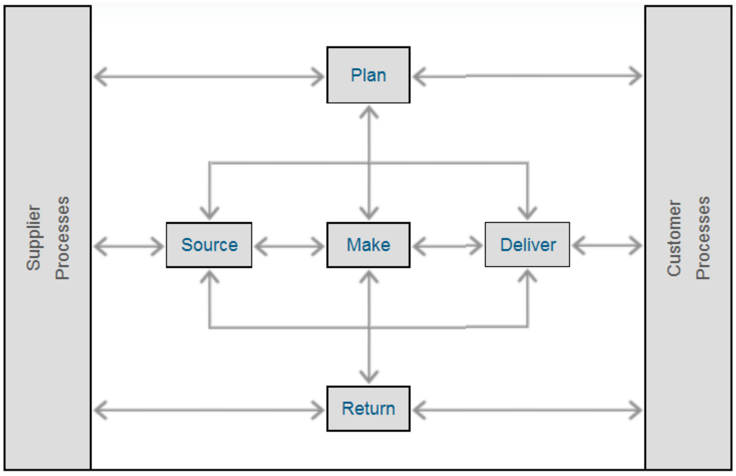


Figure 2-16: Supply Chain Operations (Core processes) ("SCOR Online Access | Supply Chain Council," n.d.)

Each of the process types will be decomposed in the second layer which is called configuration level, into the process categories. For example, process type plan includes process categories of: Plan Supply Chain, Plan Source, Plan Make, Plan Deliver, and Plan Return. In the third layer each of process categories will be decomposed into process elements. This layer is used to model the operations of a company. The Process elements (PE) are connected to each other with causal and/or temporal relations. The relations are used to define dependencies or connections of process elements within and across the types and categories from which the PE´s were hierarchically decomposed from (Graser et al., 2005b).

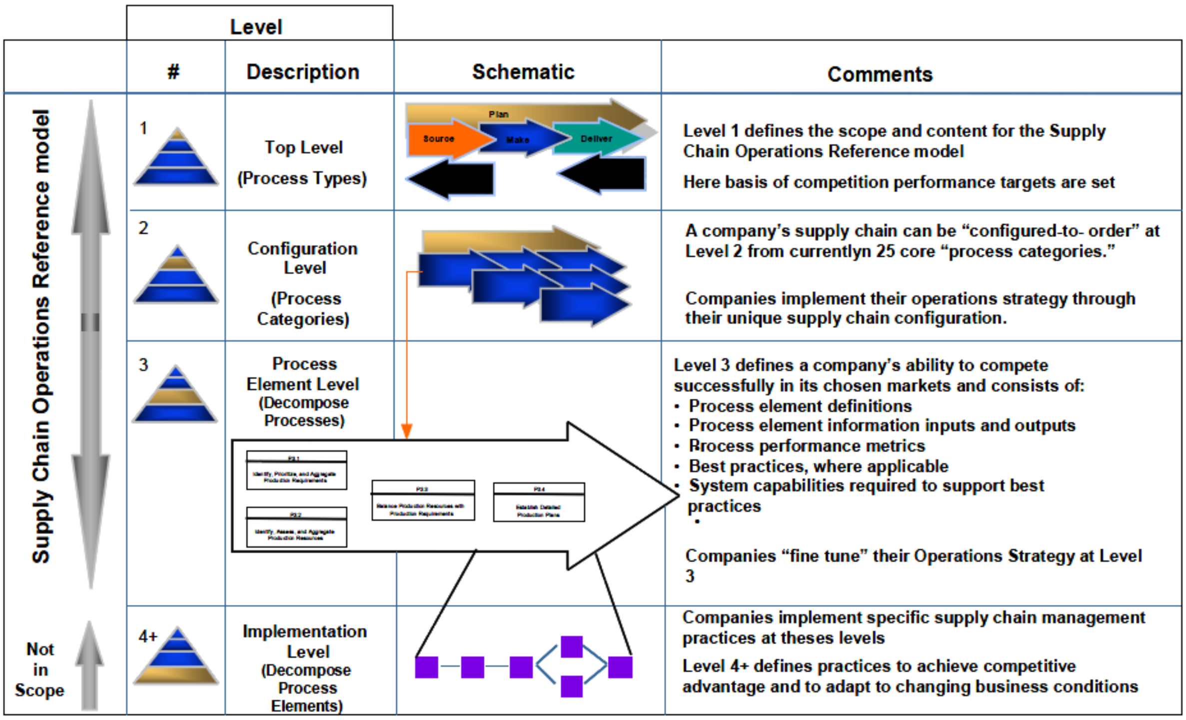


Figure 2-17: The SCOR Model Hierarchy (Graser et al., 2005b)

The other lower three layers are called Implementation layers which are case specific and so are not detailed in the model. Figure 2-17 briefly describes the decomposition layers schematically (Graser et al., 2005b).

The major advantage and one of the reasons for having gained a wider acceptance of SCOR in Industry is that it connects performance metrics to the design elements. Motivation was to assess the efficiency of the process as well as having a basis to build up a best practice approach. Enterprises who have mapped their supply chain using the SCOR model, benefit therefore from both the common procedure of mapping business processes, and the usage of standardized performance indicators (Graser et al., 2005b).

SCOR model uses five attributes to assess the performance of processes and process elements. These attributes and first layer metrics in each category is shown in Table 2-1 ("SCOR Online Access | Supply Chain Council," n.d.).

Table 2-1: SCOR Attributes and Metrics ("SCOR Online Access | Supply Chain Council," n.d.)

ID	Attribute	ID	Metric
RL	Reliability	RL.1.1	Perfect Order Fulfillment
RS	Responsiveness	RS.1.1	Order Fulfillment Cycle Time
AG	Agility	AG.1.1	Upside Supply Chain Flexibility
AG	Agility	AG.1.2	Upside Supply Chain Adaptability
AG	Agility	AG.1.3	Downside Supply Chain Adaptability
AG	Agility	AG.1.4	Overall Value at Risk (VAR)
CO	Cost	CO.1.1	Supply Chain Management Cost (total)
CO	Cost	CO.1.2	Cost of Goods Sold
AM	Assets	AM.1.1	Cash-To-Cash Cycle Time
AM	Assets	AM.1.2	Return on Supply Chain Fixed Assets
AM	Assets	AM.1.3	Return on Working Capital

One of the identified issues of the SCOR model is the lack of a connection between the performance indicators of different layers (Graser et al., 2005b). So following up a performance gap in a process category for example, may not necessarily be resulted to finding the root cause of the problem in process element. In addition the connection of enterprise targets to corresponding relevant performance indicators is not supported by SCOR (Graser et al., 2005b). In such cases, performance management would benefit from a correlation matrix where by defining the enterprise strategy and related goals the methodology would enable to select significant or key performance indicators out of the over 200 on level 3 (Sennheiser, 2004).

Despite the discussed issues, the predefined performance indicators in SCOR model enable benchmarking within a supply chain or between different supply chains. It also enables quick adaptation of new partners in an existing supply chain and quick formation of a new supply chains.

The SCOR model has the following main characteristics (Graser et al., 2005b):

- Focusing on supply chains.
- Comprehensive approach encompassing the entire supply chain.
- Defined process model with predefined metrics for different process levels.

SCOR model is specifically designed for supply chain management, and so is intended to address its requirements. As such, its main focus is on production environments and logistics processes. But whereas supply chain is a goal oriented CNO and includes collaborative business processes as well as VO, it is worthy to be considered to design the VO PM framework.

2.8 VO characteristics and the challenges toward performance measurement

According to the definition, Virtual Organization is a temporary consortium, composed of actors from different organizations, aiming for a specific objective. Thus measuring performance in a VO is different from measuring performance in one organization and for static objectives. The challenges of VO performance measurement may be grouped by its two main characteristics:

1) Impermanence of VOs and time restrictions
2) Inter-organizational issues and complexities

These both affect the whole performance management process: definition of measures, performing the measurements, making conclusions and setting up actions based on the observations. The information provided in this section about challenges toward VO PM is derived mainly from the results of ECOLEAD project (Graser et al., 2005b).

2.8.1 Impermanence of VOs and time restrictions

2.8.1.1 Measurement for short and long term purposes

Performance measurement can be used both for strategic (long term) and operational (short term) purposes. In the VO environment strategic level means measuring the performance for conclusions/decisions that are made in the partner companies after the VO has been completed. Correspondingly, the operational VO performance aims to define measurements that support the management of the VO during its operation. At the operational level therefore, the measurements should support VO creation, monitoring of progress, identification of deviations or other problems and defining the management actions.

It is not a matter of course that the short term measures are sufficient for the long term or vice versa. Thus consideration of both aspects is needed. Additionally, the users of the measures (the decision makers) for short term and long term are not necessarily the same.

2.8.1.2 Unique performance measures

As a VO must be redesigned or configured each time, also the PM solution should be checked or configured for each case.

The unique PM solution may cause problems when PM results from different VOs should be used in parallel, for example to identify future development fields or to make some comparison between different VOs. If the different VOs use totally different performance measures it is not possible to make any comparisons of different cases.

2.8.1.3 Context sensitiveness

Even if the measures were defined clearly, for example because of circumstances and time, there are always differences between the different VOs. It may be misleading to compare the high level indicators as such without looking at the elements which compose them. The performance is always context sensitive and in different VOs the contexts may be different.

2.8.1.4 Temporal requirements

As said before, a VO has a limited timeframe. In some cases the allowed lifetime is very short (for example in the emergency scenario). In these cases it may be difficult to use the measurements to support the real-time operation. But on the other hand, looking at the performance after the VO dissolution is important to keep the VO processes at the required speed and quality.

2.8.2 Implications from inter-organization

The following paragraphs summarize implications for a VOPM system coming from the fact that VOs are distributed and collaborative environments. Management of such environments is complicated by the fact that entities may not necessarily know each other, and that they are scattered in space yet need to somehow interact to realize a common goal.

2.8.2.1 Different objectives of organizations

The objective of the VO as a whole is to deliver the service/ product to the customer and this should also be the objective of each partner. However, the different partners are influenced by several factors. Often the partners have several ongoing VOs at the same time, and some of them have higher priority than the others. In case of schedule conflicts or too few resources a company may allow one or more VOs to suffer to perform well in another VO. Typically the company itself has the power to decide which VO is preferred.

The purpose of performance measurement in general is to support the achievement of the main objectives. If the companies in the VO have several different objectives, it must be decided, to which objectives the PM of VOs should be devoted to. From this point of view, the main objective to be measured is the success of the VO. The elements and criteria of VO success must be further clarified to define the performance measures.

Even if the main objective of VO Performance measurement is to support VO success, it should be considered how this measurement would become interesting also for the VO partners. The interest is needed to obtain information from the partners. Thus VO measurement could also give information which supports the objectives of the different VO partners.

In addition, the VO measurement system could give information about the quality and performance of VO management; thus giving the partners a possibility to follow the management activities. This would give the partners a feeling of “fair play” and openness and thus motivate them in the collaboration.

2.8.2.2 Data sharing & Trust

The principles of sharing data must be defined in the VO. This also affects the partners’ willingness to give their data. The rules of the openness must be defined and the partners must be able to trust that they are followed. Trust within a VO supports the achievement of VO objectives by decreasing uncertainty. Basically, if the partners are able to trust each other, less monitoring and coordination is needed. Thus, in fact, more trust links to less needs for VOPM. On the other hand, real trust is not created out of nothing; it needs a basis to build on. VOPM can work as a tool for trust creation and maintenance.

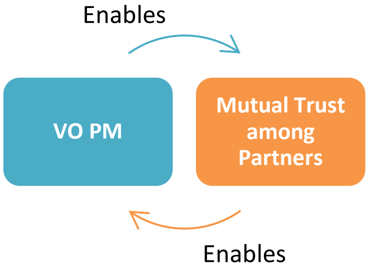


Figure 2-18: Bilateral relationship between VOPM and Trust (Graser et al., 2005b)

Performance Measurement deals with sensitive data that allow insight into the way a company's business processes are operated. Thus it requires mutual trust between the enterprises engaged in the network.

2.8.2.3 Harmonization of Business Processes

Defining a VOPM system means also the definition of the VOPM measurement points in the distributed VO processes. It is not clear how this should be done, and which factors affect the selection of the measurement points. Should the measurements be performed only at the interfaces of different organizations, or also inside the company processes? This alternative could offer more proactive information. This decision will also affect the need to harmonize the business processes of different partners.

2.8.2.4 Determination of interdependencies

The task of a VO is accomplished through collaboration of partners. But not only is the overall result influenced by the partners, there are also interactions between the partners, in particular if one partner depends on the input from another partner or single contributions are produced in teamwork. Therefore the VOPM has to regard these interdependencies when the partners' performances are measured.

2.8.2.5 Specific PM Measures

In a VO, different organizations work together for the VO objective. Most often, the tasks of the partners are dependent on each other and require collaboration. Thus, the success is not only dependent on the performance of single partners, but on the ability and productivity of their collaboration. To be able to support the VO management in a proactive way therefore, special kinds of measurements are needed. Part of these measurements cannot necessarily be presented by exact numerical values; also semi-quantitative or even non-quantitative measurement may be needed. The same applies for intangible issues like behavior or innovativeness.

2.8.2.6 Data availability & interpretation

Availability of suitable data to evaluate indicators is frequently a problem. The availability of data often restricts the definition of indicators. The participation of several organizations makes this problem even more difficult. The capability of different organizations to give information varies, the information systems are not at the same level, and the partners may not be willing to give their data. The willingness again, depends for example of the following issues:

- Do the partners understand how the data and measures are used? For example, are the measurements used as triggers for rewards or penalties?
- Can the partners themselves benefit from the measurements?
- Are the users and access levels defined clearly in the VO? Do the partners accept these definitions?

2.8.2.7 Different VO management approaches

Different VOs may apply different management approaches. This implies some questions for the VO performance management:

- Operating in large VOs often requires the distribution of VO management. This is usually implemented with management hierarchies. How should the VOPM be defined to support distributed VO management?
- How can VO PM support proactive VO management? What kind of observations / data can reveal potential problems?
- How is the performance of a VO management approach or management activities measured?

2.8.2.8 Decisions based on the measurement, assignment of benefits and risks

PM usually acts as a support tool for management of people at different levels. Thus, there is typically no automatic reaction or process following the VOPM results, but they support human decision making taking into account also elements not visible in the PM indicators. In a VO, PM also aims to act as a decision support tool; no automation of VO control is expected.

This would mean for example, that additional rewards or penalties are given to the partners based on the VOPM. This should not be done without a careful definition, development and testing of the indicators and the measurement process.

CHAPTER 3 SOVO PM FRAMEWORK

In this chapter we propose a framework for Performance Measurement (PM) in Service Oriented Virtual Organizations (SOVOs). This includes a structural framework and a procedural framework. The former defines different layers of key performance indicators (KPIs) and their relationships, while the later describes the steps to follow, in order to design and implement the structure of KPIs, communicate the results, and trigger improvements in SOVO.

Before we can describe the SOVO PM framework, we have to introduce the notion of service oriented virtual organization.

3.1 Service Oriented Virtual Organization

Today's economy has shifted from goods-based to value production-based, where service organizations play an important role. Enterprises have to respond faster and more efficiently to shifting market requirements, regulations and customer needs. Tight competition is forcing businesses to provide more and more services to their customers to keep them satisfied (Demirkan et al., 2008).

In SOVO, different organizations try to address a business opportunity, by composing their services to create a complex service that provides more value to the customer. SOA based BPM enables dynamic creation and evolution of virtual organizations. Using this technology, SOVO partners can publish their business processes as services, without threatening their privacy and competitive advantages. Then they are able to seamlessly compose their services and create added-value services for the clients.

In this research, the operations and collaborations of the SOVO partners are modeled in three different layers of Value Network (VN), Collaborative Processes (CPs), and Partners' Services. In the following section we introduce each of these layers.

3.1.1 Value Network

There are different ways to model and design collaboration between organizations. Traditionally, when organizations gather together to produce value added services, they used to start by engineering their processes using function or process oriented models. However these methods usually have shortcomings when alignment with the overall value co-production of the virtual organizations is necessary (Wang et al., 2010).

Therefore in this research we have used value networks to model the business value creation mechanism. The value network serves as the starting point for business process design and engineering. Business Value Networks "are ways in which organizations interact and share values forming complex chains including multiple providers and administrators to derive increased business value" (Ul Haq and Schikuta, 2010). This helps VO to identify service participants and their value expectations and value exchange relations.

We use E3-Value (Gordijn and Akkermans, 2003) ontology to conceptualize, map, and model the VO in value network layer. This ontology has been used in this research in global actor viewpoint. Table 3-1 summarizes the E3-Value notation, description of each component, and its equivalent in SOVO.

Table 3-1: E3-Value ontology components

No	Object	E3-Value Description	Equivalent in SOVO	Visualization
1	Actor	An actor is perceived by his/her environment as an economically independent (and often also legal) entity. A profit and loss responsible business unit, which can be seen as economically independent is an actor, although such a unit need not to be a legal entity.	SOVO Business Partners (Service Providers, Brokers, Integrators, etc.), also called roles.	
2	Value Object	Actors exchange value objects. A value object is a service, a product, or even an experience, which is of economic value for at least one of the actors involved in a value model.	Any object of value, including product, service, money, and information/ knowledge. This is also briefly called "Value".	— […] —
3	Value Port	An actor uses a value port to provide or request value objects to or from his/her environment, consisting of other actors. Thus, a value port is used to interconnect actors so that they are able to exchange value objects.	Value Port	△
4	Value Offering	An offering is a set of equally directed value ports exchanging value objects, and implies that all ports in that offering should exchange value objects or none at all.	Value Offering	△△…△

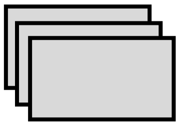
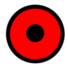
No	Object	E3-Value Description	Equivalent in SOVO	Visualization
5	Value Interface	Actors have one or more value interfaces. In its simplest form, a value interface consists of one offering, but in many cases, a value interface consociates one in-going and one out-going value offering.	Value Interface	
6	Value Exchange	A value exchange is used to connect two value ports with each other. It represents one or more potential trades of value object instances between value ports.	Value Exchange	
7	Value transaction	A concept that aggregates all value exchanges that have to occur together.	Value transaction	
8	Market segment	A market segment is defined as a concept that breaks a market (consisting of actors) into segments that share common properties. We employ the notion of market segment to show that a number of actors assign economic value to objects equally.	Market segment (e.g. Consumers/ Clients)	
9	Value Activity	Operational activities which can be assigned as a whole to actors. This element shows how the operational activities inside each partner are interacting with each other.	(Not used)[1]	
10	Consumer need	Shows the stimuli of a value network scenario. This means that the flow of value objects is triggered at this point.	Consumer need	
11	Boundary element	Shows the point that the value flow rebounds towards the consumer. In other words this element shows the boundary of the value flow.	Boundary element	

Figure 3-1 shows the use of the above notation, in case of a partnership in a supply chain, including business partners (Manufacturer, Wholesaler, and Store) and the consumer (Shopper).

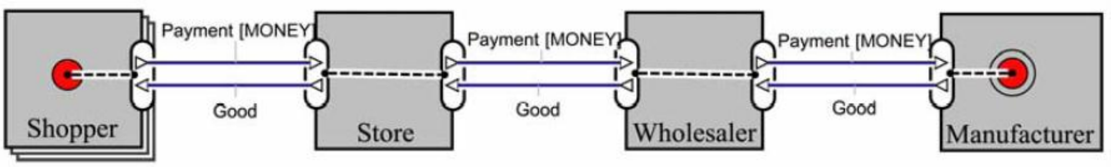


Figure 3-1: sample E3 value model in Supply chain (Carol Kort and Jaap Gordijn, 2007)

[1] In the case of virtual organizations we are not interested in the inside activities of the partners. As such, we use E3-Value ontology in global actor viewpoint, in which activity elements are disregarded.

3.1.2 Collaborative Processes

The characteristic which differentiates VOs from traditional organizations is "**Collaboration**". This term is defined as follows:

> *"Collaboration is acting in an incompletely determined and non-hierarchic way to enable joint processes with other independent organizations and human actors that are performed to reach common goals (Westphal et al., 2010)."*

This layer of SOVO is the equivalent to the first layer of SOA-based BPM system (Fiammante, 2009). The collaborative processes in our framework are modeled by service choreography. The choreography model focuses on partner collaboration and service interactions. It specifies each party's role and activities, and the sequences of service invocations. The level of information provided in the choreography model is left to the business partners and VO management consortium to decide. The choreography serves as an agreement between the participating business partners in their collaboration (Mohamed et al., 2010).

Figure 3-2 shows the BPMN v2.0 notation for choreography modeling.

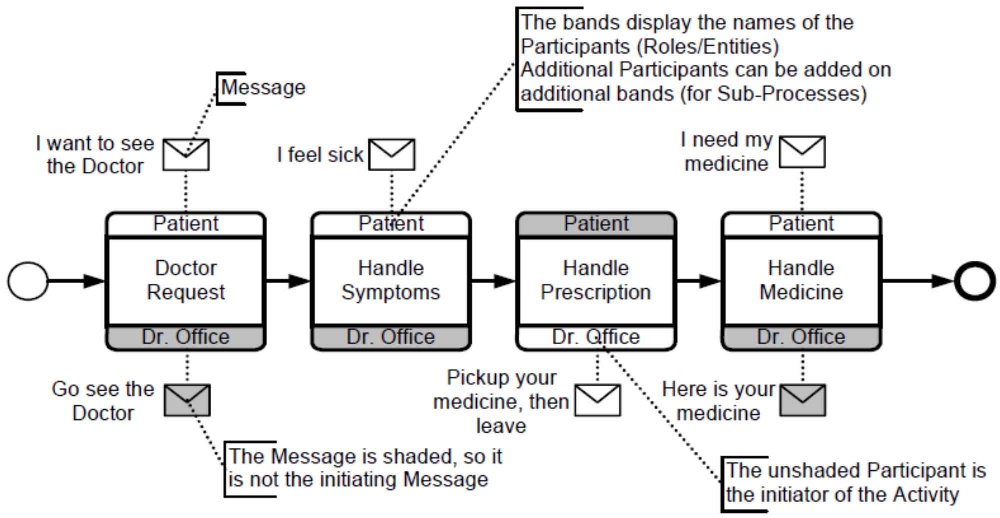


Figure 3-2: BPMN Choreography Modeling Notation (Allweyer, 2010)

3.1.3 Partners' Services

Partner organizations have to provide the services required to satisfy the service choreography model, based on their agreements of collaboration. This layer of SOVO is equivalent to the second and the third layers of a SOA-based BPM system (Fiammante, 2009).

The second layer of a SOA-based BPM system is public services, which in the case of SOVO consist of all the shared services that partners bring in the virtual hub. These public services are then orchestrated to satisfy the overall VO choreography. The service orchestration illustrates service sequences. In this layer we use BPMN (Figure 3-3) to model the final process, and derive the corresponding BPEL (Business Process Execution Language) according to the partner private services. Private services are the original services being used inside each partner's organization, for its own business. These services are equivalent to the third layer of SOA-based BPM.

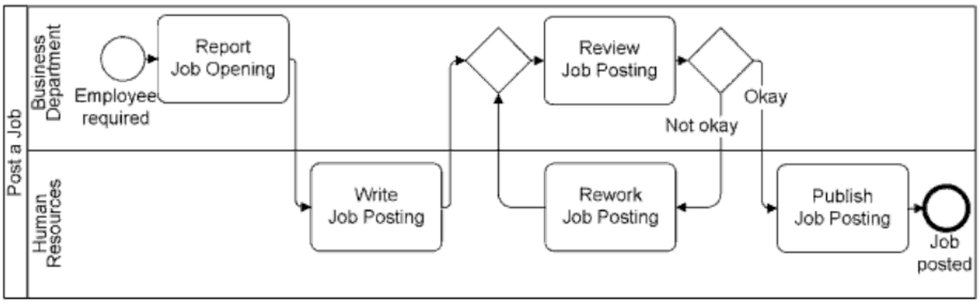


Figure 3-3: A simple BPMN model (Allweyer, 2010)

One of the most important concerns of the partners is to protect their privacy of information and competitive advantages. A new concept of service zone is introduced to satisfy this need. The service zone interaction model provides an abstraction layer that facilitates organizations to share their designated services with other partners while keeping their core competency private (Danesh, 2012).

Figure 3-4 illustrates the above three modeling layers of SOVO.

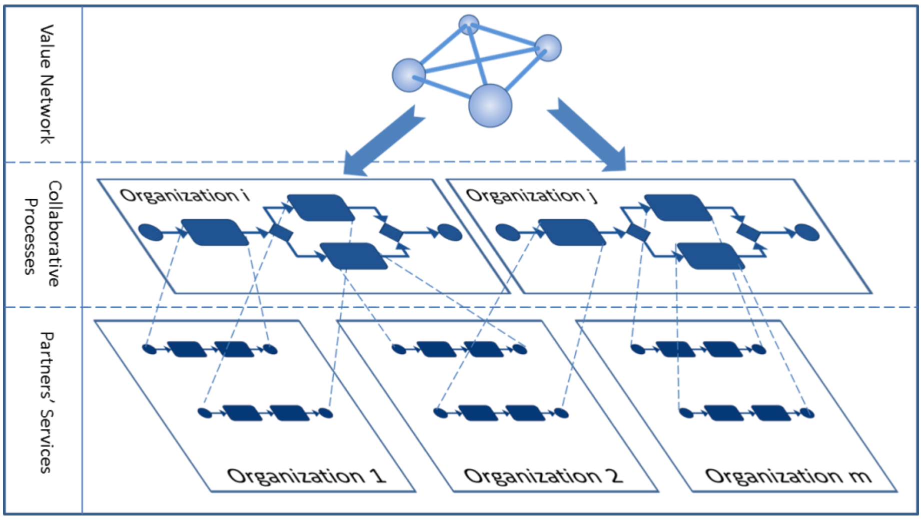


Figure 3-4: Three modeling layers of SOVO

The relationship between three layers must be clearly defined, as a pre-requisite of the definition of the performance indicators in each layer, and the mathematical relationships between them. The processes in the third layer are actually the sub-processes of the collaborative processes. As such, each instance of a collaborative process in the second layer calls one or more instance of each of its sub-processes (partners' services). So the cardinality between the service instances and collaborative process is one to many. Therefore, the relationship between the second and the third modeling layers is well-defined, and aggregation of KPIs between these two layers is clear.

The relationship between the first and the second layers is not easily identifiable, as the sequence in which value objects are exchanged is required for developing the service choreography model. As such, a method is proposed in this research to extract the choreography model from the value network, which is explained in the following section.

3.1.4 Extracting choreography model from value network

There have been different attempts to derive business choreographies from value networks. Among these attempts authors in (Wang et al., 2010) and (Wieringa and Gordijn, 2005) developed the service choreography description and dependencies based on inter-dependencies among values in the value network. Wang et al. (2010) start this by decoupling the value network into value chains with loose or no relation to each other. The service choreographies are then extracted from sets of values and finally they connect different sets of service choreography together. The downside in this method is when we have a peer-to-peer network where decoupling will not be an option because of inter-dependencies between values.

In this research we use a similar approach based on value dependencies, however we do not develop our choreographies based on sets of decoupled value chains. Instead we propose the following steps for extracting choreography model from value networks:

1. Note that information and service values in the value network need to be broken down to the smallest unit possible. Now we assign every value in the network an ID. As a result, we have a set of values which can be defined as V= $\{v_1, v_2, \ldots, v_n\}$.
2. At the next step the following matrix must be formed. In the presented matrix v_i's are value exchanges of the set V. p_{ij} is 1 if v_j has a dependency on v_i in a

sense that v_j cannot be performed as it should, unless v_i is performed. Otherwise p_{ij} is 0. Note that this dependency needs to be a direct dependency which means if $p_{ij} = 1$ and $p_{jk} = 1$ but there is no direct relation between v_i and v_k then $p_{ik} = 0$.

$$M = \begin{array}{c} \\ v_1 \\ v_2 \\ \vdots \\ v_n \end{array} \begin{array}{c} \begin{array}{cccc} v_1 & v_2 & \cdots & v_n \end{array} \\ \begin{bmatrix} 0 & p_{12} & \cdots & p_{1n} \\ p_{21} & 0 & \cdots & p_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ p_{n1} & p_{n2} & \cdots & 0 \end{bmatrix} \end{array}$$

Eq. 3-1

3. For each value exchange in V, count its immediate successive values (SV_i) :

$$\boldsymbol{SV_i = \sum_{k=1}^{n} p_{ik}}$$

Eq. 3-2

4. For each value exchange in V, Calculate its depth of influence (DF_i) which is equal to the following formula (note the best way to calculate this formula is to start from the value exchange v_i with $SV_i = 0$) :

$$DF_i = SV_i + \sum_{j=0}^{n} DF_j \text{ ; } where\ p_{ij}\ in\ matrix\ M\ is\ equal\ to\ 1$$

$$\mathrm{DF_i} = 0 \text{ for values with } \mathrm{SV_i} = 0$$

Eq. 3-3

5. Rank the value exchanges based on DF_i
6. Start modeling service choreographies from the value exchange with the maximum DF_i
7. Remove the modeled value exchanges from the network,
8. Repeat step 6, and continue until no value exchanges are left.

In following lines we discuss an example of implementing this method. Figure 3-5 shows a hypothetical value network consisting of three value actors and one market segment.

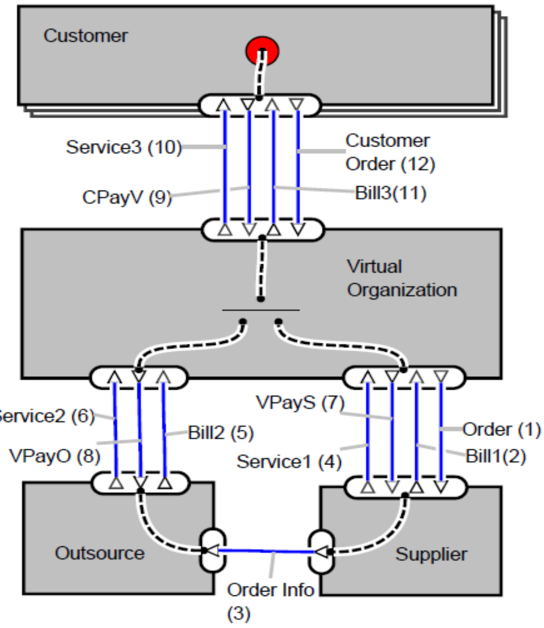


Figure 3-5: Value Network Model of a VO

The client submits an order for Service3 which is a composition of Service1 and Service2 provided by the Supplier and Outsource. The order information needed by outsource needs to be processed by the supplier. Each payment is made based on the bill provided by the payment recipient. V will be defined as the set of above values. V= $\{v_1, v_2, \ldots, v_{12}\}$. Matrix M will be formed as follows:

$$M = \begin{array}{c} \\ v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \\ v_7 \\ v_8 \\ v_9 \\ v_{10} \\ v_{11} \\ v_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccccc} v_1 & v_2 & v_3 & v_4 & v_5 & v_6 & v_7 & v_8 & v_9 & v_{10} & v_{11} & v_{12} \end{array} \\ \left[\begin{array}{cccccccccccc} 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{array}\right] \end{array}$$

Dependencies between pairs of value instances are shown in Figure 3-6.

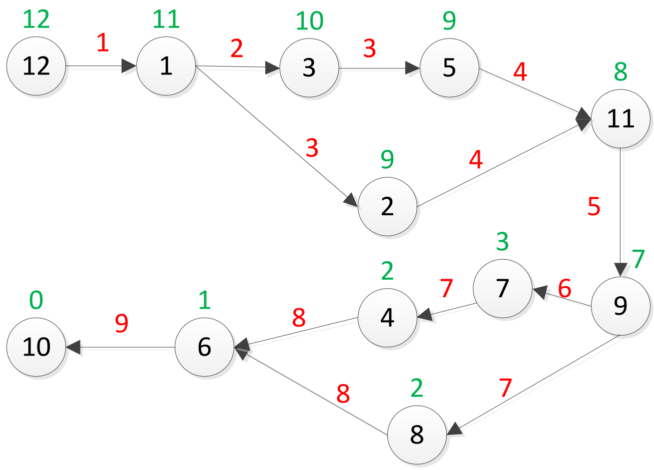


Figure 3-6: Value Dependencies

The nodes are representing value exchanges. The numbers on top of each node are depicting that specific value's depth of influence. The numbers on the edges of the graph are depicting choreography modeling steps. Following the sequence of steps we come up with the service choreography model which is shown in Figure 3-7.

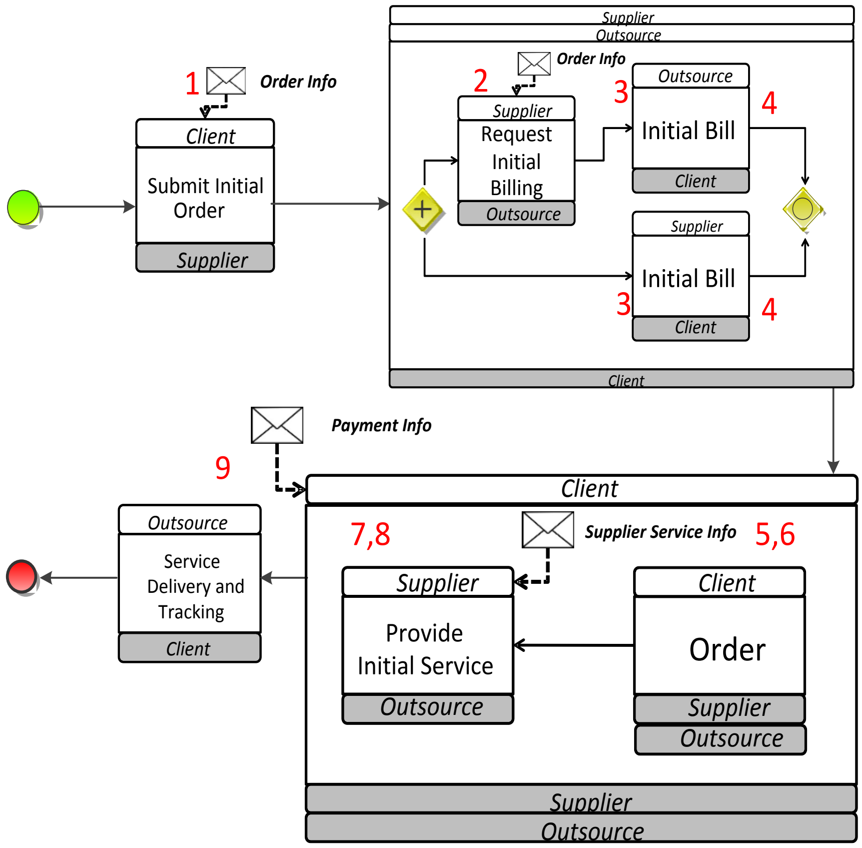


Figure 3-7: Service Choreography Model

3.2 SOVO PM Structural Framework

Performance measurement of SOVO (SOVO PM) needs a specific framework to address the differences between traditional organizations and SOVOs.

One of the latest well-known studies in the field of VO PM was done by ECOLEAD project (Rabelo et al., 2006) at an abstract level. This study provided the conceptual basis for measuring performance in collaborative environments. ECOLEAD project divides Performance measurement in collaborative networks into three different categories. First category of indicators evaluates high-level management approach and methods. Second category measures the performance of partners' collaborations. And the third category measures the contributing performance of the partners in their operational domain. This structure can be mapped into the environment of the service oriented virtual organizations as shown in Figure 3-8.

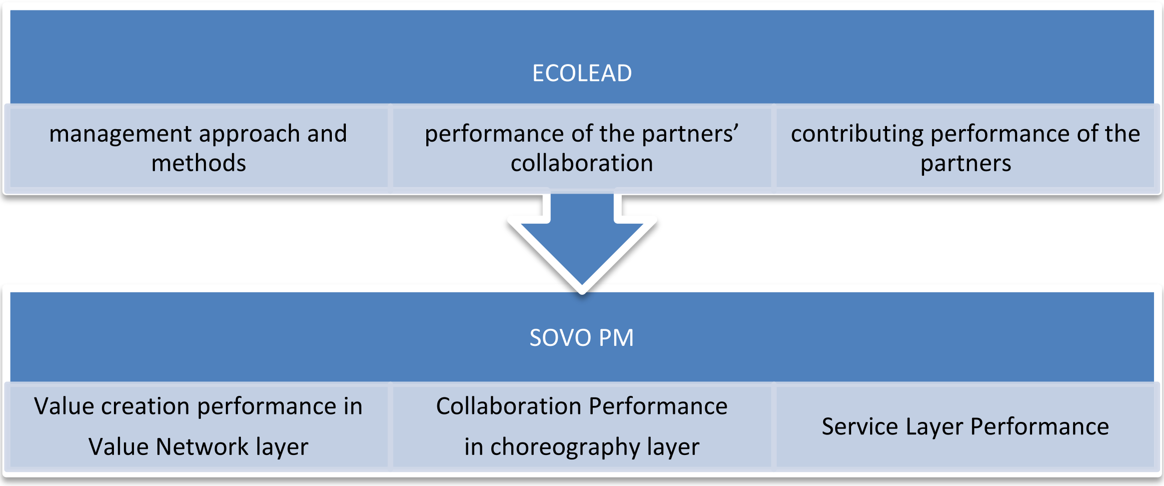


Figure 3-8: mapping ECOLEAD layers of performance in SOVO environment

In collaborative environments, inter-organizational Performance Indicators (PIs) must be addressed as well as intra-organizational ones, in order to fully cover the performance of the alliance. In other words, from a SOVO partner's point of view the performance structure must be balanced considering both internal and external factors (Folan and Browne, 2005). In order to address these requirements we propose a three layer structural framework for performance measurement. The layers are Value Network, Collaboration Performance, and Service Performance.

These performance categories can be interpreted as layers of a SOVO performance pyramid in different levels of strategic importance (Figure 3-9).

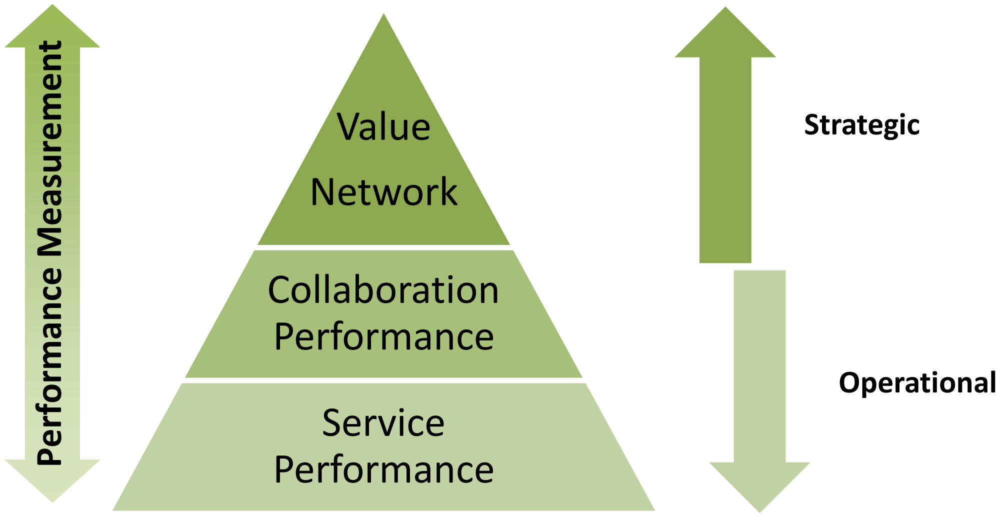


Figure 3-9: SOVO Performance Indicators Pyramid

In the following sections three layers of performance indicators are discussed in more details.

3.3 Service Performance

The lowest layer of performance indicators in VO is related to fulfilling given tasks and contributing performance of the partners. Based on the supporting infrastructure which is service oriented, the tasks are done by executing different services of partner organizations. Therefore, the low-level performance indicators in a SOVO would be used to assess the effectiveness and efficiency of services shared by a specific partner in a collaborative process. These indicators are domain specific, however they must be agreed upon by related partners. This layer of indicators can be considered as the most operational one. The specification of each service, their target level and the responsibilities of service provider must be agreed upon among partners and be documented in the form of Service Level Agreement (SLA) (Long, 2008).

ITIL V3 suggests the following performance indicators to be documented in SLA and to be measured against it (OGC-Office of Government Commerce, 2007a):

1- **Availability**: The percentage of the times that a service is available to be invoked.

2- **Responsiveness**: The time it takes for a service invocation to be responded.
3- **Reliability**: Maximum number of service breaks that can be tolerated in a specific period of time. (The definition of what constitutes a 'break' is also included in SLA.)

In SOVO, the availability and responsiveness of the service are defined the same as ITIL's definition. Thus, each service needs to meet its targets of availability and responsiveness, such as any other IT service. However we need to extend the definition of reliability, to include all of the expectations from the service throughput. In fact, the operational parameters of partners are reflected in the services such as quotation service, ordering service, billing service, etc. These parameters include the cost of the products or services, the quantity to be delivered, the quality measures to be satisfied, and the duration of service or product delivery. Therefore, definition of reliability KPIs in service level is case specific, and has to be defined based on the requirements of product or service production and delivery. The extension of definition of reliability is also suggested by ITIL guidelines, to meet the business needs as much as possible.

Table 3-2 summarizes the performance indicators of SOVO in service layer.

Table 3-2: SOVO Service Performance Indicator

Dimension	Code	Indicator	Description	Interpretation
Availability	AV1.1	Service Availability	The percentage of the times that a service is available to be invoked. It is measured by dividing the number of successful invocations to the total number of invocations.	It can be any percentage in range of (0,100). Values near 100 are desirable.
Responsiveness	RS1.1	Service Response Time	The average time it takes for invocation of a service to be responded.	Threshold for this KPI is agreed and documented in SLA. The service responsiveness below the threshold is desirable.
Reliability	RL1.1	Service Breaks	The number of service breaks for each service. Each time that the service goes out of availability is counted as one service break.	Threshold for this KPI is agreed and documented in SLA. The threshold is the maximum number of service breaks that can be tolerated in a specific period of time. The service breaks below the threshold are desirable.
	RL1.2	Time Measures	Measures related to the duration of the production of goods, or delivery of business services.	Threshold for this KPI is agreed and documented in SLA. The values below the threshold are desirable.
	RL1.3	Cost Measures	Measures related to the cost of the production of goods, or delivery of business services. This includes infrastructure cost, material cost (if applicable), operational cost, human resource cost, etc.	Threshold for this KPI is agreed and documented in SLA. The level of inclusion of the details depends on the agreements between the SOVO partners. The costs below the threshold are desirable.
	RL1.4	Quality Measures	Measures related to the quality of the product or service.	Target for this KPI is agreed and documented in SLA. The quality measures above the target are desirable.
	RL1.5	Quantity Measures	Measures related to the quantity of the product or service.	The target, upper limit, and lower limit for this KPI are agreed and documented in SLA. The quantities within the limits are desirable.

3.4 Collaboration Performance

Measuring the performance of the partners' collaboration is essential to managing VOs in general (Camarinha-Matos et al., 2008). Meeting the targets of collaboration performance indicators enables merging of SOVO partners' processes to accomplish a common task in a non-hierarchic way (Graser et al., 2005b). These indicators are necessary to assess the effectiveness and efficiency of how partners work together in joint processes for a common goal. So this layer of performance measurement is the key for coordination among partners and success of SOVO.

SCOR model (Supply Chain Council, 2010), ECOLEAD project (Camarinha-Matos et al., 2008), and ITIL V3 (OGC-Office of Government Commerce, 2007a) are considered as reference for this layer.

SCOR (Supply Chains Operation Reference) model proposes five dimensions, to measure the overall performance of supply chains, which includes: Cost, Asset, Reliability, Responsiveness, and Agility. Three of them (Reliability, Responsiveness, and Agility) are intended to measure collaboration performance. ECOLEAD builds its collaboration performance dimensions based on SCOR, and extends it with two additional dimensions of Communication and Commitment. Definitions of the above five performance dimensions base on SCOR and ECOLEAD are as follows:

1- **Responsiveness:** the speed at which collaborative tasks are performed such as cycle-time metrics
2- **Reliability:** the ability to deliver material, information, and services within agreed upon quality, quantity, time and cost
3- **Communication:** the ability to communicate, which includes the aspect of using ICT as a means of communication
4- **Flexibility:** the ability to respond to internal or external changes and the ability to adapt to new situation.
5- **Commitment:** the willingness of partners to predict, prevent, and solve the critical situations

Communication dimension is defined to represent the capability of the partner organizations to communicate, which includes the aspect of using ICT as a means of communication (Westphal et al., 2010). The communication of VO partners in SOVO is supported by SOA infrastructure. The indicator that shows the potential communication of partners is *availability* of services and collaborative processes. Based on ITIL, availability is defined as the portion of the time that the service/process can be invoked. Therefore the communication capability of SOVO partners is measured by the availability of the services and the collaborative processes.

Responsiveness reflects the speed at which the collaborative tasks are performed. In collaboration layer of SOVO, it is measured by the response time of the collaborative process. Response time equals the interval between invocation of the collaborative process and having its response back.

In the context of SOVO we use the ECOLEAD definition for *reliability* of business service. However, the reliability of the collaborative process as an IT service must be considered as well. The reliability of IT service is defined by ITIL as the maximum number of service breaks that can be tolerated in a specific period of time.

Flexibility (Agility) describes the ability to respond to internal or external changes and the ability to adapt to the new situation. Internal changes include the changes made to the internal structures and procedures of VO, in different layers of value network, collaborative processes, and partners' services. The external changes include non-forecasted increases or decreases in demand, partners leaving the alliance, natural disasters, etc.

Finally *commitment* represents the willingness of partners to avoid critical situations. This includes two sub-dimensions of *re-active* and *pro-active* commitment. Re-active aspect describes how the VO members react on critical situations or problems. The active aspect describes the intention of partners to actively collaborate to avoid critical situations (Camarinha-Matos et al., 2008).

In order to define the collaborative performance indicators of SOVO, first we need to identify the Entity Relationship Diagram (ERD). The entities included in SOVO are VO, Partner, Collaborative Process, and Service.

Figure 3-10 shows the relationship and cardinality between these entities. KPIs are the properties of these entities. Therefore the ERD helps us to define the hierarchy of KPIs and aggregation functions, so that the summarization of performance information between the entities can be addressed well.

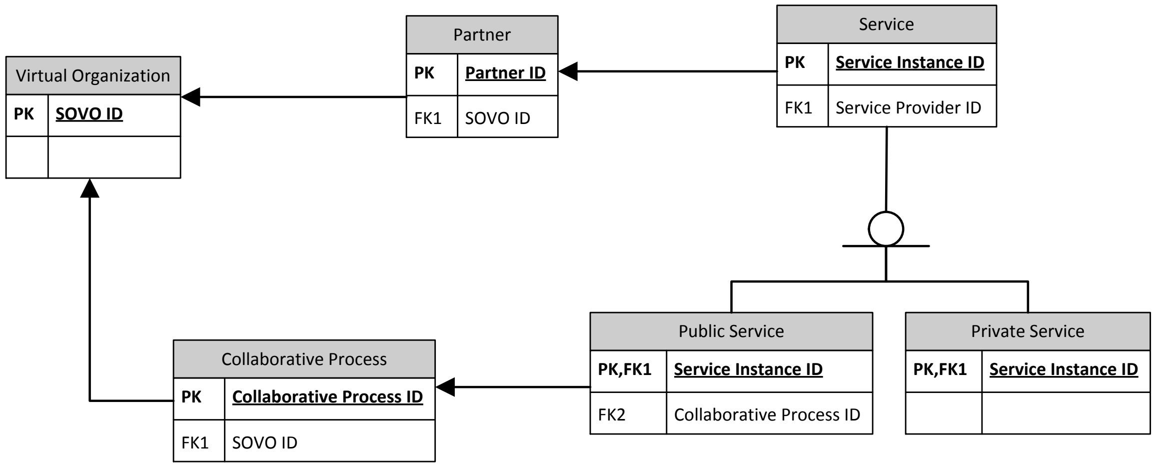


Figure 3-10: ERD of SOVO excluding the properties

In Table 3-3 we summarize the collaborative KPIs regarding above five dimensions.

Table 3-3: SOVO Collaboration Performance Indicators

Dimension	Code	Indicator	Description	Interpretation
Reliability	RL2.1	CP Breaks	Maximum number of breaks that can be tolerated in a specific period of time. Each time that the CP goes out of service is counted as one CP break.	Threshold for this KPI is agreed and documented in SLA. The service breaks below the threshold are desirable. If exceeded the threshold there is a problem with either breaks of the underlying services or the collaborative process itself.
	RL2.2	CP Time Measures	Any measures related to the duration of the production of goods, or delivery of business services, in CP layer.	Threshold for this KPI is agreed and documented in SLA. The values below the threshold are desirable. If exceeded the threshold there is a problem with either time measures of the underlying services or the collaborative process itself.
	RL2.3	VO Time Measures	Shows the average time measures of all collaborative processes of the VO.	Threshold for this KPI is agreed and documented in SLA. The values below the threshold are desirable. If exceeded the threshold then the time measures of the collaborative processes should be checked.
	RL2.4	CP Cost Measures	Any measures related to the cost of the production of goods, or delivery of business services, in CP layer. This includes infrastructure cost, material cost (if applicable), operational cost, human resource cost, etc.	Threshold for this KPI is agreed and documented in SLA. The values below the threshold are desirable. If exceeded the threshold there is a problem with either cost measures of the underlying services or the collaborative process itself.
	RL2.5	VO Cost Measures	Shows the average cost measure of all collaborative processes of the VO.	Threshold for this KPI is agreed and documented in SLA. The values below the threshold are desirable. If exceeded the threshold then the cost measures of the collaborative processes should be checked.

Dimension	Code	Indicator	Description	Interpretation
	RL2.6	CP Quality Measures	Shows the average quality measure of the product or service that is provided by each collaborative process. Quality measures are defined case by case. This KPI must be implemented for each quality measure separately.	Target for this KPI is agreed and documented in SLA. The values over the target are desirable. If did not meet the target, there is a problem with either quality measures of the underlying services or the collaborative process itself.
	RL2.7	VO Quality Measures	Shows the average quality measure of all collaborative processes of the VO.	Target for this KPI is agreed and documented in SLA. The values over the target are desirable. If did not meet the target, then the quality measures of the collaborative processes should be checked.
	RL2.8	CP Quantity Measures	Shows the average instances of product or service provided by each collaborative process.	Upper and lower control limits for this KPI is agreed and documented in SLA. The values within the limits are desirable. If out of threshold, there is a problem with either quantity measures of the underlying services or the collaborative process itself.
	RL2.9	VO Quantity Measures	Shows the average instances of product or service provided by all collaborative processes of the VO.	Upper and lower control limits for this KPI is agreed and documented in SLA. The values within the limits are desirable. If out of threshold, the quantity measures of the collaborative process should be checked.
Responsiveness	RS2.1	Partner Response Time	Average response time of the services provided by the partner.	The partner average response time must not exceed the agreed-upon threshold. If it does, then the response time of the partner's services should be checked.
	RS2.2	CP Services Response Time	Average response time of the services used in a collaborative process.	The collaborative process services response time must not exceed the agreed-upon threshold. If it does, then the response time of the included services should be checked.
	RS2.3	CP Response Time	Average response time of the collaborative process.	The collaborative process average response time must not exceed the agreed-upon threshold. If it does, then the response time of the included services should be checked.

Dimension	Code	Indicator	Description	Interpretation
	RS2.4	CP Execution Time	Average Execution time of the collaborative process.	The collaborative process average execution time must not exceed the agreed-upon threshold. If it does, then the response time of the included services should be checked.
	RS2.5	CP Wait Time	Average wait-time of the collaborative process. It can be measured by deduction of CP Execution Time from CP Response Time	The collaborative process average interaction time must not exceed the agreed-upon threshold. If it does, the interaction time of the included services should be checked.
	RS2.6	VO Response Time	Weighted average of response times of the CPs.*	The VO average response time must not exceed the agreed-upon threshold. If it does, then the response time of the partners or the collaborative processes should be checked.
	RS2.7	VO Execution Time	Weighted average of Execution times of the CPs.*	The VO average interaction time must not exceed the agreed-upon threshold. If it does, the interaction time of the partners or the collaborative processes should be checked.
	RS2.8	VO Wait Time	Average wait-time of the VO. It can be measured by deduction of VO Execution Time from VO Response Time	The VO average interaction time must not exceed the agreed-upon threshold. If it does, the interaction time of the partners or the collaborative processes should be checked.
Availability	AV2.1	CP Services Availability	The average of Availability of services used in each collaborative process.	It can be any percentage in range of (0,100). Values near 100 are desirable. If the value is below the desired threshold, then the availability of the included services should be checked.
Availability	AV2.2	CP Availability	The Availability of each collaborative process itself as a service.	It can be any percentage in range of (0,100). Values near 100 are desirable. If the value is below the desired threshold, then an investigation is needed in the related communication facilities, to find the reason.

* The weight for each CP equals the number of its successful runs.

Dimension	Code	Indicator	Description	Interpretation
	AV2.3	Partner Availability	The average of Availability of services provided by each partner.	It can be any percentage in range of (0,100). Values near 100 are desirable. If the value is below the desired threshold, then the availability of each services provided by the partner should be checked.
	AV2.4	VO Partners Availability	The average of Availabilities of all Partners.	It can be any percentage in range of (0,100). Values near 100 are desirable. If the value is below the desired threshold, then the availability of each partner should be checked.
	AV2.5	VO CPs Availability	The average of Availabilities of all Collaborative Processes.	It can be any percentage in range of (0,100). Values near 100 are desirable. If the value is below the desired threshold, then the availability of each CP should be checked.
Flexibility	FL2.1	Time to Adapt to Change in SLA terms per Service	Average amount of time it takes for each partner, to adjust its configuration, in order to adapt to a change in its SLA terms.	Lower adaptation time of a partner, indicates its higher level of contribution to VO flexibility.
	FL2.2	Time to Adapt to Change in SLA terms per CP	Average amount of time it takes for each partner, to adjust its configuration, in order to adapt to a change in CP SLA terms.	Lower adaptation time of a partner, indicates its higher level of contribution to VO flexibility.
	FL2.3	Time to Adapt to Change in Client's SLA terms for VO	Average amount of time it takes for the VO, to adjust its configuration, in order to adapt to a change in Client's SLA terms. It equals the maximum of adaptation times of the partners.	Lower adaptation time of VO, indicates higher level of flexibility provided to the clients.

Dimension	Code	Indicator	Description	Interpretation
	FL2.4	Time to Adapt to new Partner	The amount of time it takes for the VO to adapt to a new partner. It equals the time it takes for all of the collaborative processes to become operational again.	Lower adaptation time of VO to a new partner, indicates its higher level of flexibility.
Pro-Active Commitment	PC2.1	Number of Alarms by each Partner	The number of problems in VO operations that are reported by each partner, and need paying attention.	More number of reported problems by each partner indicates higher level of proactive commitment of that partner.
	PC2.2	True Alarms by each Partner	The ratio of problems reported by each partner that ends up to improvement action to the total number of reported problems.	More number of True Alarms by each partner indicates higher level of effective proactive commitment of that partner.
Re-Active Commitment	RC2.1	Average Num. of Improvement Suggestions for Alarms	The average number of suggestions provided by each partner for reported problems.	More number of improvement suggestions for alarms from each partner, indicates higher level of reactive commitment of that partner.
	RC2.2	Average level of Contribution in Improvement Projects	The average level of contribution of each partner in the improvement process. The contribution measure must be defined case by case.	Higher level of contribution in improvement projects of each partner indicates higher level of re-active commitment.

The defined KPIs, now can be mapped on the Entity Relationship Diagram (ERD) of SOVO. The result is shown in Figure 3-11.

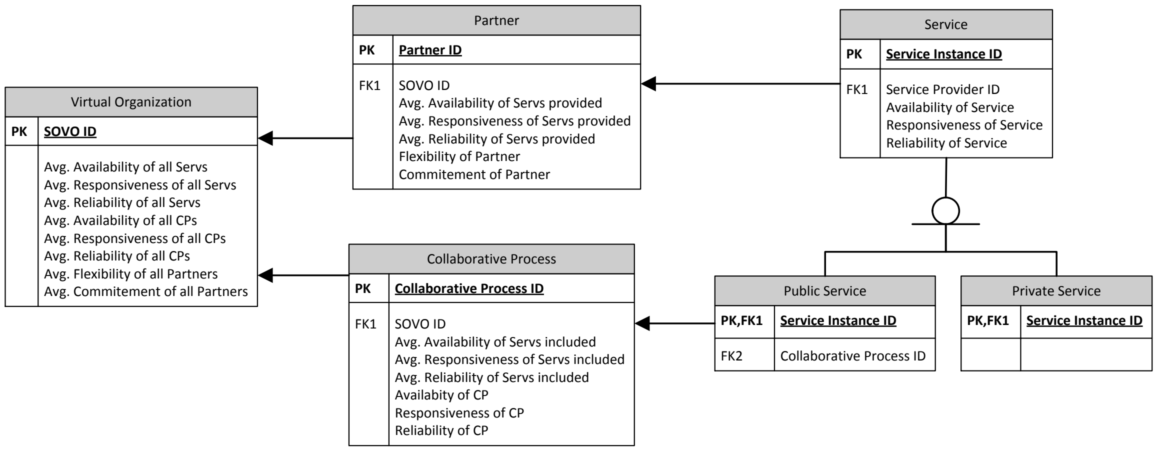


Figure 3-11: ERD of SOVO including properties

3.5 Value Network Indicators

In CNO the top layer of performance indicators has to measure the effectiveness of management approach and strategic level of decision making (Rabelo et al., 2006). This category of performance indicators is usually defined regarding high-level, long-term goals and objectives. However the VO is a "temporary" network of organizations which collaborate to address a business opportunity[1], through providing value-added products or services. Therefore the achievement of long-term goals and objectives are not of interest in this case and should be substituted by success in benefitting from short-term opportunities and creating value for the customer.

The success of a short-term business alliance to respond well to environment opportunities depends on its capability to create value-added products and/or services. Likewise, the success of SOVO must be measured based on the level of effectiveness and efficiency of creating value for the customer. In fact this is the impermanency of SOVO that substitutes the long-term strategic goals and objectives with value creation capabilities, in a network of business entities (partners) that exchange different types of values, including goods, services, money and information.

This layer can be considered as the most strategic level of performance indicators as it has the strongest ties to the SOVO's strategy, which is benefitting from business

[1] These opportunities may appear in market, technology, customers, environment, etc.

opportunities through dynamic collaborative creation of value-added products and services.

The analysis of the value networks is previously investigated in different researches. Among these approaches, some of them such as *E3-Value* (Carol Kort and Jaap Gordijn, 2007), focus more on modeling the interaction of partners, value exchanges, and the feasibility study of value networks. While the others such as *ValueNet Works* (Allee and Schwabe, 2011), introduce some indicators to evaluate structure and vitality of the value network.

The profitability analysis, recommended by E3-Value, is used in this research to assess effectiveness of the SOVO. We have also used Value Network Analysis (VNA) provided by *ValueNet Works* to analyze the efficiency of the SOVO value creation network. Performing these analyses is essential in the creation phase of SOVO, to make sure that the business constellation configuration is both feasible and viable.

3.5.1 Feasibility Analysis

Each business partner provides some value objects to its environment, and receives some other value objects in return. Profitability of a specific partnership for each actor can be described by the ratio of the incoming values to outgoing ones. If the ratio is more than 1, it means that the incoming value objects are worth more than the outgoing ones, or in other words the partnership is profitable. The pre-assumption to perform this analysis, is that each partner can assign a value to each value object exchanged with its environment. Valuation of different deliverables is perceptive, that means each partner may assess the values differently. As a result this analysis should be done by each partner separately. This does not imply inconsistency of analysis, but guarantees the viability of the business constellation. In other words, if a partner cannot find a partnership profitable from its own point of view, it will definitely leave the partnership regardless of the other partners' assessments.

The structure of a profitability analysis sheet is suggested by E3-Value and is shown in Table 3-4 with some modifications.

Table 3-4: Profitability Sheet for Actor X_L

Actor	X_L	

Scenario	1	
Scenario Path	1	
Likelihood	P_{11}%	
	Value Object In	Value Object Out
	Object IV_i^{11}: Value	Object OV_i^{11}: Value
…	…	
Scenario Path	N_1	
Likelihood	P_{1N_1} %	
	Value Object In	Value Object Out
	Object $IV_i^{1N_1}$: Value	Object $OV_i^{1N_1}$: Value

…

Scenario	S	
Scenario Path	1	
Likelihood	P_{S1} %	
	Value Object In	Value Object Out
	Object IV_i^{S1}: Value	Object OV_i^{S1}: Value
…	…	
Scenario Path	N_s	
Likelihood	P_{SN_s} %	
	Value Object In	Value Object Out
	Object $IV_i^{SN_s}$: Value	Object $OV_i^{SN_s}$: Value

Actor x value equation results		
	Total Incoming Values	Total Outgoing Values
Ratio Incoming/Outgoing		

Discussing a method of assigning economic value to deliverables is out of scope of this project. Different methods have been proposed so far by E3-Value project (Gordijn, 2002) and ValueNet Works (Allee and Schwabe, 2011).

In each VO, there might be different scenarios of collaboration. Each scenario also includes one or more scenario paths, which indicates the sequence of value exchanges.

Each scenario path happens to take place with a specific likelihood. The sum of the probabilities of different scenario paths of each scenario is 100%. In other words, in each scenario only one of the scenario paths can be executed at a time. More concisely, if SC is the set of S scenarios (i.e. SC = $\{SC_1, SC_2, \dots, SC_S\}$), and SC_i is a member of this set with N_m scenario paths (i.e. $SC_i = \{X_1, X_2, \dots, X_{Ni}\}$), and also the probability of scenario path X_j in scenario SC_i is P_{ij} then:

$$\forall\ SC_i \in SC : \sum_{j=1}^{N_i} P_{ij} = 100\%$$

Eq. 3-4

As is obvious in Table 3-4, for each actor the incoming and outgoing value objects must be added up separately, over different scenarios and scenario paths. Therefore, for each actor we have:

$$\text{Total incoming values} = \sum_{i=1}^{S}\sum_{j=1}^{N_i}\left(P_{ij}\sum_{k=1}^{I_{ij}} IV_{ijk}\right)$$

Eq. 3-5

$$\text{Total outgoing values} = \sum_{i=1}^{S}\sum_{j=1}^{N_i}\left(P_{ij}\sum_{k=1}^{O_{ij}} OV_{ijk}\right)$$

Eq. 3-6

In which, I_{ij} is the number of incoming values, and O_{ij} is the number of outgoing values, in scenario *i*, scenario path *j*. Finally, the ratio of profitability will be calculated by dividing total incoming values by total outgoing ones.

$$\text{Profit} = \text{Total incoming values (Revenue)} - \text{Total outgoing values (Expenses)}$$

Eq. 3-7

$$\text{Profitability Ratio} = \text{PR} = \frac{\text{Total incoming values}}{\text{Total outgoing values}}$$

Eq. 3-8

For a VO with *L* partners to be feasible, this ratio must be more than one, for all of the business partners. So the condition of feasibility can be written as follows:

$$\forall l \in \{1,2,\dots,L\} \ : PR_l > 1$$

Eq. 3-9

Profitability ratio is a key performance indicator showing the level of profitability of the partners in a VO.

3.5.2 Value Network Analysis (VNA)

Besides the fact that each partner in the value network needs to find the collaboration economically beneficial, they also need to evaluate the value network efficiency and whether it supports vitality of the partnership or not. One of the most comprehensive studies on the analysis of the value networks has been conducted by Allee and Schwabe, (2011). This approach has integrated classic network analysis indicators, such as social networks and informational networks, with value network specific indicators. The resulted framework is called Value Network Analysis (VNA). This approach divides the indicators into four major categories of:

1. Value Creation
2. Value Flow Optimization
3. Value Network Structure
4. Value Network Vitality

VNA has a social approach to value networks, and tries to identify the role of human perception in assessment of value to different objects. It takes the intangible values (e.g. knowledge, brand) into account as well as tangible ones (e.g. money, product, service). It also tries to describe the relationship between asset utilization and value creation process.

In SOVO environment we basically deal with tangible values, including products, services, money, and information. In addition, the notion of SOVO narrows down the generic concept of value network, to SOA based B2B value networks. Therefore, not all of the above considerations are applicable in the context of SOVO. As such, we have used the recommendations and guidelines of ValueNet research, to identify the indicators and customize them to suite SOVO requirements the best.

Two Dimensions of VN Structure and VN Vitality describe the characteristics of the structure of value network roles, value objects, and value transactions. These indicators are used in the creation and evolution phase of the VO to evaluate the *effectiveness* of the structure of the B2B alignment, and the importance of each object in the value network to success of the VO. The indicators of structure and vitality remain the same as long as the value network has the same configuration and has not evolved.

The indicators in the other two dimensions (Value Creation and Value Flow Optimization) are defined to evaluate how much *efficient* the value is created and if the flow of value in the network is optimized. These indicators are subject to changes during operation and evolution phase of the VO. However the frequency of change is not as much as the service/process layer KPIs.

Table 3-5 summarizes SOVO value network indicators derived from VNA study.

Table 3-5: SOVO Value Network Indicators

Dimension	Code	Indicator	Definition	Interpretation
Value Creation	V1.1	Partners' contribution	The total economic equivalent of the outgoing values per role.	The higher each partner's contribution, the greater share in the value received by customer, and the greater share in the benefits.
	V1.2	Value creation capacity	The maximum number of value instances that can be provided by each partner per value item.	The higher Value Creation Capacity for each role, the greater value creation capability for that role.
Value Flow Optimization	V2.1	Percentage of structured value delivery channels	The portion of automated, technology supported value channels to traditional ones. The channel is the medium or mechanism used to transport the deliverables (e.g. email, instant messaging, physical transport, shared directories, face-to-face meetings, etc.).	The higher portion of automated channels, the greater reliability of the value creation process is expected.
	V2.2	Value exchange sequence	The order in which value exchanges take place within the network.	Is required to calculate value exchange depth of influence, and value exchange degree of dependency
	V2.3	Value transaction speed	The speed at which each value transaction takes place.	The higher value transaction speed for each pair of roles, the greater contribution on the overall speed of the whole value network.
Value Network Structure	V3.1	Value exchange depth of influence	Depth of influence for each value exchange equals the number of value exchanges which are dependent on it.	The higher depth of influence for each value exchange, the greater importance for the overall value creation process. The value exchange with higher depth of influence has priority of implementation.
	V3.2	Value exchange degree of dependency	The number of value exchanges which are prerequisite for specific value exchange	The higher this indicator, the greater the level of dependency on the other value exchanges. The value exchanges with higher level of dependency are at more risk.

Dimension	Code	Indicator	Definition	Interpretation
	V3.3	Value transaction reciprocity	The portion of incoming value objects to outgoing ones per transaction.	Asymmetric transactions with unreciprocated value exchanges are found to be unstable. Therefore the ideal value for this indicator is one.
	V3.4	Value network reciprocity	The average of reciprocities of all value transactions.	Asymmetric networks with unreciprocated value transactions are found to be unstable. Therefore the ideal value for this indicator is one.
	V3.5	Partner's level of centrality	The number of outgoing value deliverables per partner	If there is too much structural dependency on a partner, then the whole network is in danger, if something goes wrong with that partner.
Value Network Vitality	V4.1	Risk	Variance of the level of centrality of all partners	The higher levels of this indicator means that some partners are contributing much more than the others. Such unbalanced value networks are at more risk.
	V4.2	Agility	The speed at which information moves through the network.	The speed at which information moves through the network show the level of value network agility. In other words if the speed of information transmission in the network is high, then solutions of the problems will be found more quickly. As a result network will adapt faster to the internal and external changes.
	V4.3	Stability	Stability is revealed by measures of network density. The level of network density is calculated by dividing the current number of value transactions by the number of maximum potential value transactions.	Higher level of network density means that the value network is more stable.

3.6 Multi-level SLA Structure

SLA guarantees the expected quality of service to different stakeholders. The structure of an SLA includes different sections as shown in Appendix A. Not all sections of a typical SLA document are relevant to performance measurement. As such, we use the following structure to document the SLA terms:

1. Title
2. Service provider and service consumer
3. Service description
4. Service hours
5. Service performance
    a. Service availability
    b. Service reliability
    c. Service responsiveness
    d. Expected service throughput
6. Responsibilities
7. Charges, Penalties, Bonuses
    a. Service cost (Charging formula)
    b. Penalties
    c. Bonuses
8. Service reporting and reviewing

ITIL suggests multi-level SLA structure, to keep SLAs to a manageable size, avoid unnecessary duplication, and reduce the need for frequent updates (OGC-Office of Government Commerce, 2007a). Any terms in higher level SLA applies to lower levels as well. In context of SOVO, following the same guideline leads to three levels of SLAs are as follows:

1. **SOVO Level:** covering all the generic performance issues appropriate to every SLA throughout the SOVO. These issues are likely to be less volatile, so updates are less frequently required. In other words, the terms in this SLA govern all of the services in different levels of SOVO.
2. **Collaborative Process Level:** covering all performance issues relevant to the particular collaborative process, regardless of the services being used.

As such, each collaborative process has an SLA which governs all of the services being used in it.

3. **Service Level:** covering all performance issues relevant to the specific service, in relation to a specific collaborative process. The terms of each service level SLA only governs one service provided to one collaborative process.

Within a business network, services are composed together to make value added services for the client. This implies some form of aggregation pattern of SLAs for business partners, which is discussed by Ul Haq & Schikuta (2010). This structure includes aggregation nodes, SLAs, and dependencies. Each service provider/consumer is modeled as an aggregation node that provides some services and consumes some others. The aggregation function that defines the contribution of each lower level SLA term to the terms in the higher level SLAs is defined in the aggregation nodes (e.g. Sum, Average, Count, AND, OR, etc.). Two types of aggregation nodes are defined as physical and virtual aggregation nodes. The physical nodes represent the actual business partners, while the virtual nodes represent the collaboration between two or more physical nodes, that ends up to provision of a value-added service. The dependency of the SLAs and the nodes are modeled by directed arrows. The services are provided in the direction of the dependencies. Figure 3-12 shows an example of SLA aggregation pattern for a network of enterprises.

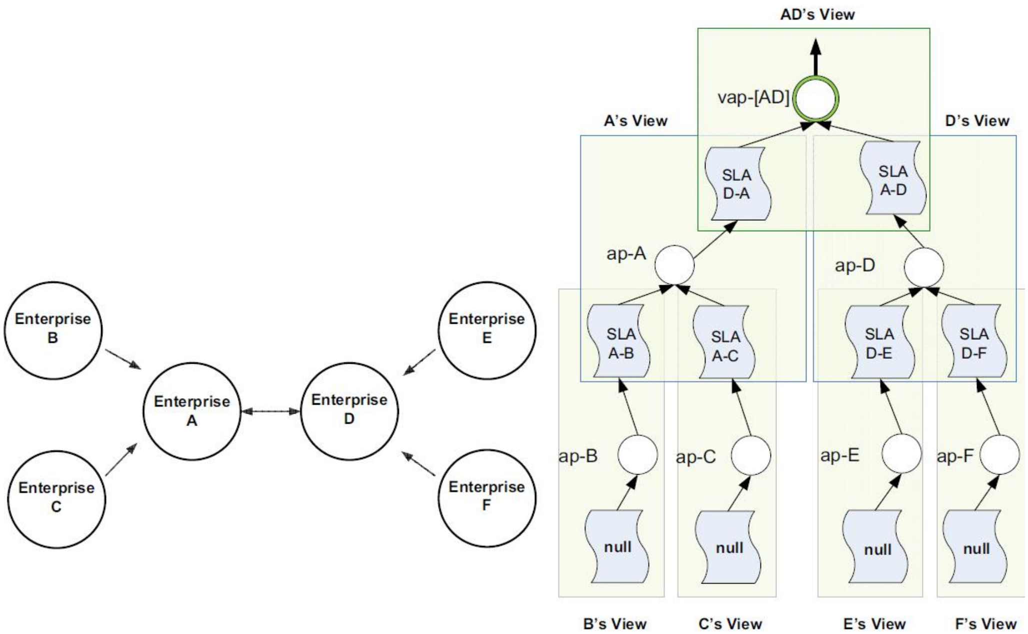


Figure 3-12: SLA aggregation in VEs (Ul Haq and Schikuta, 2010)

In this research, performance indicators of SOVO partners' contributing services are defined based on this structure. SOVO partners are modeled as physical aggregation nodes. The collaborative processes and the SOVO as a whole are modeled as virtual aggregation nodes. Figure 3-13 shows the generic multi-level SLA aggregation pattern for SOVO.

Each organization contributes to one or more collaborative processes by providing services. The specific terms of each service are documented in an SLA. The composition of services takes place in the collaborative processes. So the service level SLA's are aggregated in CP aggregation nodes. The specific terms of the resulted service from each CP is documented in a CP SLA. The aggregation of CP SLAs ends up to the Client's SLA, which contains the service terms for the client. The Client's SLA plays the role of a contract between the SOVO and the final service consumer and makes sure of a customer centric performance measurement.

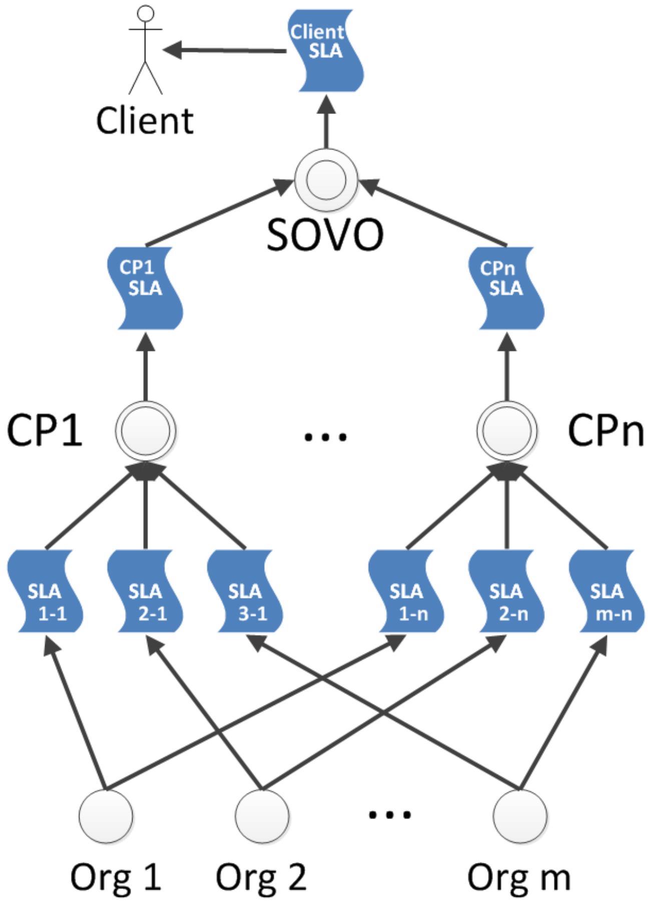


Figure 3-13: SOVO SLA Aggregation Pattern

3.6.1 SLA Views and Performance Information Access Levels

For each partner, a zone is defined as that partner's SLA view. This zone is defined as a set including consumer oriented SLAs, provider oriented SLAs, and dependencies to those SLAs. The view shows the level of access to the SLA information, including performance related information for each partner. SOVO partners have independent SLA views, as well as shared SLA views. The independent SLA view includes the partner's node, SLA of the services that it provides, and dependency of those SLAs. While the shared SLA views of each partner, includes the Client's SLA and any CP SLAs which the partner has a contribution to. As such, each partner has access to the SLA terms and performance level requirements of both independent and shared SLA views.

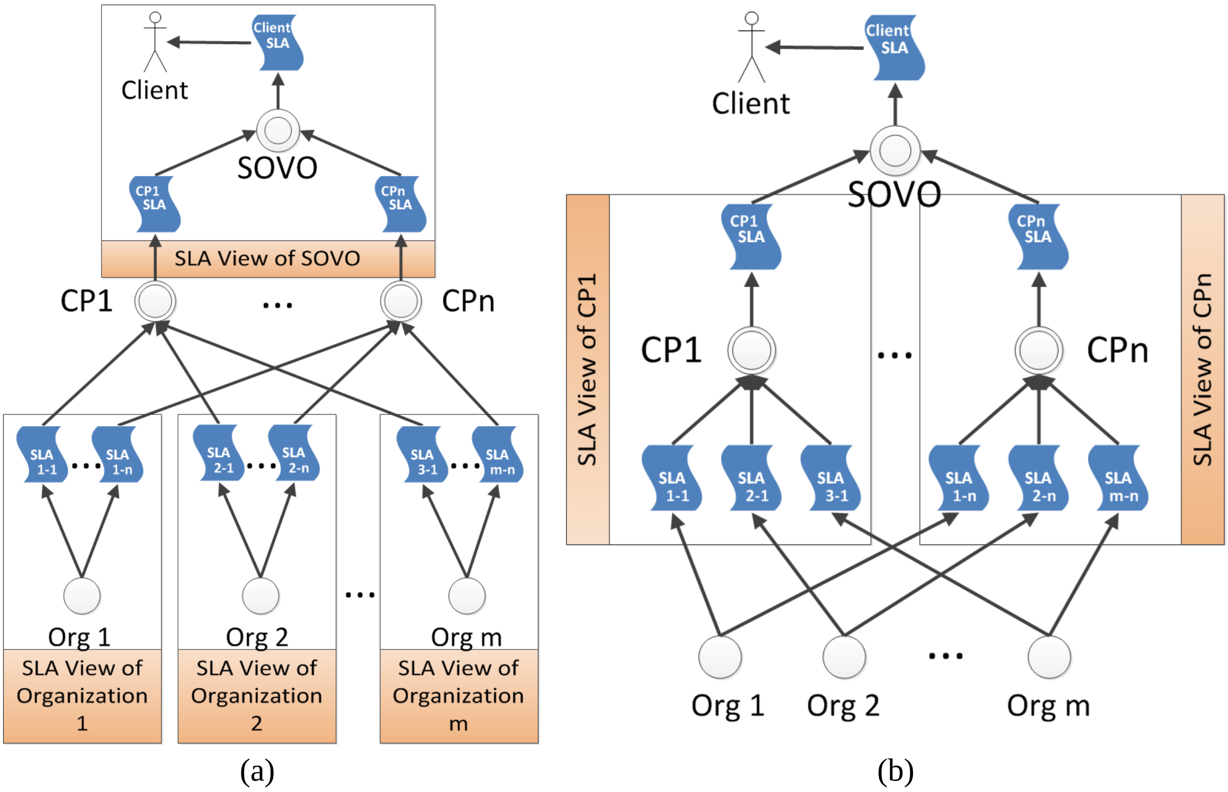


Figure 3-14: SOVO partners and collaborative processes SLA Views

We can also demonstrate the SLA view of each collaborative process by reconfiguring the SLA aggregation structure (Figure 3-14, b). In cases that the CP is hosted and managed by a partner other that its service providers, the CP SLA View defines the level of access to the performance information for the CP host/manager.

3.6.2 Drilling Down to the Responsibility Zone

Who is responsible for unsatisfactory level of each SLA term? The answer to this question is critically important to identify the corrective action and the responsible party for implementing the improvement. This can be answered using the concept of drilling down in performance KPI structure. As such, when the performance level for a high level KPI (e.g. a Client's SLA term) is out of the agreed-upon thresholds, the root cause of the unsatisfactory level can be identified by checking the lower level KPIs (e.g. CP SLA terms, and partner services' SLA terms) that have contribution to it. This can be done my implementing the drill down feature based on the SLA structure. After conducting this investigation, we come up with a set of low level KPIs that are not in control. The concept of responsibility zone is used to identify the partners that need to take the corrective action. Responsibility zone of each partner is the set of SLAs for the services that it provides to various CPs. As is shown in Figure 3-15, the responsible party for an unsatisfactory performance level in Client's SLA terms can be identified by drilling down the SLA structure to reach one or more responsibility zones.

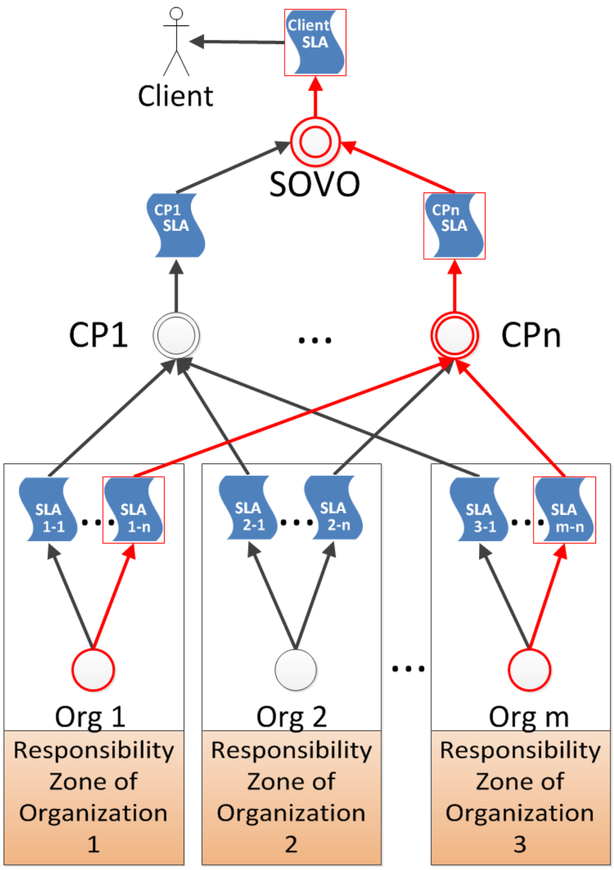


Figure 3-15: Drilling Down to Partners' Responsibility Zones

3.7 SOVO PM Procedural Framework

The structural framework can not guarantee the success of a performance measurement system by itself. Besides, we need a mechanism to plan, implement, communicate and improve the performance of VO. This mechanism characterizes a Performance Measurement System (PMS) which is defined based on specific requirements of SOVO. The processes needed to define a business PMS is classified in five main categories as follows by Franco-Santos et al. (2007):

1. Selection and design of measures
2. Collection and manipulation of data
3. Information management
4. Performance evaluation and rewarding
5. System review

ITIL V3 also provides a seven step improvement process as follows (OGC-Office of Government Commerce, 2007b):

1. Define what you should measure
2. Define what you can measure
3. Gather the data
4. Process the dada
5. Analyze the data
6. Present the information, assessment, summary, action plans, etc.
7. Implement corrective action

Benchmarking improvement process is another reference for the SOVO PM framework. The steps are as follows (Camarinha-Matos et al., 2005):

1. Plan
2. Do
3. Check
4. Act

DMAIC process to implement Six Sigma is also considered as a reference for the SOVO PM framework. The steps of this process are as follows:

1. Define

2. Measure
3. Analyze
4. Improve
5. Control

The above reference frameworks are introduced with enough details in the literature survey. Mapping these categories into SOVO environment resulted in the procedural framework shown in Figure 3-16.

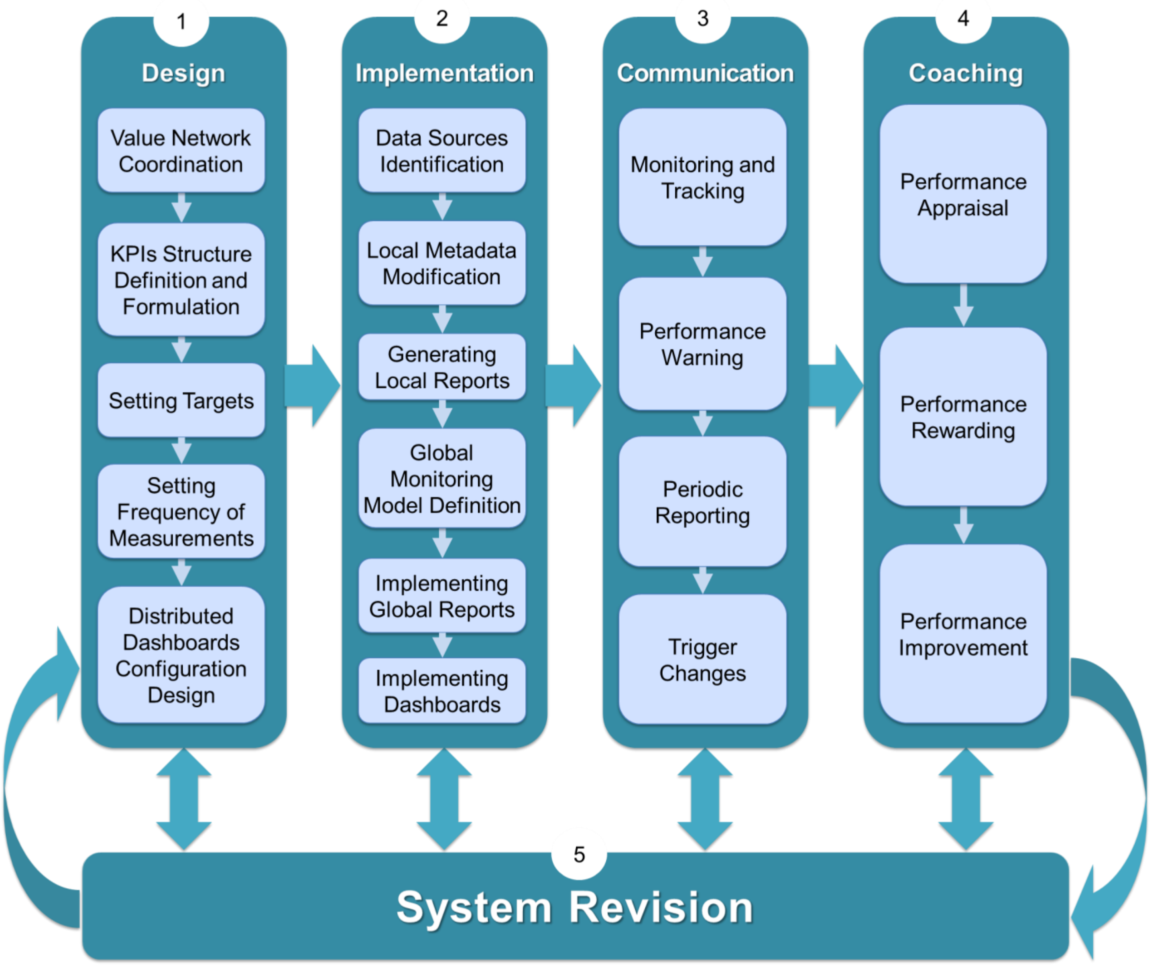


Figure 3-16: SOVO PM Procedural Framework

The following lines explain the steps within each phase of the proposed procedural framework:

1. **Design:** first phase includes identification of stakeholders' needs, coordinate partners' value proposition, designing the structure of performance indicators, setting the targets, setting the frequency of measurement, setting the responsibility

zone for each partner, and designing the configuration of the distributed dashboards.

2. **Implementation:** The second phase includes the process of capturing data from distributed sources and making them consistent and integrated. This implies establishing links between the performance data and performance indicators by implementing KPI formulations. To do that the local metadata must be modified to become consistent with VO performance measurement requirements. As such, the resulted local reports have consistent namespaces. Then the global monitoring model can be defined based on the modified local metadata. Physical implementation of dashboards will be last step of the implementation phase.

3. **Communication:** The third phase encompasses the processes of information provision, interpretation, and communication. The modules in this phase are monitoring and tracking, performance alarming, providing periodic reports, and triggering changes. In fact communication of performance information should support both pro-active and re-active commitment of the partners. Monitoring and tracking KPIs in a relatively real-time manner and providing periodic reports are means for pro-active monitoring. On the other hand performance warning (reporting specific events or out of control performance levels), and triggering changes, will facilitate re-active monitoring.

4. **Coaching:** The fourth phase includes the processes of evaluating performance and linking it to rewards in order to keep the VO on track towards the targets and support relevant improvements in operations and collaborations of the partner organizations. This includes performance appraisal, rewarding and improvement. The agreed-upon levels of performance in the most abstract layer (value network), and aggregated operational performance of VO partners can be used as a basis to reward the partner organizations, based on their success in realizing added value for the customer.

5. **Revision:** The last phase includes different review procedures to improve each and every part of the PM system. These procedures will ensure that there is a feedback loop which facilitates revision and improvement of the system. Determining the details of this phase will enable inter-organizational learning;

however this is not in the scope of this project and will be a part of potential future works. The difference between system revision and performance coaching is the target of improvement. In performance coaching the target is the processes of the partners. But the goal of system revision is to improve the performance measurement system itself, including the structure of performance indicators and the procedures required to implement, measure, monitor, and improve them.

The main focus of this research has been to provide the information basis required to perform coaching and revision. Therefore, addressing the steps within the first three phases has been the main outcome of this research.

Table 3-6 shows the equivalent modules or processes of the reference frameworks for each phase of SOVO PM procedural framework.

Table 3-6: Mapping the Procedural Framework onto Reference Frameworks

<table>
<tr><th>Phase</th><th>SOVO PM Procedural Framework</th><th>ITIL Service Improvement Process</th><th>Business Performance Measurement System</th><th>Benchmarking Improvement Process</th><th>DMAIC Process to Implement Six Sigma</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Design</td><td>Define what you should measure</td><td rowspan="2">Selection and design of measures</td><td rowspan="3">Plan</td><td rowspan="2">Define</td></tr>
<tr><td>Define what you can measure</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Implementation</td><td>Gather the data</td><td rowspan="2">Collection and manipulation of data</td><td rowspan="2">Measure</td></tr>
<tr><td>Process the dada</td><td rowspan="2">Do</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Communication</td><td>Analyze the data</td><td rowspan="2">Information management</td><td rowspan="3">Analyze</td></tr>
<tr><td rowspan="3">Present the information, assessment, summary, action plans, etc.</td><td rowspan="3">Check</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Coaching</td><td rowspan="2">Performance evaluation and rewarding</td></tr>
<tr><td>Improve</td></tr>
<tr><td>5</td><td>Revision</td><td>Implement corrective action</td><td>System review</td><td>Act</td><td>Control</td></tr>
</table>

CHAPTER 4 IMPLEMENTATION

4.1 Implementation Architecture

During the past few decades, solutions for the implementation of intra-organizational performance measurement have been addressed thoroughly in both business and academia. However this has not been the case for performance measurement in B2B collaborations. Therefore, this research provides an implementation architecture (as well as conceptual framework) to enable inter-organizational performance measurement.

This architecture has to enable collecting performance data from different data sources throughout the partners' infrastructure, re-structuring the metadata, integrating the performance data, publishing the resulted information, and enabling collaborative performance monitoring. We describe this architecture in three layers, including:

1- SOA based BPM
2- Local Performance Monitoring
3- Global Performance Monitoring

In order to implement this architecture we have used IBM products as follows:

1- IBM WebSphere Service Registry and Repository (WSRR)
2- IBM WebSphere Enterprise Service Bus
3- IBM Service Federation Management Feature Pack (SFM)
4- IBM WebSphere Application Server (WAS)
5- IBM Business Process Manager (BPM) Advance
6- IBM Business Monitor
7- IBM Cognos BI
8- IBM Cognos Framework Manager (FM)
9- IBM Cognos Transformer
10- IBM Cognos Report Studio

In the following lines we discuss the role of each of the above products in different layers of the architecture, which is shown in Figure 4-1.

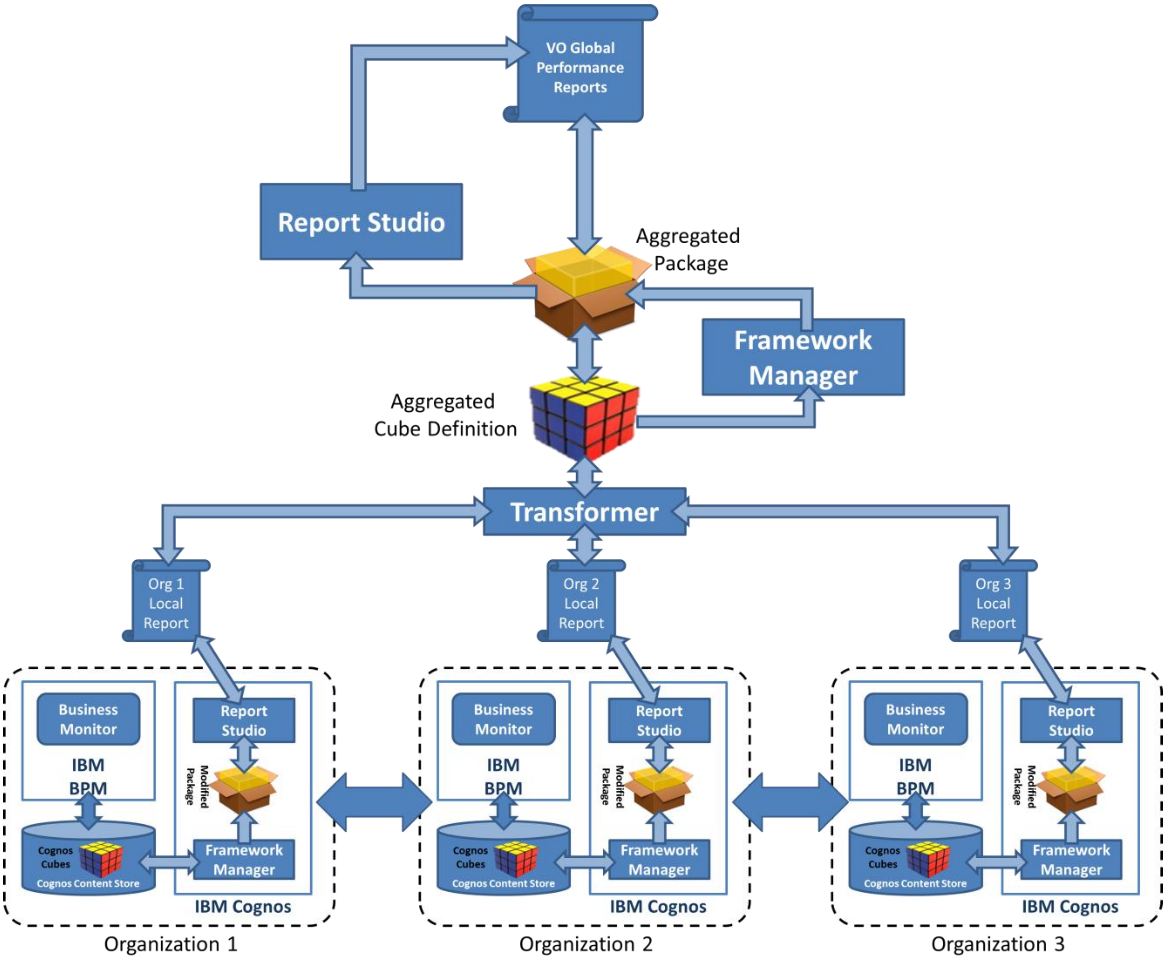


Figure 4-1: SOVO PM Implementation Architecture

4.1.1 SOA based BPM

SOA based Business Process Management (BPM) system is the base for SOVO partners operations and collaborations. This means that they can perform the assigned tasks using BPM system. However the partners have the flexibility to perform their tasks using their own infrastructure, they are still required to publish the applications as web services to facilitate integration of their services. The collaborative processes created in BPM are published as applications on Websphere Application Server (WAS). This layer of the architecture has to facilitate the integration of business process management systems of the partners, through mediation, federation, and integration of the partners' services. As such, each partner publishes its services on the web service registry and repository (WSRR). Mediation of the services to the appropriate partner is done through the federated enterprise service bus (ESB). This component facilitates integration of new composite SOA and BPM applications. It provides capabilities such as complex integration logic and adapters needed for composing and mediating services. Services published by each partner need to be accessible by specific partners, according to the topology of the SOVO. Service federation manager (SFM) which is a feature pack added to WSRR that supports sharing information and services between service domains, and handles the connectivity setup required to make services useable between domains. Although SFM is a feature pack installed on WSRR, it needs ESB installed to have a proper functionality.

This layer supports dynamic creation and operation of SOVO. The detailed specifications of this layer and the way to configure it, is out of scope of this project and is discussed thoroughly by Danesh (2012).

4.1.2 Local Performance Monitoring

The role of this layer is to monitor the performance of services and collaborative processes hosted by each partner. This job is performed by IBM Business Monitor, which is a feature pack installed on IBM BPM. This component facilitates definition of the monitor model and structure of the OLAP cube, including performance dimensions, measures, KPIs, and query subjects. Monitor model is created for each collaborative process, and is published on the WAS. This component captures the performance data, including time stamps, events, and process throughput, during the operation of BPM application. This information is published as OLAP cubes and stored as Cognos Packages in the database called Content Store. The access level for each package in the content store can be defined according to the SOVO requirements.

SOVO partners need to have a common metadata definition which enables easier integration of performance data in the next layer. As such, the metadata of each package may need to be modified to match the others. This job can be performed in framework manager (FM), by adding a presentation layer with agreed-upon namespaces to the package. Consequently, we have a set of Cognos packages with common meta-data definition.

Then an authoring tool such as Cognos Report Studio is able to create local reports according to the structure required by the SOVO authorities. The Cognos reports have real-time access to the local packages. The level of access to each report in the Cognos content store can be defined to make it accessible for external modeling tools.

4.1.3 Global Performance Monitoring

The role of this layer is to aggregate the local performance KPIs, and provide global integrated reports. Definition of the aggregated KPIs is provided in the SOVO PM Structural Framework, which includes aggregation per collaborative process and per partner. In order to perform the data integration, a standalone installation of Cognos Server and its tools including Transformer and Framework Manager is required. This installation is done on a virtual machine hosted by any of the partner organizations.

The local reports of the partners are made accessible to the modeling tools in this layer. Thus they are accessed by an instance of Cognos Transformer to define aggregated cubes. The structure of these cubes supports summarization of the KPIs according to the structural framework. The cube created in transformer is published as a Cognos package on the Content Store. This package can be further modified for representation purposes by Cognos Framework Manager. This modification includes defining new query subjects and KPIs based on the measures included in the package.

The global reports then are designed based on the modified package, using an authoring tool. Report Studio is used in our prototype to create the final reports. Access level for each of the partners to access the reports is set according to the SLA view zone specification of each partner, which is discussed in the SOVO PM Structural Framework.

CHAPTER 5 A SOVO PROTOTYPE

In order to validate the framework, we considered a scenario of a hypothetical SOVO. In this scenario there are two organizations, wireless service provider, and a cell phone provider. They want to bundle their services and provide an added-value service package to the customer, which includes a cell phone with activated wireless service. Therefore, they can provide a more cost efficient product/service that saves clients time, and makes the whole process more convenient for them. They provide the service bundle with a new brand of let's say VOWireless.

In this scenario, the client submits a request for quotation, with the specification of the cell phone and the wireless service. Each of the two partners receives the related information, process the request, and provide an aggregated quotation to the client. Then the client can submit an order based on the received quotation. The cell phone provider initiates the shipment of the cell phone with a SIM card and instructions to the customer. The wireless service provider has to activate the service upon delivery of the cell phone. So that when the client receives the order, it is ready to use.

In order to measure the collaborative performance of this partnership, first we need to model the value network and service choreography. Then we define the KPIs within three layers of the SOVO PM framework.

5.1 Modeling the Prototype: VOWireless

5.1.1 Modeling the Value Network

The value network of the collaboration between wireless service provider and cell phone provider has been mapped using E3-Value ontology. The value objects are any objects of economic value exchanged between the roles of the value network. These value objects can be of any types of product, service, money, and Information. The model is shown in Figure 5-1. The value exchanges between the roles are described in Table 5-1.

Table 5-1: Value Exchanges' Descriptions

ID	Title	Description
1	Request for Quotation	The specification of the wireless service and the cell phone provided by the client to the VO.

ID	Title	Description
2	Quotation	Quotation for the wireless service and the cell phone provided by VO to client.
3	Order	Order for the service package submitted by the client to the VO.
4	Final Service	Service package including wireless service activation and cell phone shipment initiation.
5	Request Quotation for Wireless Service	Request for quotation for wireless service issued by the VO to wireless service provider.
6	Request Quotation for Cell Phone	Request for quotation for cell phone issued by the VO to cell phone provider.
7	Quotation for Wireless Service	Quotation for wireless service provided by WS provider to the VO.
8	Quotation for Cell Phone	Quotation for CP provided by CP provider to the VO.
9	Wireless Service Order	Order for WS submitted by the VO to the WS Provider.
10	Cell Phone Order	Order for CP submitted by the VO to the CP Provider.
11	Wireless Service Activation	Activation of WS which is performed by WS provider.
12	Initiate Cell Phone Shipment	Initiation of CP shipment which is performed by CP provider.
13	Client Payment	The money that the client pays to VO for the service package.
14	VO Payment to Wireless Service Provider	The money that VO pays WS provider for WS activation.
15	VO Payment to Cell Phone Provider	The money that the VO pays CP provider for CP shipment initiation.

Current performance management solutions do not support all of the concepts and objects of value network. As such the indicators of value network analysis can not be implemented with current tool sets. The only tool that is available with this approach is E3-Value Editor. This tool has been developed as a part of E3-Value research project. We have used E3-Value Editor to model and perform feasibility analysis of the VO value network. To do so, each partner/role assigns its perceived value to the incoming value objects. The feasibility study is performed by constructing profitability sheet for each actor in the value network, as is described in Feasibility Analysis section. E3-Value tool provides the capability to assign probability to each scenario path, setting perceived values by each partner, and creating the profitability sheet in Excel.

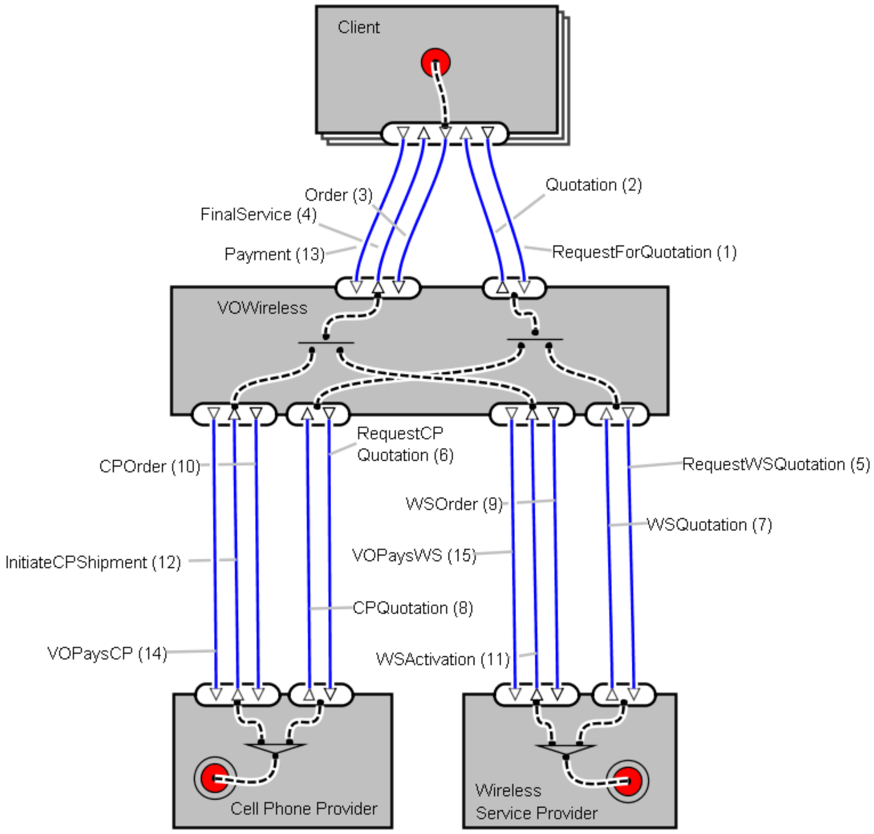


Figure 5-1: VOWireless E3-Value Model

A sample profitability sheet for the node VOWireless is shown in Table 5-2. For a value network to be feasible the balance of profitability sheet for all roles must be positive.

Table 5-2: VOWireless Profitability Sheet

Value Interface	Value Port	Value Transfer	Occurrences	Valuation	Economic Value	Total
{ClientQuotation}					-5400	
	in	RequsetForQuotation	1000	6	6000	
	out	Quotation	950	12	-11400	
{WSQuotation}					0	
	out	RequestforWSQuotation	1000	0	0	
	in	WSQuotation	990	0	0	
{WSOrderFulfillment}					-5295	
	out	WSOrder	570	0	0	
	out	VOPaysWS	542	40	-21680	
	in	WSActivation	565	29	16385	
{CPQuotation}					0	
	out	RequestforCPQuotation	1000	0	0	
	in	CPQuotation	950	0	0	
{CPOrderFulfillment}					-15718	
	in	InitiateCPShipment	542	71	38482	
	out	CPOrder	570	0	0	
	out	VOPaysCP	542	100	-54200	
{ClientOrderFulfillmer					33080	
	in	Order	570	20	11400	
	in	Payment	542	140	75880	
	out	FinalService	542	100	-54200	
INVESTMENT					700	
EXPENSES					200	
total for actor						5767

A set of assumptions are made for constructing this profitability sheet. For example the perceived value for each value object is set hypothetically. In real cases, the valuation of each value object has to be done by the related partners, because the deal should make sense from the point of view of all partners. This method enables us to find out break-even point and perform sensitivity analysis on the model. The break-even point is found by changing the number of occurrences of RequestForQuotation and see when the balances for all of the partners become positive. To perform sensitivity analysis, we increase or decrease the number of requests incrementally to see how it affects the balances.

Some of the indicators of the value network analysis are also shown in Table 5-3.

Table 5-3: Value network indicators for VOWireless case

Code	Indicator	WS Provider	CP Provider	VOWireless
V1.2	Value creation capacity per week	1250 service	850 shipment	850 service package
V2.1	Percentage of structured value delivery channels	100%	75%	93.75%
V3.4	Value network reciprocity	(2/3+3/2+3/2)/3=1.22		
V3.5	Partner's level of centrality	2	2	8
V4.1	Risk	3.46		
V4.3	Stability	3/6		

Here we provide the interpretation of the above mentioned value network indicators:

Value creation capacity: The value creation capacity shows the maximum number of product/service that can be provided in specific period of time. The capacity values are hypothetical and are shown for the sake of explanation. Value creation capacity of the wireless service provider is 47% more than cell phone provider. Whereas each service package includes equal number of wireless service and cell phone shipment, the value creation capacity of VOWireless equals the minimum capacity of the partners which is 850 service packages. This means that the CP provider is a bottleneck in this value network. This information can be used to suggest a solution to maximize value creation capacity of the network. Two solutions for example could be increasing the capacity of

CP provider or adding another CP provider to the network to activate the unused capacity of WS provider.

Percentage of structured value delivery channels: This percentage shows the percentage of structured (technology supported) channels of value delivery. In this example physical shipment of product is considered as unstructured channel. Higher levels of this indicator show more reliability of the value creation of each partner, because the unstructured value channels are at more risk of failure or disruption. The corrective action could be to provide tracking system for the shipment, to minimize the likelihood of failure.

Value network reciprocity: The ideal value of network reciprocity is one, which indicates a perfect balance between incoming and outgoing value objects for each partner. This value for the whole value network is 1.22, which indicates a good level of reciprocity. However, this can be still decreased to improve the network reciprocity.

Partner's level of centrality: This value shows the number of outgoing values per each partner. Apparently, VOWireless has the highest level of centrality, which indicates high level of importance for this entity in the VO. Since the VO collaborative processes are defined through the central entity of VOWireless, this value makes a perfect sense.

Risk: This value is calculated by the standard deviation of the level of centrality for all entities. The high level of variation of network centrality (3.46) shows that the value creation is highly dependent on some of the entities, comparing to the others. This variation of dependency on partners is a good indicator of the risk associated to the network.

Stability: The stability is revealed by network density. Therefore, stability is calculated by dividing the actual to the potential number of transactions in the network. In VOWireless case, potentially there could be other transactions between WS provider and Client, CP provider and Client, and WS provider and CP provider. So the maximum potential number of transactions is six, which is not exhausted by the current three transactions. This means that the network could be more stable if more connections between partners existed.

5.1.2 Modeling the Service Choreography

In the next step, transformation of the value network model to operational business processes is performed. To do so, the choreography model is derived from value network using the method discussed in the structural framework. The steps of this transformation are discussed below:

1- We assign an ID to each value exchange. These IDs are shown in Table 5-1. So we define a set of value exchanges with 12 members as V= $\{v_1, v_2, \dots, v_{12}\}$.

2- At the next step the dependency matrix (M) must be formed. In the presented matrix v_i's are values of the set V. p_{ij} is 1 if v_j has a dependency on v_i in a sense that v_j cannot be performed as it should, unless v_i is performed otherwise p_{ij} is 0.

$$M = \begin{array}{c} \\ v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \\ v_7 \\ v_8 \\ v_9 \\ v_{10} \\ v_{11} \\ v_{12} \\ v_{13} \\ v_{14} \\ v_{15} \end{array} \begin{array}{c} \begin{array}{ccccccccccccccc} v_1 & v_2 & v_3 & v_4 & v_5 & v_6 & v_7 & v_8 & v_9 & v_{10} & v_{11} & v_{12} & v_{13} & v_{14} & v_{15} \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

3- For each value in V, count its successive values (SV_i). For example for value exchange number 3 we have:

$$SV_3 = \sum_{k=1}^{15} p_{3,k} = p_{3,9} + p_{3,10} + p_{3,13} = 3$$

4- For each value in V, Calculate its depth of influence (DF_i) which is equal to the following formula. Note the best way to calculate this formula is to start from the values with $SV_i = 0$. For example for value exchange number 3 we have :

$$DF_3 = SV_3 + \sum_{j=0}^{n} DF_j \text{ ; } where\ p_{i,j}\ in\ matrix\ M\ is\ equal\ to\ 1$$

$$DF_3 = SV_3 + DF_9 + DF_{10} + DF_{13} = 3 + 2 + 2 + 6 = 13$$

Figure 5-2 shows the dependency of the value exchanges. Numbers inside the circles represent the ID of the value exchange, and the green number above each node is the depth of influence for that value exchange. According to the descending order of DF_i's, the red numbers on the edges of the graph represents the sequence in which the service choreography is modeled.

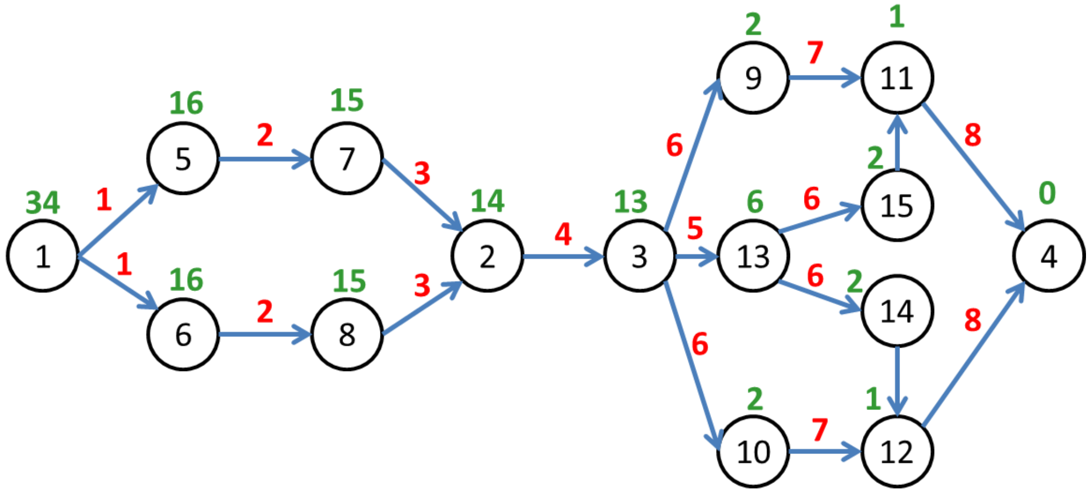


Figure 5-2: Value Dependency Graph

5- Rank the value exchanges in descending order of DF_i

6- Start modeling service choreography from the value exchange with the maximum DF_i .

7- Remove the modeled value exchange from the graph.

8- Repeat step 5 until all value exchanges are modeled.

The resulted service choreography model is shown in Figure 5-3.

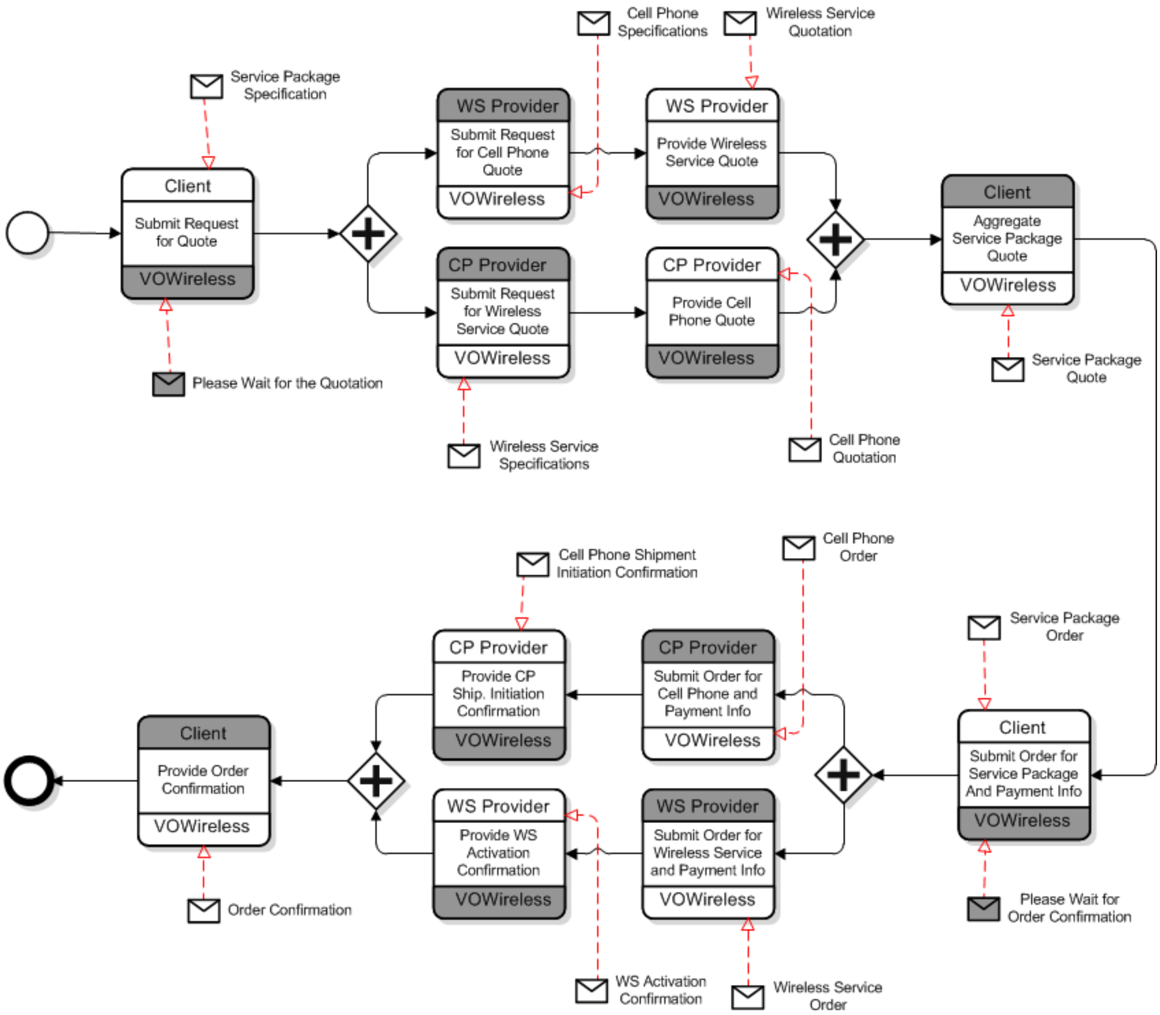


Figure 5-3: VOWireless Service Choreography Model

Note that the above choreography model may not be the only solution. In fact, the goal of the proposed method is to make sure that the choreography model and business processes are aligned with the value network.

5.1.3 Modeling the Performance Indicators

After identifying the value network, choreography model, and business processes, we define the multi-level SLA structure of the VOWireless according to the guidelines of ITIL V3.

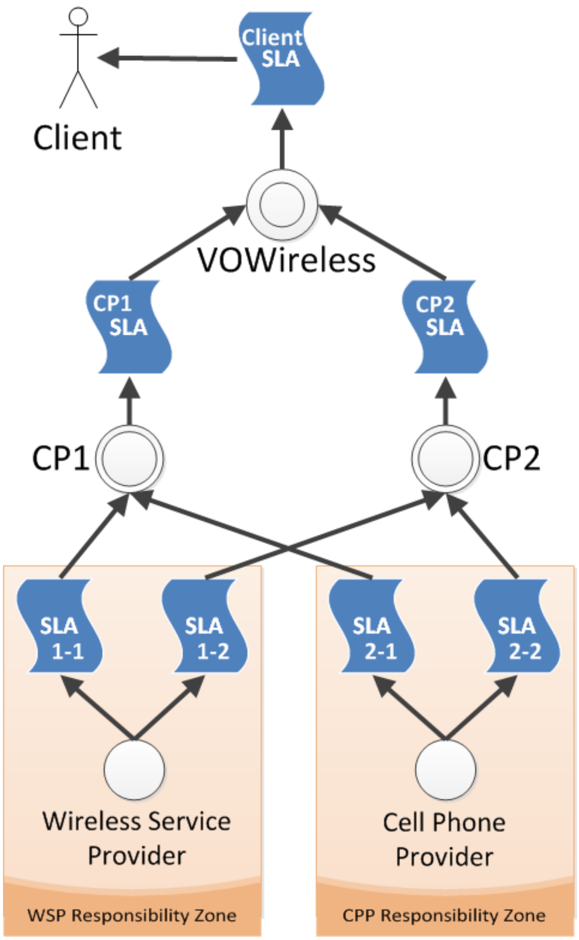


Figure 5-4: SLA Aggregation for VOWireless

The terms of the SLAs have to be negotiated and documented accordingly. The terms for each SLA shown in Figure 5-4 have been identified using the SOVO PM Structural Framework. The SLAs in the figure document the terms of the services as follows:

- SLA1-1: The quotation service provided by WS Provider.
- SLA1-2: The order fulfillment service provided by WS Provider.
- SLA2-1: The quotation service provided by CP Provider.
- SLA2-2: The order fulfillment service provided by CP Provider.
- CP1-SLA: The aggregated quotation service provided by collaborative process 1.

- CP2-SLA: The aggregated order fulfillment service provided by collaborative process 2.
- Client-SLA: The final service provided by VOWireless to the Client.

The partners have to create and publish reports, for each service and collaborative process, using any authoring tool. In this case we used Cognos Report Studio. Each record of the reports represents an instance of the process or service that has been instantiated. Each service report must follow the structure shown in Table 5-4.

Table 5-4: Structure of the Services Local Reports

Instance _ID	Service Provider_ID	ParentProcess Instance_ID	AV1.1	RS1.1	RL1.1	RL1.2	RL1.3	RL1.4	RL1.5

Each collaborative process has two categories of KPIs. One category includes the aggregated KPIs of the underlying services' KPIs. The other category includes the KPIs of the collaborative process itself. Per each collaborative process, a report must be published including the second category of KPIs, which information is not available in the underlying services reports. These reports must follow the structure shown in Table 5-5.

Table 5-5: Structure of the CP Local Reports

CPInstance_ID	ServiceProvider_ID	AV2.n	RS2.n	RL2.n	FL2.n	PC2.n	RC2.n

The aggregation of services and collaborative processes' KPIs in the higher layers (per partner and per the whole VO) is implemented using OLAP Cubes. Here the dimensions and measures of the OLAP Cube are designed. Dimensions can be a variety of different query subjects that are used to summarize the measures of the reports, as is shown in Figure 5-5.

In order to reflect the structure of multi-layer processes and services, a category of dimensions are designed called *Structural Dimensions*. These dimensions enable us to drill-down the reports from higher layers of the processes to the lower ones, to the process instance. That is the reason we have included *ParentProcess_InstanceID* and *ServiceProvider_ID* in the records of each process/service.

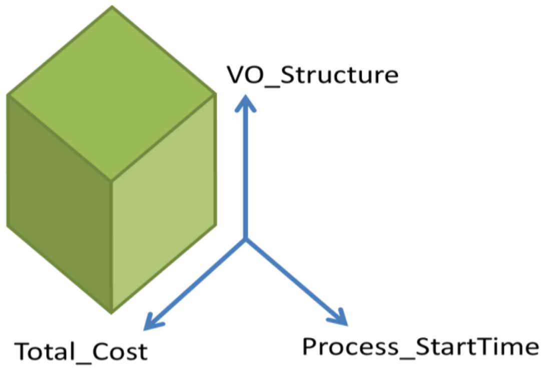


Figure 5-5: Aggregated Cube Sample Dimensions

Figure 5-6 shows the sub-dimensions design specification of the *Process Structure* dimension that aggregates the performance information based on different layers of processes. This design enables VO partners to evaluate the overall performance of each collaborative process specifically. As such, *Collaborative Process* is the highest level of this dimension design. Therefore, the sequence of sub-dimensions would be: *VO*, *Collaborative Process*, *Service*, and *Service Instance*.

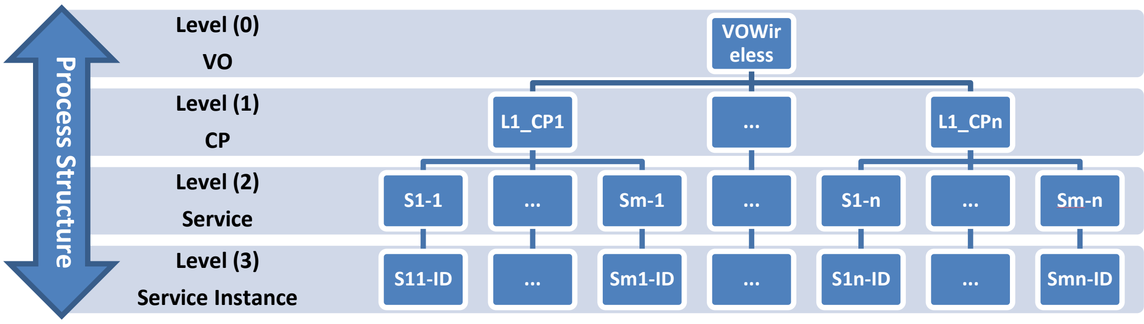


Figure 5-6: Sub-levels of Process Structure Dimension in the Aggregated Cube

Another goal of the structural dimensions is to aggregate the KPIs by partners, in order to enable evaluation of their contributions. To satisfy this need, another structural dimension is required which is called *Process Owner*. This dimension aggregates the performance information based on the VO partners. This enables identification of the responsible parties for each unsatisfactory performance level.

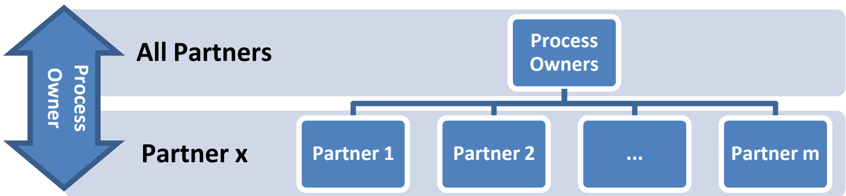


Figure 5-7: Sub-levels of Process Owner Dimension in the Aggregated Cube

The *Process Structure* dimension along with the *Process Owner* dimension enables implementation of the multi-level SLA structure. The aggregation logics are defined by the role-up functions for each performance measure specifically. As such, the VO partners are able to drill down the KPIs through the VO structure and find the root cause of each unsatisfactory performance level, in either VO process structure or process owner.

5.2 The Prototype in Action

We use IBM BPM process designer to implement the collaborative processes. Figure 5-8 and Figure 5-9 show the collaborative processes implemented in BPM Process Designer.

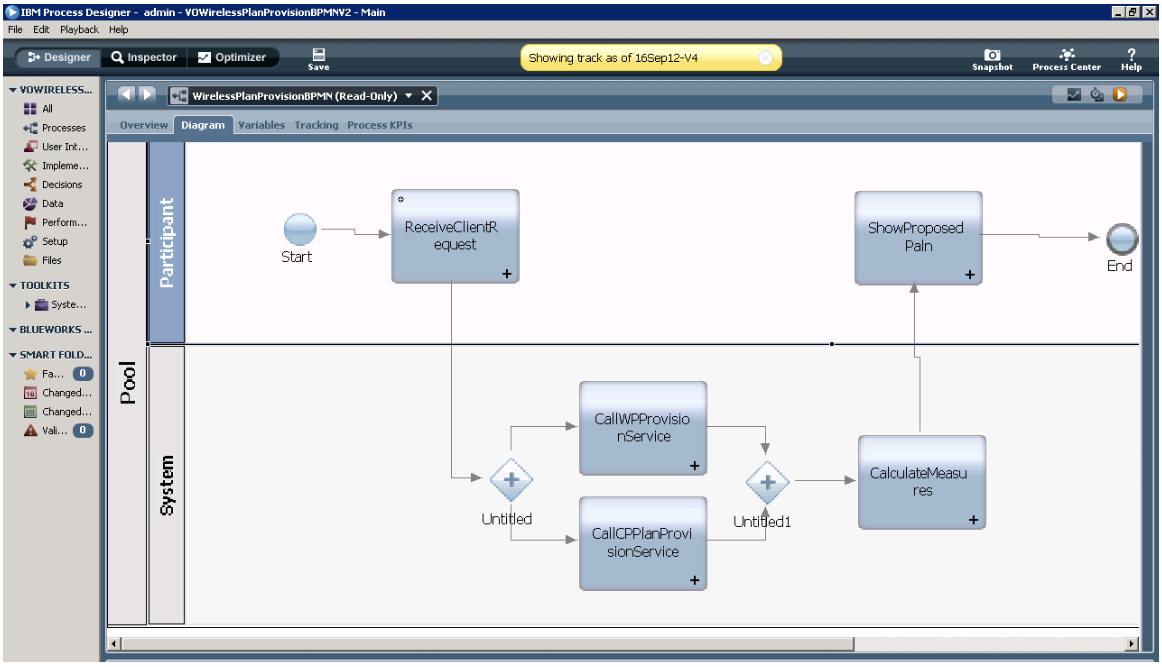


Figure 5-8: Quotation Collaborative Process

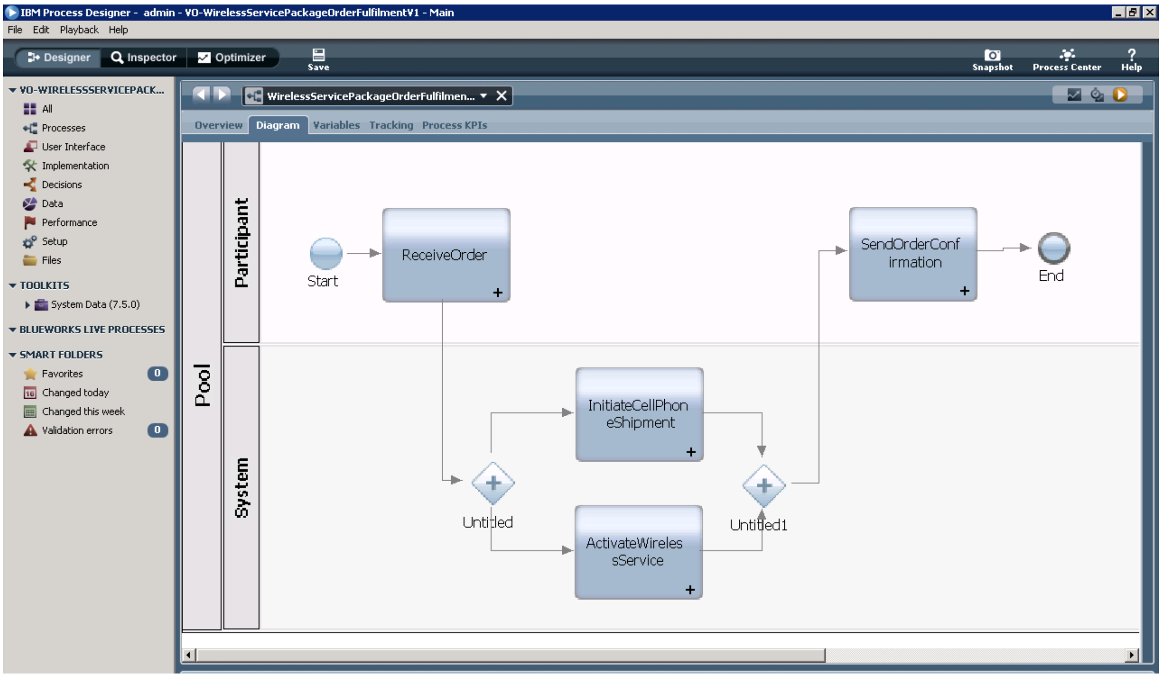


Figure 5-9: Order Fulfillment Collaborative Process

Integration of the collaborative processes with the underlying services of the partners is done in BPM Integration designer. As such, the services of the partners are published as web services. The VOWireless Collaborative Process has access to the WSDL interfaces and imports them into BPM Integration Designer. Figure 5-10 shows a sample of service provider side integration assembly diagram. The VO side assembly diagram is also shown in Figure 5-11.

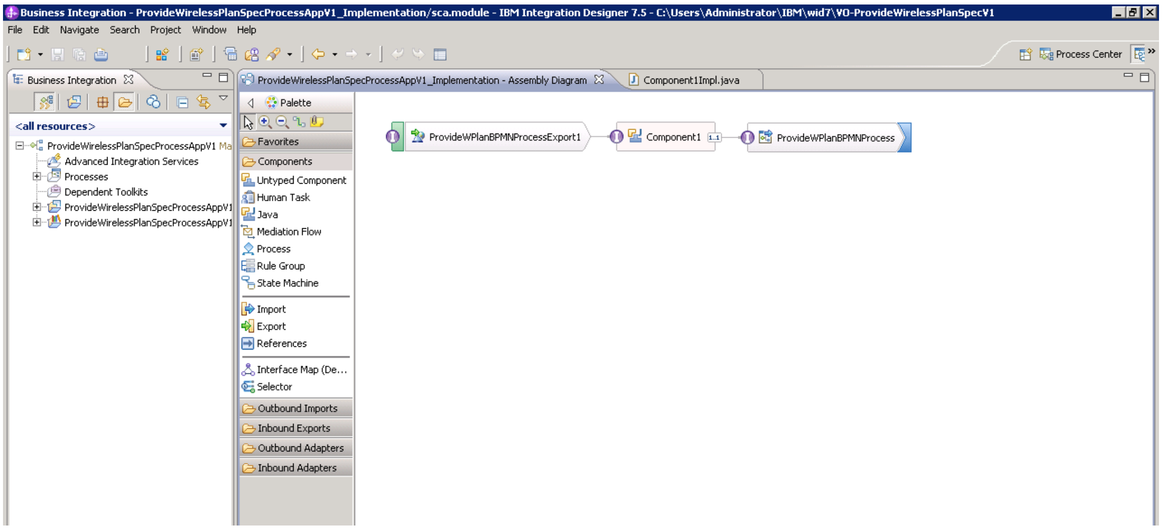


Figure 5-10: Service integration assembly diagram on service provider side

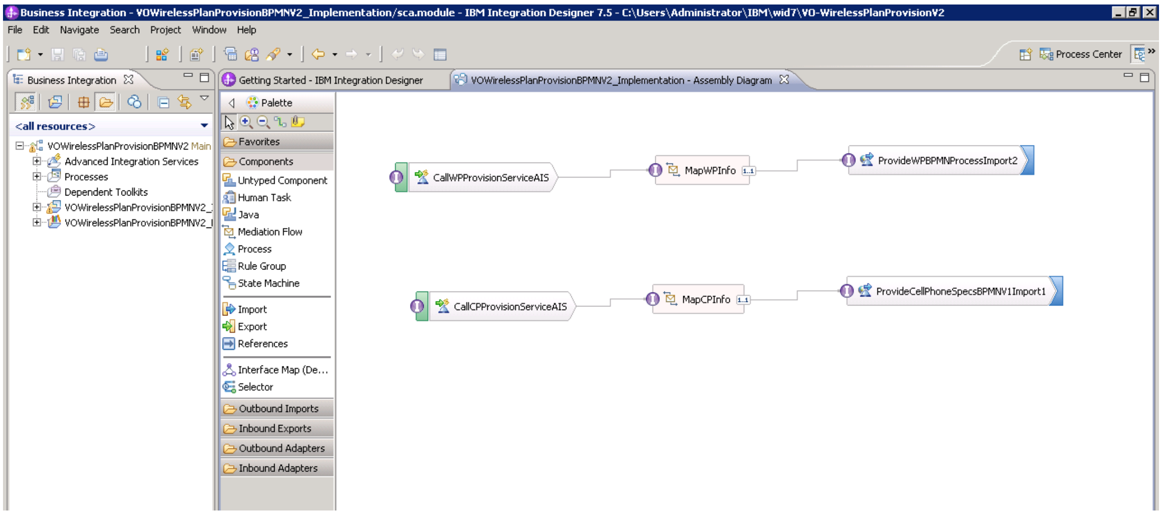


Figure 5-11: Service integration assembly diagram on VO side

After implementing and integrating the collaborative process and the underlying services, monitor models are generated using IBM Business Monitor. These models include the definition of the dimensions, sub-dimensions, measures, events, and KPIs associated with each process. The monitor model must be published as an application on the IBM Web Application Server. This application listens to the events inside each process application and captures the information defined in the monitor model project. Figure 5-12 and Figure 5-13 show the monitor model components of KPI model and dimensional model. The KPI model is used to define and formulate the KPIs, and set the control limits for each. The structure of the cube including dimensions, sub-dimensions, and measures are designed and modified in dimensional model. After publishing the monitor model, Cognos cubes are generated automatically and published as Packages on the Cognos Content Store (In this case implemented using DB2 express).

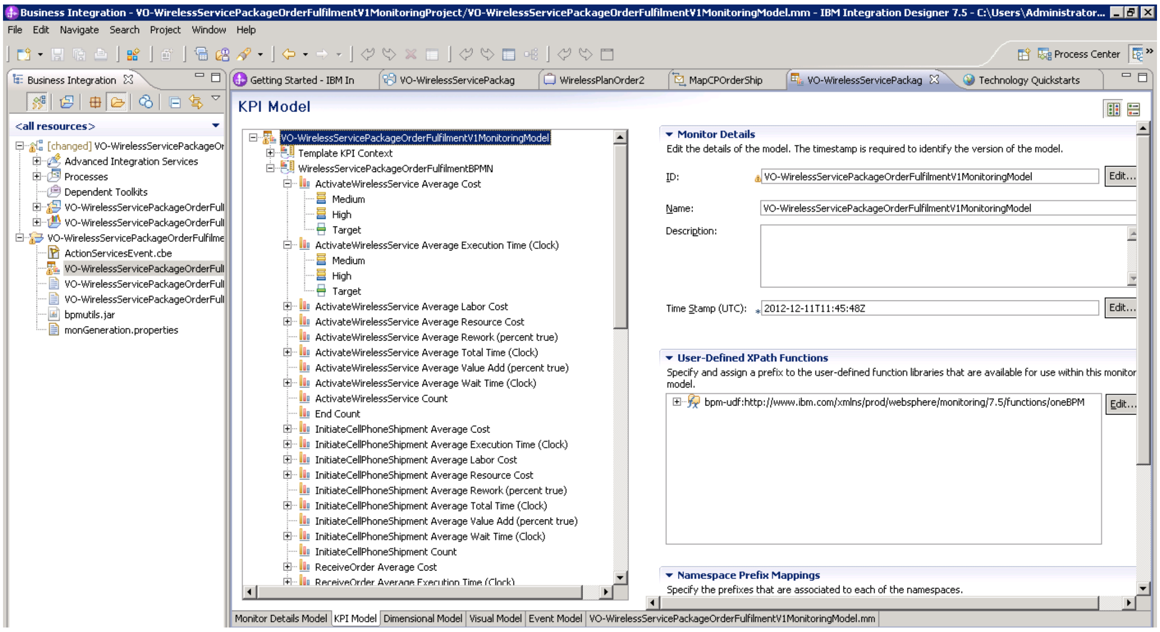


Figure 5-12: Business Monitor KPI Model

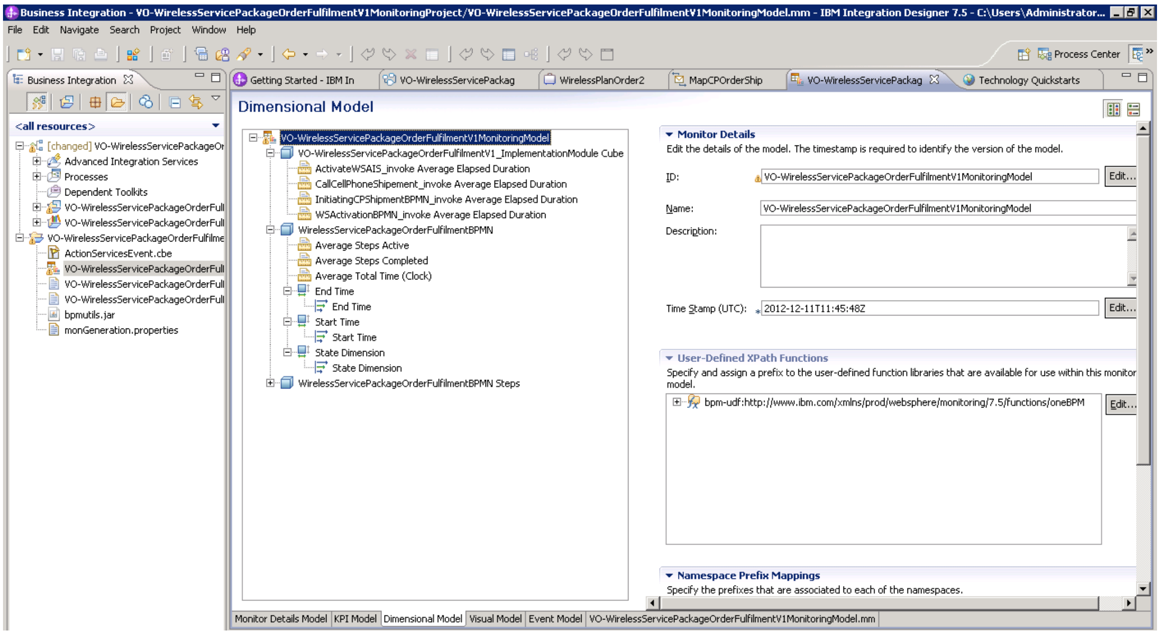


Figure 5-13: Business Monitor Dimensional Model

The metadata of the stored packages then can be modified if needed, using Cognos Framework Manager, to follow common namespaces in the VO. This is required to enable integration of performance information. To do so, a presentation model (also called presentation layer) is created from the original model (called native layer) of the package. The new package then is published on the content store. Figure 5-14 shows the Cognos package in framework manager environment including the presentation layer.

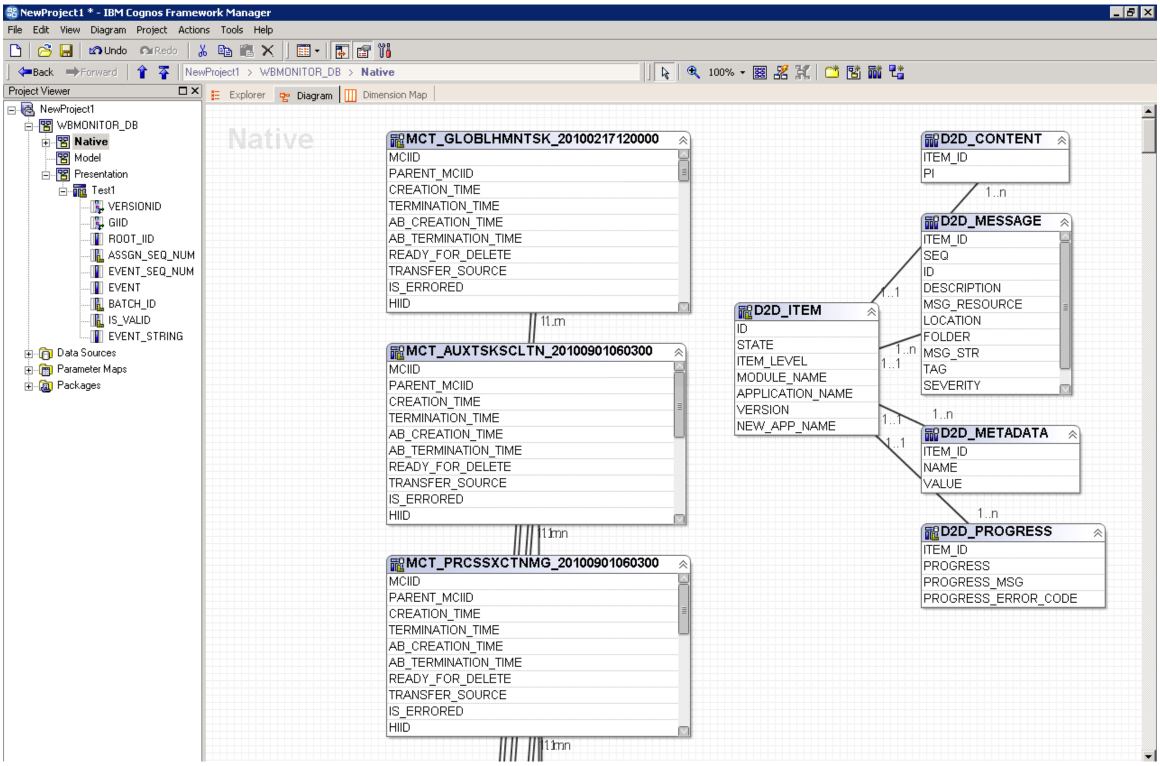


Figure 5-14: Adding Presentation Model to the Package in Framework Manager

The local reports are designed using Cognos Report Studio, and stored in a common directory that the Cognos Server has access to. The reports are published, with an agreed-upon frequency, as CSV files to a directory in the Cognos Server environment. The aggregated Cognos Cubes are designed and published as packages using Transformer, according to the SOVO PM Structural Framework. Figure 5-15 shows the cube definition in Cognos Transformer environment.

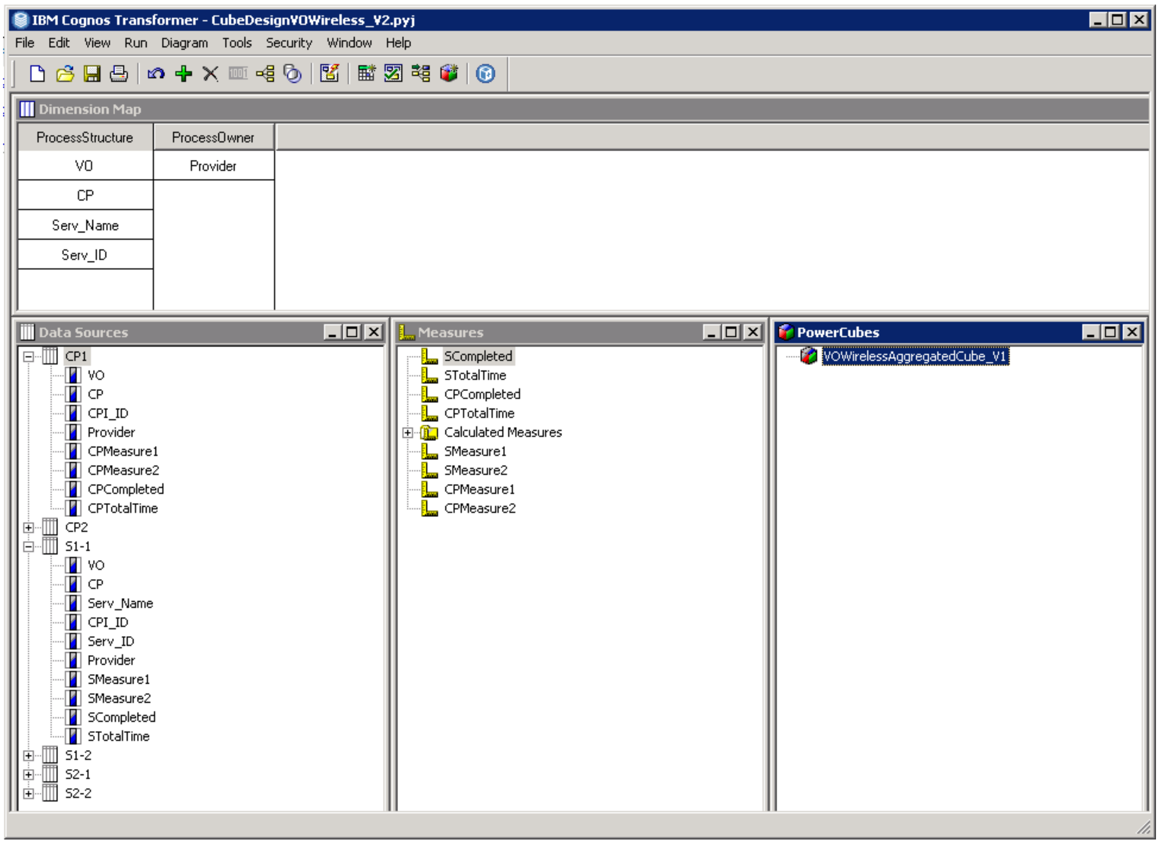


Figure 5-15: Cube definition in Cognos Transformer

This cube is being repopulated and republished with the frequency in which the local reports are being generated. This frequency depends on the requirement of the SOVO partners, and available resources. In this case, we set the refresh frequency to 30 minutes. As such, the partners republish the local reports to the common directory with the same frequency. This frequency can be reduced by the use of more computing resources.

Various authoring tools can be used to create reports, charts, and dashboards, based on the published Cognos package. We have used Cognos Report Studio to design reports with drill down/up capability. Figure 5-16 shows drilling down process for a sample chart showing *Service Availability* KPI.

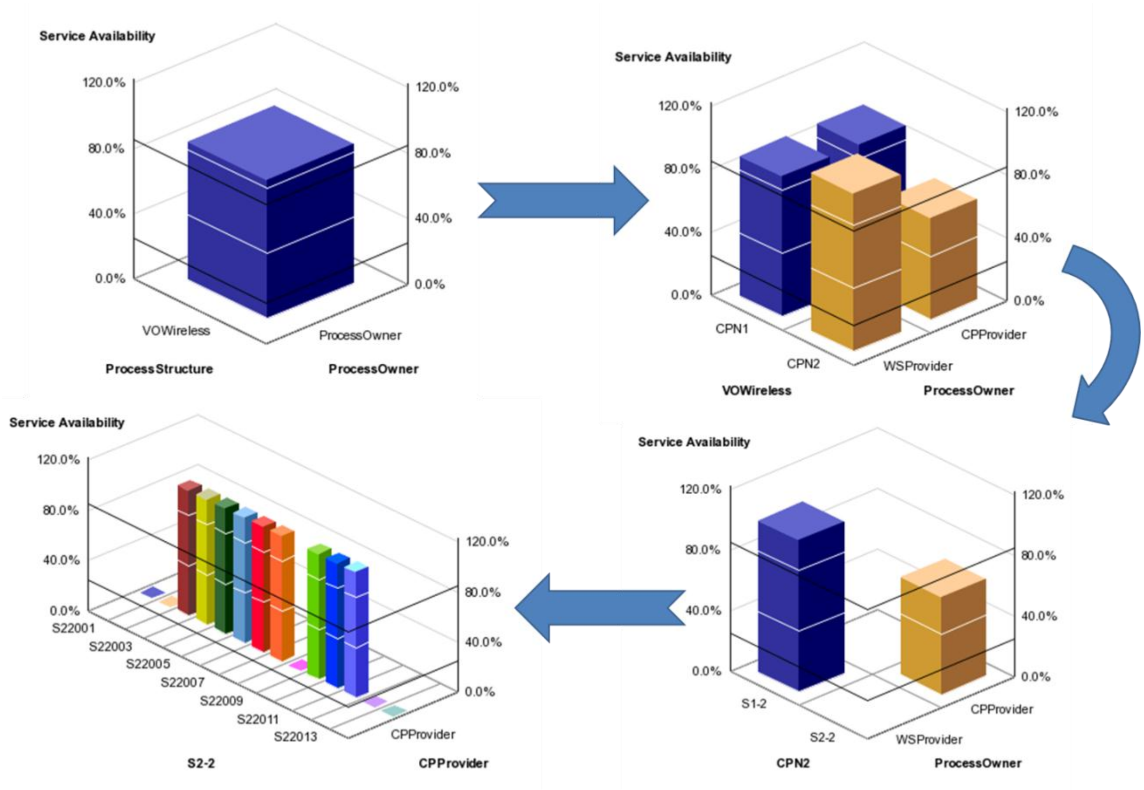


Figure 5-16: Drill-down through Structural Dimensions for Service Availability Chart

Cognos Server supports authentication mechanisms in different levels of Content Store and Cognos objects. Therefore the access of partners can be defined for specific tables in the database, or for specific objects in Cognos Content Manager (packages, reports, charts, dashboards, etc.).

5.3 Analysis and validation of the Proposed Framework and Implementation Architecture

The proposed framework and implementation architecture is evaluated based on the implemented prototype, according to the set of criteria defined in Table 5-6. This table includes breakdown of the main concept construct, to the operational concepts, their required properties criteria, and the mechanisms or solutions proposed to meet the criteria.

Strategic alignment of partners in CNOs generally, and VOs specifically, is one of the most important challenges in managing such alliances. The proposed PM framework addresses this important issue through coordination of partners' value creation network. Consequently, partner's values will be compatible following a common goal, i.e. providing value-added services to the customer. The proposed solution must provide the capability to evaluate the feasibility of the business scenario. This is done by the use of profitability sheet as a feasibility analysis tool. This method proves the effectiveness of the VN. But the efficiency of the VN is evaluated by the use of value network analysis indicators.

The core characteristic of a VO is collaboration between the partners. This implies challenges including different measurement logics of the partners, for the collaborative processes. The way to tackle this issue is to define common performance indicators to measure partnership effectiveness and efficiency. The proposed framework also addresses interdependencies among partners' services by mapping the collaboration performance on the service choreography model. Performance management in collaborative environments implies the need for decentralized performance measurement and monitoring. This need has been answered by integration of local performance information into the aggregated OLAP cube, and providing monitoring capabilities over the aggregated cube.

The mutual trust between partners is enabled by providing transparency at an agreed-upon level, through definition of SLA views. The main characteristic of business collaborations is commitment of the partners. This is evaluated from both pro-active and reactive aspects by predefined KPIs. The dynamic nature and rapid changes of VO, calls for flexibility. These changes can be handled based on their scope by referring to the related layer of the performance structure. Evaluation of collaboration's flexibility is also enabled by definition of flexibility KPIs.

The ultimate goal of a performance measurement solution is to derive improvements in the VO in a distributed manner. This implies traceability of the unsatisfactory levels of SLA terms, which is enabled by the use of drill-down capability over the SLA aggregation patterns. Improvement action plans are supported by the identification of responsible parties, through definition of the responsibility zone for each partner. Finally the agility of performance improvement can be guaranteed by real-time monitoring. This requirement has been met to an acceptable extent, by the proposed implementation architecture.

Table 5-6: SOVO PM Framework Success Criteria

<table>
<tr><th>Concepts Construct</th><th>Operational Concepts</th><th>Properties</th><th>Criteria</th><th>Proposed Mechanism/ Solution</th></tr>
<tr><td rowspan="12">Inter-Organizational Performance Measurement</td><td rowspan="4">Strategic coordination</td><td>Goal consistency</td><td>Value proposition alignment</td><td>E3-Value model</td></tr>
<tr><td>Feasibility</td><td>Providing feasibility analysis method</td><td>Profitability Sheet</td></tr>
<tr><td rowspan="2">Strategic alignment efficiency</td><td>Value network analysis</td><td>VNA indicators</td></tr>
<tr><td>Customer centric measurement</td><td>Multi-layer SLA structure</td></tr>
<tr><td rowspan="8">Collaboration</td><td>Common measurement logics</td><td>Common KPI formulation</td><td>Providing definition of collaboration KPIs</td></tr>
<tr><td rowspan="4">Joint Processes</td><td rowspan="3">Process inter-operability</td><td>Define availability KPIs</td></tr>
<tr><td>Define responsiveness KPIs</td></tr>
<tr><td>Define reliability KPIs</td></tr>
<tr><td>Interdependencies among partners’ services</td><td>BPMN service choreography model</td></tr>
<tr><td rowspan="2">Decentralized PM (Partners’ Autonomy)</td><td>Distributed measurement</td><td>Integrate global and local performance measurement</td></tr>
<tr><td>Distributed monitoring</td><td>Dishoarding over the aggregated OLAP cube</td></tr>
</table>

Concepts Construct	**Operational Concepts**	**Properties**	**Criteria**	**Proposed Mechanism/ Solution**
		Mutual trust	Providing transparency at an agreed- upon level	Defining SLA view zones
		Commitment	Support both pro-active and re-active aspects	Define pro-active and re-active commitment KPIs
		Flexibility	Evaluate effort needed for change	Define flexibility KPIs
	Performance Improvement	Integrity of performance structure	Traceability of root causes of unsatisfactory performance levels	Drill through the multi-layer SLA structure
		Supporting improvement action plans	Identify authority of change	Definition of responsibility zones of the partners
		Providing Agile improvement	Real-time performance monitoring	Inter-organizational performance monitoring implementation architecture

5.4 Observations and Recommendations

In this research IBM products are used to implement the VO prototype services, processes, monitoring models, OLAP cubes, and dashboards. In this procedure we faced some obstacles in the way. This was mainly due to the complex nature of collaborative environments and specific requirements of virtual organizations. The standard modeling tools are usually developed to address the problems within single organizations. Cognos performance modeling tools have the same limitations when it comes to collaborative environments.

The point is that each Cognos BI instance and its incorporating tools (e.g. Framework Manager, Transformer, etc.) are designed to be configured to access only one Content Store at a time. So when we need to access multiple Content Stores (in this case each Content Store belongs to one VO partner), we have to change the Cognos configuration. But there is always a high level of risk associated with changing the configuration of Cognos when the server is up and running. So for the safety considerations, this implies turning the Cognos Server off before any changes are made to the configuration, and turning it back on after the changes are applied. Although this procedure of toggling between multiple content stores can be handled by the use of few lines of codes in a batch file, this is not a standard way of using the products and the high risk of crashing the server still remains.

This issue was handled by the definition of required structure of local reports and the way to incorporate them in the aggregated cube using Cognos Transformer. Although this method works well, it creates some limitations for real-time monitoring. As described in implementation architecture, the local reports have to be re-published with an agreed-upon frequency, and the Transformer can only re-generate the cube with the same frequency. In practice, this time between repopulating the cubes can be decreased only to the extent that the resources allow.

In order to enable more real-time inter-organizational performance monitoring, we recommend that the Cognos modeling tools should be allowed to access more than one Content Store at a time. The level of access in the target Content Stores can be restricted for the modeling tools to packages that are created specifically for the VO.

CHAPTER 6 CONCLUSIONS

6.1 A Summary of the Research

To keep pace with the growth of global economy and the intense hyper-competition, organizations, especially SMEs, tend to form strategic alliances to better deliver value to customers. These alliances, formed with the main purpose of collaborative value creation, have evolved to form today's well known Virtual Organizations.

The current literature on performance measurement has not addressed inter-organizational relationships in much detail. Therefore, the need to conceptualize such interactions exists. This research focuses on meeting this demand, and providing a base for aligning VO partners at their strategic layers, as well as their operational activities. As such, we proposed a consolidated framework for performance measurement in service oriented virtual organizations. This includes a structural and a procedural component.

The structural component of the framework defines virtual organization's performance indicators in three layers of value network, collaborative processes, and underlying services. Our work on value network analysis, along with collaborative performance measurement in service choreography layer and SLA aggregation pattern, enables such a pervasive multi-level alignment within a VO.

The procedural component provides a step-by-step procedure for constructing the process structure of VO, designing the KPIs, implementing the solution, monitoring the performance, and deriving improvements. In the infrastructure layer, service oriented architecture is used to maintain agility and scalability of partner's collaboration, and at the same time, provide an agreed upon level of privacy and security. The conceptual framework along with the proposed implementation architecture enables distributed performance management and business intelligence capabilities in collaborative environments.

6.2 Contributions of the Thesis

In order to provide a consolidated framework, the relationships between the layers were identified. This includes deriving service choreography model, and SLA aggregation pattern from the value network. We designed a method to perform the extraction of service choreography from value network. This method is validated by various prototype implementations.

The SLA aggregation pattern is modified with respect to ITIL V3 guidelines, to support the concept of drilling down through the multi-level SLA structure. We have also defined responsibility zone that supplements the SLA aggregation pattern, with identification of the responsible parties for each out of threshold SLA term.

Current studies on virtual organizations do not provide concrete definitions for KPIs. Therefore, we needed to define and formulate them based on VO's needs. In order to do so, basic definition of performance indicators are derived from the richest studies and best practices in the related fields (such as E3-Value, ValueNet, SCOR, ECOLEAD, and ITIL), and customized to meet the specific requirements of service oriented virtual organizations the best. The result was the definition of consistent KPIs in the three layers of value network, collaborative processes, and services.

From an implementation point of view, the current performance measurement solutions mainly support the scope of a single organization, which do not cover inter-organizational relationships. Therefore we proposed implementation architecture that enables collaborative performance measurement and monitoring. This architecture is implemented in KDD lab, by using IBM tools for performance management. The proposed architecture integrates performance information from different data sources into aggregated OLAP cubes. We designed the cube dimensions and measures, considering the structure of the collaborative processes and services of the VO, in a way that supports summarization of information based on the structure. This structure enables drilling up/down capabilities through the process breakdown structure.

6.3 Publications Resulted from This Research

The resulted posters, conference papers, and journal articles are as follows:

1) M. H. Danesh, S.M.Amin Kamali, B. Raahemi, and G. Richards, "A Service Oriented Framework for Distributed Business Process Management in Virtual Organizations", Poster presentation in IBM Research Café 2011
2) M. H. Danesh, S.M.Amin Kamali, B. Raahemi, and G. Richards, "A Distributed Infrastructure for Business Process and Performance Management in Virtual Organizations", Poster presentation in CASCON2011

3) M. H. Danesh, B. Raahemi, and S.M.Amin Kamali, “A framework for process management in service oriented virtual organizations,” in 2011 7th International Conference on Next Generation Web Services Practices (NWeSP), 2011, pp. 12 -17.
4) M. H. Danesh, B. Raahemi, S.M.Amin Kamali, G. Richards, “A Distributed Service Oriented Infrastructure for Business Process Management in Virtual Organizations”, IEEE 25th Canadian Conf. on Electrical and Computer Engineering, Montreal, Canada, May 2012.
5) S.M.Amin Kamali, G. Richards, M. H. Danesh, and B. Raahemi, “A Framework for Performance Measurement in Service Oriented Virtual Organizations - A Value Network Approach to Collaborative Performance Measurement,” in SciTePress, Rome, Italy, 2012, pp. 263 - 271.
6) M. H. Danesh, B. Raahemi, S.M.Amin Kamali, and G. Richards, “A Framework for Process and Performance Management in Service Oriented Virtual Organizations,” IJCISIM, vol. 5, pp. 203 -215, 2013.
7) S.M.Amin Kamali, Bijan Raahemi, Greg Richards, Mohammad Hossein Danesh, Soroosh Sharif, Waeal Jomma, Steve Smith, “Proposed Implementation Architecture: Inter-Organizational Performance Measurement”, Poster presentation in IBM Research Café 2012
8) S.M.Amin Kamali, Bijan Raahemi, Greg Richards, Mohammad Hossein Danesh, Soroosh Sharif, Waeal Jomma, Steve Smith, “Implementation Architecture and Methodology for Collaborative Performance Measurement in Service Oriented Virtual Organizations”, Poster presentation in CASCON2012

6.4 Limitations and Future Works

Some limitations have restricted the scope of the theoretical works and practical implementations of this research. One of the characteristics that make this work unique is hiring the concepts of value creation network, to explain and evaluate the collaboration of VO partners in a big picture. The notion of value network is quite new and was first adopted in late 1990s by S.A. Armstrong Company (Allee and Schwabe, 2011). This modeling approach has been used mostly for strategic planning, and the potentials for linking to the operational performance have not been investigated enough. As a result, the current performance management tools do not support the notations of value networks to an acceptable extent. This fact restricts our degree of freedom for implementing the value network indicators in practical cases. However these limitations has not prevented us to investigate the field in this research; the doors remain open for future works for hiring value networks indicators in more operational manners.

From an implementation architecture point of view, the current PM tools follow a traditional mindset that restricts the performance measurement within the boundaries of one organization. This approach has made most of the solutions incapable of breaking the boundaries and targeting multiple data sources. For instance the IBM Cognos tools can only be configured to access one Content Store (Cognos database) at a time. This limitation decreases our ability to perform real-time monitoring, as we need to add one layer of local performance data to be integrated and published as aggregated cubes. Therefore, the improvement in the current solutions to overcome this limitation will enable more real-time collaborative PM.

These limitations apply not only to the IBM BI product (Cognos BI), but also to other solutions with the traditional performance measurement mindset. This mindset restricts the monitoring to the boundaries of one organization, and also does not support new concepts such as value networks. Therefore, the discussed limitations do not seem to be limited to the IBM products we employed in this thesis. Other BI solutions (preferably open source ones) can be studied to identify the best candidates with the most required capabilities.

This research works as an enabler for a diverse set of potential research. The use of SOVO concepts in different fields of public and private sector still remains to be investigated more. This will generate different versions of SOVO framework specifically designed for various industries. As an instance, a research for customization of SOVO, based on the specific requirements of healthcare industry, is currently being conducted in KDD-lab. The potentials of adopting SOVO in aviation industry are also studied in an internship project performed jointly by IBM CBAP and Navigation Canada.

Another field of research which is enabled by SOVO framework is in operations management area. The proposed conceptual framework and infrastructure can be modified to be used as a simulation tool, to examine different operational plans and find the optimized configurations for specific cases (e.g. Supply Chains). These studies can be expanded to examine the use of SOVO framework for implementation of MRP/ERP systems.

APPENDICES

Appendix A: Service Level Agreement (SLA – Sample)

This sample is derived from ITIL Service Design book (OGC-Office of Government Commerce, 2007a).

This agreement is made between...and

....

The agreement covers the provision and support of the ABC services which..... (Brief service description)

This agreement remains valid for 12 months from the (date) until (date). The agreement will be reviewed annually. Minor changes may be recorded on the form at the end of the agreement, providing they are mutually endorsed by the two parties and managed through the Change Management process.

Signatories:

Name..Position.......................................Date...............

Name..Position.......................................Date...............

Service description:

The ABC Service consists of.... (a fuller description to include key business functions, deliverables and all relevant information to describe the service and its scale, impact and priority for the business).

Scope of the agreement:

What is covered within the agreement and what is excluded?

Service hours:

A description of the hours that the customers can expect the service to be available (e.g. 7 x 24 x 365, 08:00 to 18:00 – Monday to Friday).

Special conditions for exceptions (e.g. weekends, public holidays) and procedures for requesting service extensions (who to contact – normally the Service Desk –- and what notice periods are required).

This could include a service calendar or reference to a service calendar.

Details of any pre-agreed maintenance or housekeeping slots, if these impact on service hours, together with details of how any other potential outages must be negotiated and agreed – by whom and notice periods etc.

Procedures for requesting permanent changes to service hours.

Service availability:

The target availability levels that the IT service provider will seek to deliver within the agreed service hours. Availability targets within agreed service hours, normally expressed as percentages (e.g. 99.5%), measurement periods, method and calculations must be stipulated. This figure may be expressed for the overall service, underpinning services and critical components or all three. However, it is difficult to relate such simplistic percentage availability figures to service quality, or to customer business activities. It is therefore often better to try to measure service unavailability in terms of the customer's inability to conduct its business activities.

For example, 'sales are immediately affected by a failure of IT to provide an adequate POS support service'. This strong link between the IT service and the customer's business processes is a sign of maturity in both the SLM and the Availability Management processes.

Agreed details of how and at what point this will be measured and reported, and over what agreed period should also be documented.

Reliability:

The maximum number of service breaks that can be tolerated within an agreed period (may be defined either as number of breaks e.g. four per annum, or as a Mean Time Between Failures (MTBF) or Mean Time Between Systems Incidents (MTBSI)).

Definition of what constitutes a 'break' and how these will be monitored and recorded.

Customer support:

Details of how to contact the Service Desk, the hours it will be available, the hours support is available and what to do outside these hours to obtain assistance (e.g. on-call support, third-party assistance etc.) must be documented. The SLA may also include reference to internet/Intranet Self Help and/or Incident logging. Metrics and measurements should be included such as telephone call answer targets (number of rings, missed calls etc.)

Targets for Incident response times (how long will it be before someone starts to assist the customer – may include travelling time etc.)

A definition is needed of 'response' – Is it a telephone call back to the customer or a site visit? – as appropriate. Arrangements for requesting support extensions, including required notice periods (e.g. request must be made to the Service Desk by 12 noon for an evening extension, by 12 noon on Thursday for a week-end extension)

Note. Both Incident response and resolution times will be based on whatever Incident impact/priority codes are used – details of the classification of Incidents should also be included here.

Note. In some cases, it may be appropriate to reference out to third-party contacts and contracts and OLAs – but not as a way of diverting responsibility.

Contact points and escalation:

Details of the contacts within each of the parties involved in the agreement and the escalation processes and contact points must be documented. This should also include the definition of a complaint and procedure for managing complaints.

Service performance:

Details of the expected responsiveness of the IT service (e.g. target workstation response times for average, or maximum workstation response times, sometimes expressed as a percentile – e.g. 95% within two seconds), details of expected service throughput on which targets are based, and any thresholds that would invalidate the targets).

This should include indication of likely traffic volumes, throughput activity, constraints and dependencies (e.g. the number of transactions to be processed, number of concurrent users, and amount of data to be transmitted over the network). This is important so that performance issues that have been caused by excessive throughput outside the terms of the agreement may be identified.

Batch turnaround times:

If appropriate, details of any batch turnaround times, completion times and key deliverables, including times for delivery of input and the time and place for delivery of output where appropriate.

Functionality (if appropriate):

Details of the minimal functionality to be provided and the number of errors of particular types that can be tolerated before the SLA is breached. This should include severity levels and the reporting period.

Change Management:

Brief mention of and/or reference out to the organization's Change Management procedures that must be followed – just to reinforce compliance. Also targets for approving, handling and implementing RFCs, usually based on the category or urgency/priority of the change, should also be included and details of any known changes that will impact on the agreement, if any.

Service Continuity:

Brief mention of and/or reference out to the organization's Service Continuity Plans, together with details of how the SLA might be affected or reference to a separate Continuity SLA, containing details of any diminished or amended service targets should a disaster situation occur. Details of any specific responsibilities on both sides (e.g. data backup, off-site storage). Also details of the invocation of plans and coverage of any security issues, particularly any customer responsibilities (e.g. coordination of business activities, business documentation, backup of freestanding PCs, password changes).

Security:

Brief mention of and/or reference out to the organization's Security Policy (covering issues such as password controls, security violations, unauthorized software, viruses etc.). Details of any specific responsibilities on both sides (e.g. Virus Protection, Firewalls).

Printing:

Details of any special conditions relating to printing or printers (e.g. print distribution details, notification of large centralized print runs, or handling of any special high-value stationery).

Responsibilities:

Details of the responsibilities of the various parties involved within the service and their agreed responsibilities, including the service provider, the customer and the users.

Charging (if applicable):

Details of any charging formulas used, charging periods, or reference out to charging policy documents, together with invoicing procedures and payment conditions etc. must be included. This should also include details of any financial penalties or bonuses that will be paid if service targets do not meet expectations. What will the penalties/bonuses be and how will they be calculated, agreed and collected/paid (more appropriate for third-party situations). If the SLA covers an outsourcing relationship, charges should be detailed in an Appendix as they are often covered by commercial in-confidence provisions.

It should be noted that penalty clauses can create their own difficulties. They can prove a barrier to partnerships if unfairly invoked on a technicality and can also make service provider staff unwilling to admit to mistakes for fear of penalties being imposed. This can, unless used properly, be a barrier to developing effective relationships and problem solving.

Service reporting and reviewing:

The content, frequency, content, timing and distribution of service reports, and the frequency of associated service review meetings. Also details of how and when SLAs and the associated service targets will be reviewed and possibly revised, including who will be involved and in what capacity.

Glossary:

Explanation of any unavoidable abbreviations or terminology used, to assist customer understanding.

Amendment sheet:

To include a record of any agreed amendments, with details of amendments, dates and signatories. It should also contain details of a complete change history of the document and its revisions.

It should be noted that the SLA contents given above are examples only. They should not be regarded as exhaustive or mandatory, but they provide a good starting point.

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