Chapter 7
ArchiMate Extension to Value Co-creation: The Smart Airport Case Study

Christophe Feltus, Hend*erik* A. Proper, Andreas Metzger, and Juan Francisco Garcia López

Abstract The design and engineering of collaborative networks and business ecosystems is a discipline that requires an outstanding and upfront attention of the value cogenerated among the parties involved in the business exchanges of these networks. Understanding this value co-creation is undoubtedly paramount, first to adequately sustain the design and the development of the information system that brings about this value, second, to support the communication between the information system designers, and third to allow discovering new co-creation opportunities among the networks companies. In that context, we proposed an abstract language (meta-model) that structures, and provides an explanatory semantics to, the co-creation of value between information system designers, allowing a better definition of the collaboration and of each one of the value propositions. The design of this language is achieved in the frame of the design science theory and accordingly follows an iterative improvement approach based on real case studies from practitioners. This chapter introduces the second iteration of the language based on a real case in a smart airport network.

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7.1 Introduction

All engineering steps for information systems (IS) involve a plethora of actors from inside and from outside the company (e.g., software architects, security providers, or consulting companies). These steps include, among others, defining the system requirements, developing software components, testing the system, and deploying appropriate security mechanisms. Traditionally, the relationship between the company and its suppliers aims to generate value in exchange for money. This relationship has been largely investigated through the vector of value exchange and value chains (Vargo & Lusch, 2004, 2008; Wille et al., 2013; Gordijn et al., 2000; Chew, 2016; Proper et al., 2018a). For instance, monitoring a bank information system may be outsourced to a security provider offering a SOC (Security Operation Center) service in exchange of annual fees.

In this chapter, value co-creation (VCC) is investigated as a specialization of value creation and represents the close collaboration between two or more parties to generate value following an ordered set of value co-generation processes inspired by knowledge-intensive business services (KIBS) (Lessard, 2015). The work, as reported in this chapter, was part of the ValCoLa project as mentioned in Sect. 1.3.

Although a plethora of research exists aiming at depicting the fundamentals of VCC, few contributions exist in the area of modeling language for supporting VCC design and deployment. Nevertheless, a common model is needed to facilitate communication among the many different actors. Such a model and modeling language are necessary to describe and to visualize different components of the information system, as well as their underlying relationships and dependencies. As a result, the goal for such a modeling language is to support the process of decision-making and to allow understanding and analyzing the impacts associated to a change of the system architecture on the whole information system.

We propose such a VCC modeling language as an extension of ArchiMate, a standardized enterprise architecture modeling language (Band et al., 2016).

ArchiMate is an open, independent, and non-sector specific language maintained by The Open Group.[1] It supports the description, analysis, and visualization of architectures in an unambiguous way, by structuring the enterprise elements on different layers. These layers cover the business concepts (like the collaboration, the process, etc.) down to the very technical one (like the network, the servers, etc.). In particular, ArchiMate proposes two extension mechanisms that allow extending the model and the language to various fields of interest like IS governance or risk analysis (Grandry et al., 2013). In that context, ArchiMate appears to be appropriate as a language to express the value creation and, by the way, the value co-creation.

To illustrate the designed language extension, a case study related to the development of value co-creation in a smart airport is proposed (Feltus et al., 2018d). The airport systems support the complete operations of the airport, including in

[1] https://www.opengroup.org/ArchiMate-forum/ArchiMate-overview.

particular arrival and departure control system (such as assignment of planes to gates), on-site check-in, baggage handling, and security control. In parallel, the airline management systems support the activities of the airline companies in offering transport services to its customers and in particular support ticketing, online check-in, and passenger management. Both airport and airline systems are essential for supporting the execution of the air transport. These systems continuously provide data to facilitate proactive decision-making based on the real context. In parallel, the operation module uses anonymous passenger data to trace passenger flow.

The remainder of the chapter is structured as follows: In Sect. 7.2, we provide relevant background work on VCC. In Sect. 7.3, we present the value creation model and an extension of ArchiMate to express this value creation. In Sect. 7.4 we present a VCC meta-model and an extension of ArchiMate to express the latter. In Sect. 7.5 we illustrate the extension through a case study in the smart airport domain. Finally, Sect. 7.6 concludes and discusses the proposed approach.

7.2 Background

VCC discipline originates from the marketing theory. It aims to define and to explain the mechanisms for the co-generation of value during business exchanges among companies (Vargo & Lusch, 2004, 2008). Vargo and Lusch (2004); Wille et al. (2013) formalize it using a framework for defining VCC in the perspective of the service-dominant logic (S-DL). According to them, service is the basis of all exchanges and focuses on the process of value creation rather than on the creation of tangible outputs. As a result, a service system is a network of agents and interactions that integrates resources for VCC (Vargo & Lusch, 2004). On that basis, value is proposed by a service provider and is determined by a service beneficiary. According to Grönroos (2008), this interaction is defined through situations in which the customer and the provider are involved in each other's practices. Frow et al. (2015) propose a framework to assist firms in identifying new opportunities for VCC. Therefore, they provide a strategically important new approach for managers to identify, organize, and communicate innovative opportunities. In that matter Cesarotti et al. (2016) explore the opportunity to increase the value cocreated in a service process through improved design using multiple channels and (Herzfeldt et al., 2016) analyze the relationship between cloud service provider profitability and value facilitation.

More recently, Chew (2016) argues that, in the digital world, service innovation is focused on customer value creation, and he proposes an integrated Service Innovation Method (iSIM) for analyzing the interrelationships between the design process elements. At the IS domains level, Gordijn et al. (2000) explain that business modeling is not about process but about value exchange between different actors. Accordingly, Gordijn and Akkermans (2001) propose e3value to design models that sustain the communication between business and IT groups. In Weigand (2009), e3value is extended for considering co-creation. Therefore, the authors define the so-called value encounters which consist in spaces where groups of actors interact to derive value from the groups' resources. The financial case used to illustrate our method is modeled with this e3value language (see Sect. 7.3). In the same vein, Razo-Zapata et al. (2016) propose visual constructs to describe the value co-creation process.

7.3 Value Creation Model and Language

In this section, we present the value creation model and an extension of ArchiMate to express this creation, and the next section will extend the language to the value co-creation (see Fig. 7.1).

7.3.1 Model Elaboration

In this subsection, value is defined according to the following three dimensions (see Fig. 7.2): the nature of the value, the method of VC, and the object concerned by VC (Feltus & Proper, 2017a). In the next subsections, each dimension is conceptualized, modeled, and illustrated with real cases.

At a methodological level, the research that we tackle concerns the improvement of co-creation of value in the field of collaborating companies. Accordingly, we

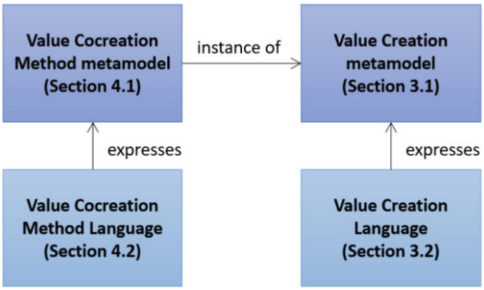

Fig. 7.1 Modeling approach and language extension design (section numbers are relative to this chapter)

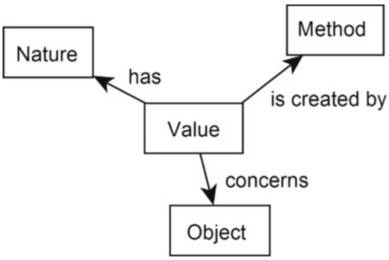

Fig. 7.2 Three value dimensions

have conceptualized and defined a language to support the SPCC process on the basis of the three dimensions of the value creation meta-model. Through this research, we aim to strengthen the organizational capability to improve the design of the SPCC related to the IS. Accordingly, Hevner et al. (2004) explain that the Design Science Research (DSR) paradigm seeks to extend the boundaries of human and organization capability by creating new and innovative artifacts. Practically, provided that we aim to design a new artifact (VCC language) to support the design of the information system value, we acknowledge that this research may plainly be considered in the scope of DSR (Peffers et al., 2007). As advocated by the DSR theory (Hevner et al., 2004; Peffers et al., 2007), the method that we use to design these value dimensions is an iterative approach consisting first of analyzing different instances of the domain under scope, second of extracting the relevant concepts from the instances, and third of designing elementary domain models. For example, to model the nature of the value, we have analyzed some instances of this nature like security, privacy, and quality, we have extracted the more relevant concepts of these domains in Table 7.1, and we have designed the nature of the value model (Fig. 7.3). For the sake of pragmatism, only the last version of the iterations is presented in the next sections.

Table 7.1 Nature of the value

Value reference framework	Nature of the Value examples		
	Nature of the value	Characteristics of the nature of the value	Concerned object
Web Quality Model (Calero et al., 2005)	Quality	Functionality, Reliability, Usability, Efficiency, Portability, Maintainability	Web feature
ISSRM (Matulevicius et al., 2008b)	IS Security	Confidentiality, Integrity, Availability, Non-repudiation, Accountability	Business Asset
HCI (Dix, 2009)	Usability	Learnability, Flexibility, Robustness	Design rules, design knowledge
ReMMo (Feltus et al., 2009)	Responsibility	Accountability (e.g., RACI)	Actor
EA Compliance Model (Foorthuis et al., 2009)	Compliancy	Correctness, Justification, Consistency, Completeness	Acts of software developers
VDML (OMG, 2015)	Generic Value	Factor of benefit, Factor of interest	Business item
Privacy Meta-model (Feltus et al., 2018a; Langheinrich, 2001)	Privacy	Notice, Choice and Consent, Proximity and Locality, Anonymity and Pseudonymity, Security, and Access and Resource	Sensitive Information Hawley et al. (2013)
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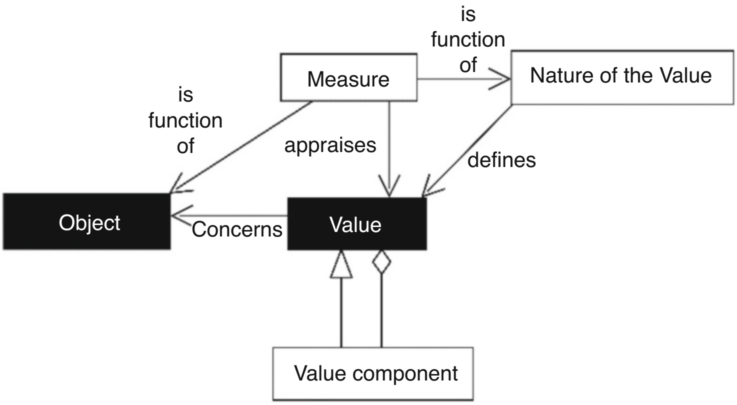


Fig. 7.3 Nature of the value meta-model

7.3.2 Nature of the Value

Value is an abstract concept that expresses a measureable information of a determined nature and which is associated to a well-defined object. According to Zeithaml (1988), value implies some form of assessment of benefits against sacrifices. Most researches that focus on depicting the semantic of value agree on the abstract character of the latter, mostly generated by the different types of existing value nature (Alves et al., 2016). Whatever, two main categories of value nature emerge depending on the context: value at provider side vs. value at customer's side. When value is perceived at the provider side, economists largely argue that the latter is created (manufactured) by the firm and distributed in the market, usually through exchange of goods and money (Smith, 1963). This nature of value has for a long time traditionally been represented by the possession of wealth and money. However, it is also worth to note that considering the provider in the context of the digital society expands this narrow interpretation to the consideration of other value elements, like the information collected on the customers which, afterward, fills the bill of economic increase (Nyman, 2016). On the customer side, value generated by a transaction never refers to money but consists in other wealth, which contributes in sustaining and supporting the customer's own business.

Let us take the example of a SME that outsources the privacy management of its assets to dedicated enterprises, in order to remain being focused on its core business. In this case, the privacy nature of the value is traditionally expressed with well-defined characteristics (e.g., pseudonymity, anonymity, consent, etc. (Table 7.1) that are specifics for privacy). Moreover, two types of value are created by this outsourcing: a direct value (privacy of the assets) and an indirect value (more time for core activities). Over and above that, this transaction happening with a customer being a citizen also contributes to the latter's improvement of his well-being as observed in Korkman (2006) that asserts that value for customer means that after they have been assisted by a self-service process or a full-service process, they are or feel better off than before.

As summarized in Table 7.1, our analysis to understand and to define the nature of the value has been performed by tackling a set of frameworks in different areas like security, quality, compliancy, privacy, responsibility, and so forth. For instance, we have analyzed the information systems security risks management (ISSRM) framework that addresses the IS security (Matulevicius et al., 2008b). ISSRM characterizes security through integrity, confidentiality, non-repudiation and accountability, and availability, and the latter concerns business asset of the company. Moreover, according to Theoharidou et al. (2012), we acknowledge that the abovementioned characteristics also constitute complementary types of value. Based on our review, we have observed that value is an abstract concept defined by a well precise nature with well-determined characteristics, that it is measureable, and that it concerns a well-defined object.

The concepts composing the nature of the value model are:

- *Value*—This concept is defined as a degree of worth that concerns something (Calero et al., 2005; Foorthuis et al., 2009) and that improves the well-being of the beneficiary after it is delivered (Vargo & Lusch, 2004).
- *Nature of the value*—Table 7.1 shows that the nature of the value expresses a domain of interest related to which the value will be delivered (e.g., security of the IS, the cost of a transaction, or the privacy of personal data). As a consequence, the nature of the value *defines* the value to be delivered. In the case of the datacenter that archives the data of the bank customers, the nature of the value generated by the datacenter is the *availability* of the customer's data.
- *Value component*—This concept expresses the different elements that constitute the value, or the pillars that found this nature (e.g., availability, confidentiality, portability, etc.). Hence, the value *aggregates* value components and the latter may also, as a result, themselves be other *types of* value. Regarding the case study, one component of the availability is the *accessibility in real time*.
- *Object*—The object concerned by the value is the element from the information system that has significance and is necessary for a company to achieve its goal, and that is be better off after that value is delivered (e.g., software, process, data). From a modeling point of view, the value is associated to an object with a relation of type *concerns* or objective to be achieved. In the case study, the object concerned by the value is the *customers' data*.
- *Measure*—The measure corresponds to a property on which calculations can be made for determining the amount of value expected from a value creation method. This measure (e.g., the *% of time data is available*) can result from different factors impacting value. This corroborates the statement made in Calero et al. (2005), which argues that the value components are measured by means of estimation methods. Accordingly, there exist an association named *appraises* from the concept of measure to the concept of value and an association named *is function of* between the concept of measure and the type of value and between the concept of measure and the object concerned by the value. The first expresses

that the measure is characterized by the nature of the value and the second that the measure also depends on the object concerned by the value. According to Calero et al. (2005), this measure may integrate qualitative and quantitative elementary performance expressions.

Based on the above definitions, the nature of the value has been modeled in Fig. 7.3.

7.3.3 *Method of Value Creation*

A method of value creation is a formalized activity which contributes to the generation of value. Traditionally, value is acquired by exchanging goods or services and emerges out of its use (Wille et al., 2013). Methods for value creation are the body of techniques and series of steps necessary to create value. This corresponds, at the corporate level, to a bundle of approaches including processes, audits, controls, decisions, etc. Likewise, as for the nature of the value, in order to depict the elements relevant for the creation of value, we have reviewed a set of value creation methods among a plethora of them (Table 7.2).

The methods that we analyzed so far are the "method chunk" (Ralyté, 2004), the risk-based method (Daneva, 2006), the model-driven approaches (Bénaben et al., 2008; Becker & Klingner, 2013), the process based method (Manuj & Mentzer, 2008), the impact assessment (Becker, 2014), and the method by design (CPDP, 2014). By looking more closely to all of them, we observe that these methods have each a dedicated goal, that they are composed of method elements, and that the latter are organized in ordinate steps. For instance, by investigating the model-driven approach, we notice that it has a goal to improve interoperability of enterprises information systems, that it is composed of models, and that three steps are required for model-driven interoperability, to know models design, models integration, and models instantiation.

Among the other methods reviewed, it is interesting to highlight that one of them (method chunk) has as its primary objective the creation of method themselves (Ralyté, 2004).

As a summary and according to our analysis, the concepts which compose the method of value creation are:

- *Method*—The method is a specific *type of* object that defines the means used by the stakeholder to *create* objects and value. According to Table 7.2, a method is *composed* of a set of activities necessary to achieve a dedicated goal. In the same vein, Sein et al. (2011) explain that the elementary quantitative value expressions (the value components) are aggregated by means of selected aggregation methods and quantitative weights to generate the overall value. The method used to create the availability is *the exploitation of a redundancy system (tools and procedures to guarantee redundancy)*.

Table 7.2 Method of value creation

Method reference	Method of Value creation examples			
	Method	Goal of the method	Method elements	Activity
Ralyté (2004)	Method chunk	Method creation	Chunk of existing methods	Decomposition of existing methods into method chunks and definition of new method chunks from scratch
Daneva (2006)	Risk-based	Security strategy development	Risk, Costs, Benefits	Analysis of the methods elements and identification of the options that exist in investment decisions
Bénaben et al. (2008); Becker and Klingner (2013)	Model-driven	Improve interoperability of companies information systems – service modeling and configuration	Model – Meta-model	Models design, model integration and model instantiation
Manuj and Mentzer (2008)	Process-based	Risk management for global supply chain	Process, Step, Dependency	Step-by-step execution in a function of the dependency amongst them
Becker (2014)	Impact assessment	Explore social consequences for social security policies	Scenario, Strategy, Impacts, Implementation	Scenario design, Design of strategies, Assessment of impacts, Ranking of strategies, Mitigation of negative impacts, Reporting, Stimulation of implementation, Auditing and ex-post evaluation
CPDP (2014)	By design	Prevent privacy risk from occurring	Project	Project-by-project approach realization
Aier and Winter (2010)	Enterprise integration patterns	Enterprise integration project	Services, Cluster, Patterns	Services clustering
…				

- *Activity*—The activity is an element of the method that corresponds to a unitary task (e.g., analysis, collection of information, or reporting). The activities *compose* the method and are organized and coherently articulated with each other (e.g., if-then-else, process elements ordination, etc.). This relation is modeled using an iterative association of a type: activity *follows* activity. The articulation of activities corresponds to the aggregation from Feltus et al. (2018b). One particular type of activity consists in *generating* resources, for instance, *acquiring a backup tool, maintaining the backup tool, etc.*.
- *Stakeholder*—A stakeholder is a human, a machine, or an organization that is involved in the creation of value at three levels. First, it *performs* the method that generates value (e.g., the risk manager performs a risk analysis); second, it *generates* resources used by the method; and third it *expresses* the value expected after the execution of the method. For example, the *datacenter* is the stakeholder that exploits the redundancy system and the *bank* expresses that it expects availability of the data.
- *Resource*—This element is a *type of* object from the IS that is generated by a stakeholder and that *is used by* an activity composing the value creation method. Resources are typically information and data (e.g., passenger location) but could also consist in computing resources, funding, manpower, etc. For instance, the *backup software* is the resource used by the exploitation of a redundancy system.

Based on the above definitions, the value creation method has been modeled in Fig. 7.4.

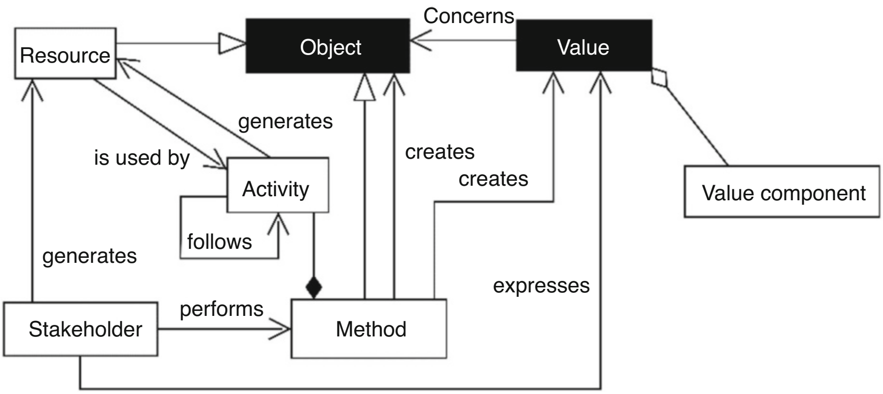


Fig. 7.4 Value creation method meta-model

7.3.4 Object Concerned by the Value

The object concerned by the value corresponds to the elements (mostly existing at the information system level, e.g., information, process, tool, actor) that have significance for a company to achieve its goal. This object exists in a determined environment represented at the information system level by the context, the latter having an influence on the type and the amount of value associated to this object. For instance, a customer browsing history is an object of a data type that has a particular pecuniary value for an airline travel agency which can estimate the value ascribed to a flight ticket for a customer. This value is calculated based on the number of times this flight ticket was viewed on the company website by the customer. At the opposite, this customer browsing history is not an object of value on a drugstore website with fixed prices. Additionally, it is also worth to note that this context has no impact on the nature of the value. For example, privacy in the healthcare sector is defined the same way as in the industry, meaning with the same characteristics.

To collect and to deal with the concepts that are necessary to model the object of value, we assume that each sector of activities, should it be the manufacturing, the finance, or the healthcare sector, for instance, is associated with a specific information system. The latter models the objects composing them and the relationships between these objects, using a dedicated language. In order to focus on the right object of value when defining a business model or when analyzing the co-creation of value, it is important to have an understanding of, and an alignment between, the objects of value of all stakeholders involved.

Sector-specific information systems and enterprise architecture (EA) models and languages are good approaches because they semantically define generic objects and sometimes concrete languages to express the latter. Numerous frameworks have been designed to model IS and EA of various sectors, e.g., CIMOSA (Berio & Vernadat, 2001), HL7 (Dolin et al., 2006), DoDAF (DoD Deputy Chief Information Officer, 2011), etc.

Table 7.3 provides a review of some meta-models and languages to depict the context targeted, the IS under scope, and some examples of objects addressed.

The above frameworks have been systematically reviewed and distilled in order to capture the semantic of their value-related concepts. After that, the meaning of all these concepts has been precisely and methodically compared and synthesized with each other. As a summary and according to this review, the concepts which define the context and the object concerned by the value are:

- *Information system*—The information system encompasses, and *is composed of*, the objects concerned by the value and the stakeholders that benefit from the value created.
- *Context*—The context represents the surrounding of the IS. It includes (1) the constraints on the system in which the value is created and (2) the definition of the borders of this system (e.g., the sector and the sector purpose of the business entity that is concerned by the IS, the rules and regulations related to the sector or the IS, the institutional arrangements, etc.).

Table 7.3 Object concerned by the value

Language+Reference	Object concerned		
	Sector	Information system	Examples of objects
DEMO (Dietz, 2006)	Enterprise	Business Process, Information Systems	Models (Interaction, Business Process, Action, Interstriction, Fact), Actor, Action, …
ARIS (Scheer & Nüttgens, 2000)	Enterprise	Business process management	Data, Function, Organization, Material, IT resources, or Machine resources, …
CIMOSA (Berio & Vernadat, 2001)	Production Industry	Industrial information system	Business process, flow, step, function, information, resource and organization aspects, business user, control, capability, …
HL7 (Dolin et al., 2006)	Healthcare	Clinical document architecture	Organization, Clinical document, Author, Legal Authenticator, Person, product, consumable, …
DoDAF (DoD Deputy Chief Information Officer, 2011)	Military	DoDAF Meta-Model (DM2)	Guidance, activity, capability, resource, performer, location, information, project materiel, system, service, organization, …
BSE (Feltus et al., 2015)	Enterprise	Business Service Ecosystem	Service, Capability, Resource, Process, Actor, …
…			

Accordingly, the context is associated to the information system with an association named *characterizes*. As stated in Li et al. (2017), the context also allows selecting the “performance components […]” necessary “to define the scope of the performance evaluation problem.” Hence, this selection defines a particular context, or viewpoint, for the evaluation of the value. To model this, the concept of context is associated to the measure with a relation named *influence*. Regarding the case study in the financial sector, the context is the *financial regulation*.

Based on the above definitions, the context and the object concerned by the value have been modeled in Fig. 7.5.

Figure 7.6 represents the integrated meta-model of value creation based on the integration of the three value creation dimensions proposed in Figs. 7.3, 7.4, and 7.5. In that figure, the concept of value (co-)creation has been added and consists in a type of value (cf. Sect. 7.3.2).

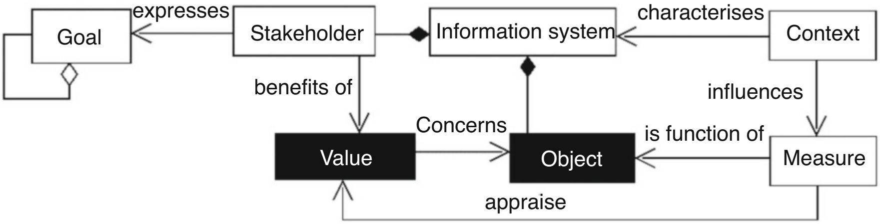


Fig. 7.5 Object concerned by the value

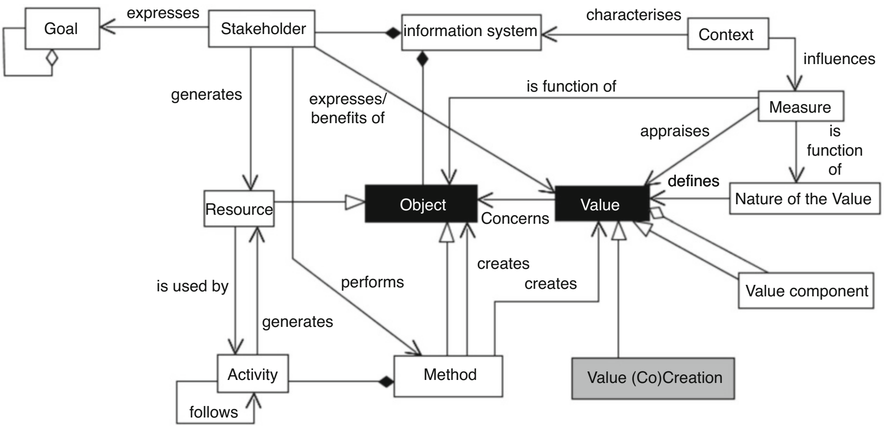


Fig. 7.6 Integrated VC meta-model built on the integration of Figs. 7.3, 7.4 and 7.5

7.3.5 ArchiMate Language Extension to Express Value Creation

In this subsection, we extend the ArchiMate language to the VC domain. Therefore, first we introduce ArchiMate (meta-model), then the ArchiMate language and its extension mechanisms, and finally the extended ArchiMate to VCC.

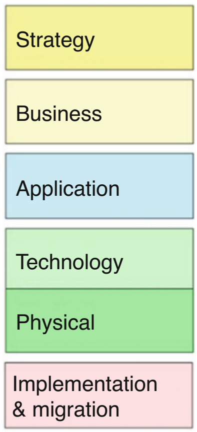
7.3.6 Introduction to ArchiMate

ArchiMate is an enterprise architecture framework (i.e., meta-model and syntax) used by enterprise and IT architects to design business and IT static views and their links, of the corporate architecture (Josey et al., 2016). ArchiMate allows reducing the complexity and proposes means to model and thus better understand the enterprise, and the interconnections and interdependency between the processes, the people, the information, and the systems. Consequently, one objective of ArchiMate is to express and visualize enterprise architecture aspects such as the organizational structure, the business processes, the information processing system, the infrastructure, or the responsibility (Feltus et al., 2012). It permits to ensure uniform semantics of the instantiated models, but it is not really appropriate to enable quantitative analysis.

Another objective of the enterprise architecture is to highlight the creation of business value. For instance, in the ArchiSurance scenario (Josey et al., 2016), the customer needs to "be insured" with the instance "be insured" being a type of "business value." This business value is generated by the business processes which are supported by applications and infrastructures.

Core ArchiMate is structured in six horizontal layers (see Fig. 7.7): strategy, business, application, technology, physical, and implementation and migration. Three of these layers are particularly relevant to express the value co-creation: the *business layer* in light yellow, the *application layer* in blue, and the *technology layer* in light green. All three layers are built with the same type of concepts and the same sort of associations. They are structured according to three aspects (vertical layers). The first aspect concerns the active structure elements which are defined as *entities that are capable of performing behavior*, e.g., a role or an actor. The second aspect regards the behavioral elements which are defined as *units of activity performed by one or more active structure elements*, e.g., a process or a function. The last aspect addresses passive structure elements which are defined as *objects on which behavior is performed*, e.g., a contract or an object. The generic ArchiMate meta-model is shown in Fig. 7.8. This meta-model is also contained in the specification of the ArchiMate standard (Band et al., 2016), albeit with some additional details.

Fig. 7.7 ArchiMate layers



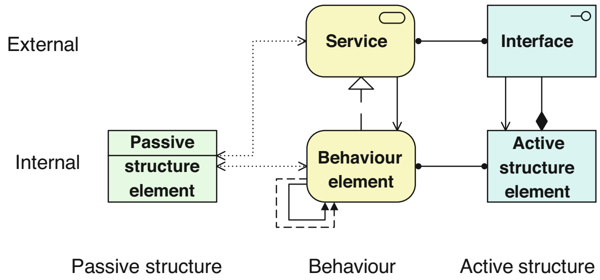


Fig. 7.8 Generic ArchiMate meta-model, adopted from Lankhorst et al. (2017); ©2017 Springer-Verlag Berlin Heidelberg; reprinted with permission

7.3.7 Relevant ArchiMate Symbols

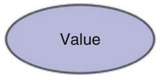
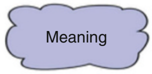
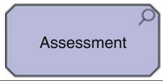
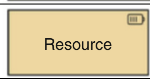
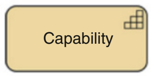
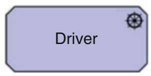
ArchiMate uses a syntax based on symbols and colors, related to the vertical and horizontal layers. Table 7.4 contains ArchiMate elements, definitions, and symbols used during the mapping and integration of both meta-models.

7.3.8 ArchiMate Extension Mechanisms

ArchiMate extension is achieved by integrating its meta-model with the meta-model of the domain that extends it. According to Zivkovic et al. (2007), the integration of two meta-models requires resolving three types of heterogeneities: syntactic, semantic, and structural. For our integration, only the semantic and the structural heterogeneities have been addressed. Indeed, the syntactic heterogeneity aims at analyzing the difference between the serializations of meta-model and, as explained by Parent and Spaccapietra (2000), addresses technical heterogeneity like hardware platforms and operating systems, or access methods, or it addresses the interface heterogeneity like the one which exists if different components are accessible through different access languages. The structural heterogeneity exists when the same meta-model concepts are modeled differently by each meta-model primitives. This structural heterogeneity has been addressed together with the analysis of the conceptual mapping and the definition of the integration rules. Finally, the semantic heterogeneity represents differences in the meaning of the considered meta-model elements and must be addressed through elements mapping and integration rules. Regarding the mappings, three situations are possible: no mapping, a mapping of a type 1:1, and a mapping of a type n:m (n concepts from one meta-model are mapped with m concepts from the other).

After defining the mapping, the concepts are integrated in a single meta-model using both ArchiMate's extension mechanisms: the addition of attribute and the specialization (Josey et al., 2016). Concretely, if no mapping is detected, the

Table 7.4 Relevant ArchiMate symbols

Modelling concept	Definition	Symbol
Value	Value represents the relative worth, utility, or importance of a core element or an outcome. Value may apply to what a party gets by selling or making available some product or service, or it may apply to what a party gets by buying or obtaining access to it. Value is often expressed in terms of money, but it has long since been recognized that non-monetary value is also essential to business.	
Meaning	The knowledge or expertise present in, or the interpretation given to, a core element in a particular context	
Assessment	An assessment represents the result of an analysis of the state of affairs of the enterprise with respect to some driver.	
Business function	A business function is a collection of business behavior based on a chosen set of criteria (typically required business resources and/or competencies), closely aligned to an organization, but not necessarily explicitly governed by the organization	
Business process	A business process represents a sequence of business behaviors that achieves a specific outcome such as a defined set of products or business services	
Business actor	A business actor is a business entity that is capable of performing behavior	
Resource	A resource represents an asset owned or controlled by an individual or organization	
Capability	A capability represents an ability that an active structure element, such as an organization, person, or system, possesses	
Driver	An external or internal condition that motivates an organization to define its goals and implement the changes necessary to achieve them	

concept from extension domain is added in the ArchiMate using the first extension mechanism which consists in adding attribute to an existing concept. If a 1:1 mapping exists without conflict between two concepts, both concepts are merged in a unique one, this concept is added into the integrated meta-model, and this concept keeps the name of the ArchiMate concept. If a mapping of type 1:1 with conflict exists between two concepts, this means that one concept from one meta-model is richer or poorer than a concept from the other meta-model and, in this case, both concepts are added in the integrated meta-model using the second extension mechanism of ArchiMate which is the stereotype (specialization).

7.3.9 ArchiMate Extension for Value Creation

In this chapter, the ArchiMate extension mechanism has been applied to the field of value creation. Table 7.5 explains the mapping between elements from the value creation and from the ArchiMate meta-models. Nine VC elements are mapped with ArchiMate elements, and only one VC element (i.e., the *value component*) has no corresponding ArchiMate element. The justification of this last case is that, although the *value component* from the VC meta-model could have been mapped to the *value* from the ArchiMate meta-model, we have preferred to keep the semantic difference among the elements of *value* and the *value component* from the VC meta-model in the ArchiMate meta-model. Note: the *value component* from the VC meta-model may be a type of *value*.

Accordingly, the integration rule that we have exploited to integrate the *value components* with the ArchiMate meta-model is the addition of attribute, and as a result, we have considered that the *value component* is an attribute of the *value*.

Another integration rule that we have used for one element is the merge, i.e., the concept of value from the VC meta-model has been merged with the concept of value from the ArchiMate meta-model because both concepts are defined more or less equivalently, respectively: as *the degree of worth that concerns something [which] improves the well-being of the beneficiary after it is delivered* (VC meta-model) and as *the relative worth, utility, or importance of a core element or an*

Table 7.5 Mapping between the VC elements and the ArchiMate elements

VC elements	ArchiMate element	Mapping	Integration rule	Integrated element
Value	Value	1-1	Merge	Value
Nature of the value	Meaning	1-1	Specialisation	<<Nature of the value>>
Value component	-	-	Addition of attribute	<<Value>>, Value component: description
Object	Business, Application and Technology layers	1-n	Generalisation	Business, Application and Technology layers
Measure	Assessment	1-1	Specialisation	<<Measure>>
Activity	Business function	1-1	Specialisation	<<Activity>>
Method	Business Process	1-1	Specialisation	<<Method>>
Stakeholder	Business actor	1-1	Specialisation	<<Stakeholder>>
Resource	Resource and Capability	1-2	Generalisation	Resource
Information system	Business, Application and Technology layers	1-n	Generalisation	Information system
Context	Driver	1-n	Generalisation	Context
Goal	Goal	1-n	Merge	Goal

outcome (ArchiMate meta-model). Four concepts from the VC meta-model also consist in specialization of concepts from ArchiMate: *nature of the value*, *measure*, *method*, and *stakeholder* are, respectively, specialization of *meaning*, *assessment*, *business function*, and *business actor*. For instance, the method is defined by *a property on which calculations can be made for determining the amount of value expected from a value creation method* at the VC meta-model level and by *the result of an analysis of the state of affairs of the enterprise with respect to some driver* at the ArchiMate meta-model level. The second definition is hence more general than the first.

Finally, four concepts from the VC meta-model consist in generalization of concepts from the ArchiMate meta-model: *object*, *resource*, *information system*, and *context* are generalizations of different elements from the *business*, *application*, and *technology* layers, as well as the *strategy* and *motivation* extension. According to ArchiMate semantics, the value creation concepts may be expressed using the ArchiMate symbols, as explained in Table 7.5, and modeled as represented in Fig. 7.9. In that figure, concepts between double angle quotes (e.g., ≪Context≫) are specializations of ArchiMate concepts, and concepts without guillemets are original concepts from ArchiMate (e.g., resource).

7.4 Value Co-creation Process Model and Language

In this figure, we investigate how VCC process may be considered as an instance of value creation (see Fig. 7.1). After this, in Sect. 7.4.2, we propose an extension of the ArchiMate language for value creation to express SPCC process.

7.4.1 From VC to VCC in KIBS

In our previous work, we have explained to what extent the value creation meta-model (Fig. 7.6) is suitable to model the processes of value co-creation in KIBS proposed in Lessard (2015) (see Fig. 7.10). To that end, we have considered one specificity of value co-creation which is that value is cocreated on the basis of a collaboration between many stakeholders who have different responsibilities during the co-creation, including the generation of the appropriate resources needed for co-creation activities. Consequently, a prerequisite before modeling the value co-creation process was to enrich the value creation model with the concepts of the stakeholder and the resources. This improvement was achieved by integrating the value creation model presented in Feltus and Proper (2017a) with the value model proposed in Li (2017) and Li et al. (2017). This chapter does not explain the integration but further details are available in Feltus et al. (2018b). The processes and generative mechanisms of value co-creation in KIBS engagements are illustrated in Fig. 7.10. These processes are, respectively (Lessard, 2015), *developing*

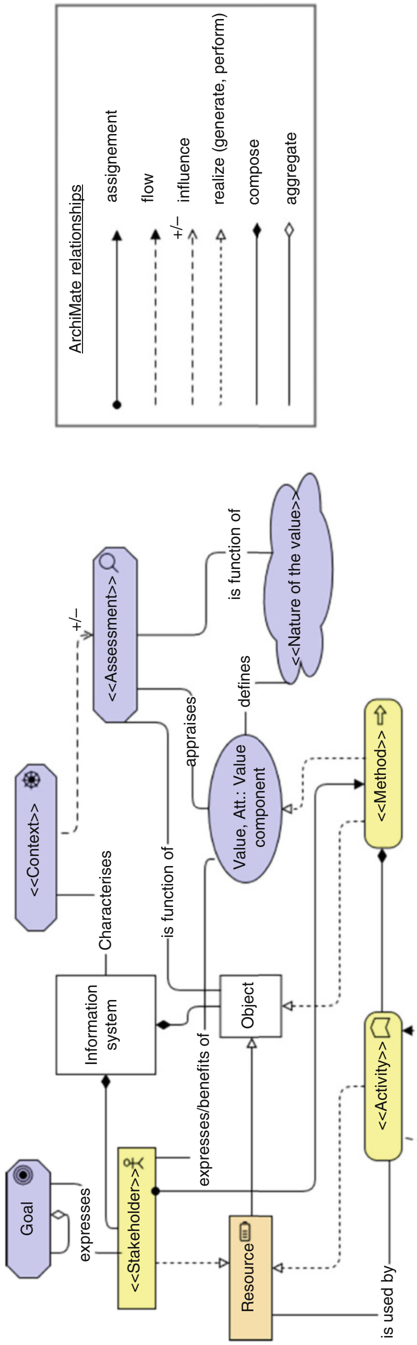


Fig. 7.9 ArchiMate extension to value creation

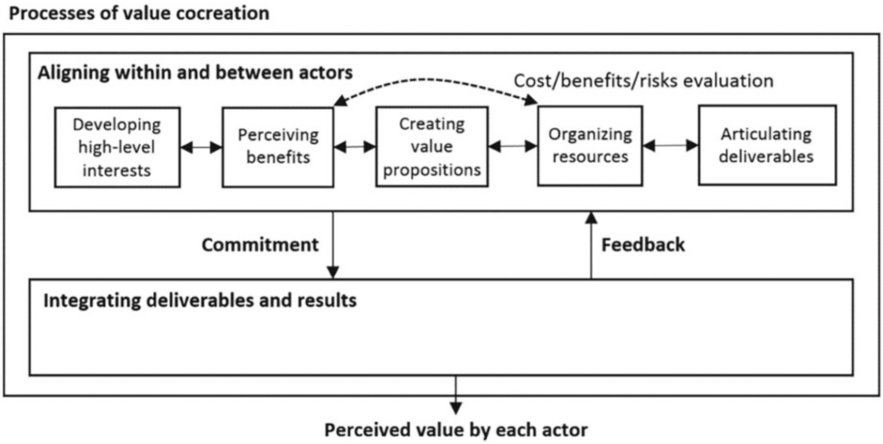


Fig. 7.10 Processes of value co-creation in KIBS engagements, adopted from Feltus et al. (2018b) ©2018 Springer-Verlag Berlin Heidelberg; reprinted with permission

high-level interest (concerns the generation of actor's motivation in co-creation), *perceiving benefits* (concerns the perception of the value proposition [in the context of service-dominant logic]), *creating value proposition* (concerns the process of adapting the proposition to the customer's need), *articulating deliverables* (concerns the definition of the output of the service engagement), and *organizing resources* (concerns the organization of the resources to create deliverables and to integrate them to the business activity). Only the processes dedicated to the alignment within and between actors are considered in the following.

The result of the specialization of the concepts of value creation into concepts of value co-creation and then into concepts of security and privacy co-creation process is the following:

- *Stakeholders*—They are the entities that perform the method that cocreates value, who benefit from this value, and who generate the resources used by the method activities. These stakeholders are of three types in the field of KIBS: companies, their customers, and partner organizations.
- *Information system*—This concept is not addressed in the processes of value co-creation (Lessard, 2015). However, it is relevant to consider it and to introduce it in the VCC to keep the specialization of the VC coherent.
- *Object*—In the value creation meta-model, like in the value co-creation meta-model, the object concerned by the value is the element from the information system that aims to be better off after that value is proposed and accepted.
- *Context*—The context of the creation of value is equivalent to the context of value co-creation.
- *Nature of the value*—The nature of the value defines the value generated by the creation or the co-creation.

- *Value component*—This concept expresses the different elements that constitute the value in the case of VC and VCC.
- *Measure*—In VC and VCC, the measure appraises the level of value created or cocreated.
- *Method*—The method corresponds approach followed to create or cocreate value (e.g., in Lessard, 2015, value is cocreated following a process-based approach. The first process related to the need for alignment among KIBS actors and the second concern the integration of the deliverables and results). The specialization of the VC to VCC only focuses on the first part and considers that the integration of the deliverables and results may be achieved similarly.
- *Activity*—To be achieved, the method is composed of activities that are articulated with each other. These activities are equivalent in each specialization of the VC meta-model, to know developing high-level interests, perceiving benefits, creating value propositions, organizing resources, and articulating deliverables.
- *Resource*—According to the definition, a resource is a type of object used by an activity. These resources are needed for the realization of the activities of the value creation process but also of the value co-creation processes.

7.4.2 ArchiMate Extension

Based on the specialization of the VC meta-model for KIBS, it is possible in turn to propose an ArchiMate extension to support value co-creation processes. Table 7.6 provides a summary of the VC concepts and of their specializations to VCC process concepts. Practically, the following concepts remain unchanged when they are specialized from VC to VCC, to know the following: *object*, *measure*, *method*, *stakeholder*, *resource*, *information system*, *context*, *goal*, *value*, *nature of the value*, and *value component*. The concept of method and activity is specialized, respectively, in *process of value co-creation* and *developing high-level interests*, *perceiving benefits*, *creating value propositions*, and *organizing resources articulating deliverables*.

Based on the mapping and the ArchiMate extension proposed in Table 7.6, Fig. 7.11 summarizes the value co-creation process language extension.

7.5 Case Study in the Smart Airport

This section illustrates, with a case study from the air transport sector, the ArchiMate extensions to express the value co-creation process.

Table 7.6 ArchiMate extension for the VCC process

VC elements	VCC elements	ArchiMate element	Integrated element
Value	Value	Value	Value, with the attribute value description
Nature of the value	Nature of the value	Meaning	<<Nature of the value>>
Value component	Value component	-	-
Object	Object	Business, Application and Technology layers	Business, Application and Technology layers
Measure	Measure	Assessment	<<Measure>>
Activity	Developing high-level interests, Perceiving benefits, Creating value propositions, Organizing resources articulating deliverables	Business function	<<Developing high-level interests>>, <<Perceiving benefits>>, <<Creating value propositions>>, <<Organizing resources articulating deliverables>>
Method	Process of Value cocreation	Business Process	<< Process of value cocreation>>
Stakeholder	Stakeholder	Business actor	<<Stakeholder>>
Resource	Resource	Resource and Capability	Resource
Information system	Information system	Business, Application and Technology layers	Information system
Context	Context	Driver	Context
Goal	Goal	Goal	Goal

7.5.1 *Case Study Description*

The case study for validating the VCC meta-model and language concerns the optimization of the passenger flow at a large European airport with around 25 million passengers per year. The information and background concerning this case study are collected from a public description of the Smart Airport Turnaround pilot that was developed as part of the European lighthouse initiative TransformingTransport[2] (Metzger et al., 2019).

[2] Smart Airport Turnaround Pilot Design, TransformingTransport Deliverable D8.1, March 2017; https://transformingtransport.eu/sites/default/files/2017-08/D8.1%20-%20Smart_Airport_Turnaround_Pilot_Design_v1.0.pdf.

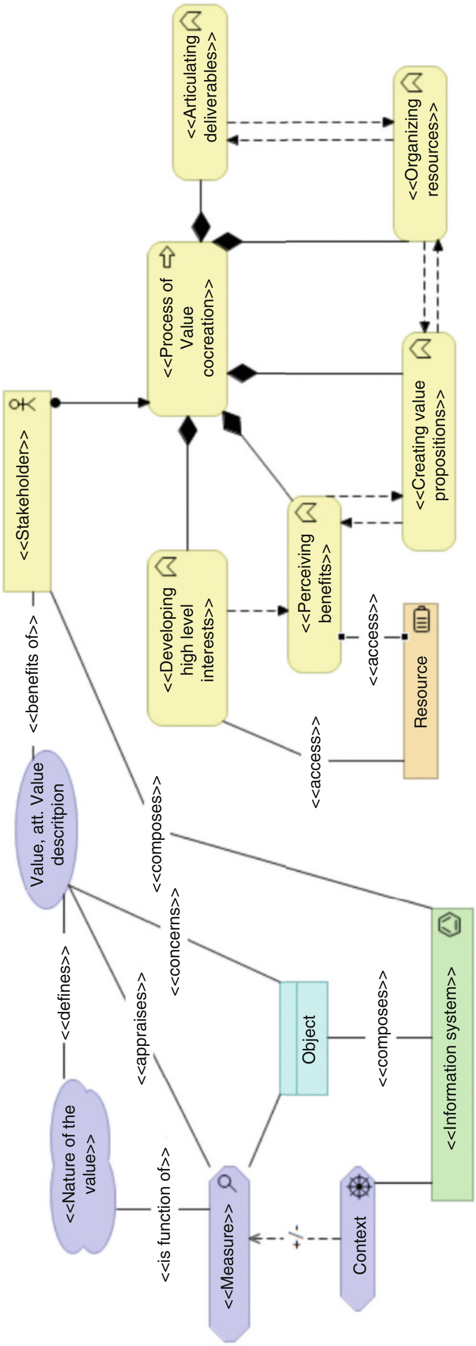


Fig. 7.11 Value co-creation process language (process-language) extension

The pilot involves a large European airline with around 14 Mio passengers per year, whose main hub is at the aforementioned airport, thereby facilitating the airport and the airline to share their data about passengers to jointly turn this available data into integrated intelligent information. At the airport and airline side, this allows significant savings in operational efficiency. Concretely, three main results were achieved: (1) decreased number of passenger losing the connecting flight, (2) facilitating a better scheduling of daily operation and resources required, and (3) enabling a better understanding of the impact of each process on the airport performance. These results potentially impact both the airport business model and the passenger's experience.

On the passenger side, the pilot aimed to improve the passenger travelling experience, which results mainly in less missed connections and decreased passenger waiting times.

The following functional requirements were addressed by the pilot:

- Req. 1: Predict time of passenger arrival to the terminal.
- Req. 2: Predict time of passenger arrival to the processing stations and their demand.
- Req. 3: Elaborate passenger movement heat maps based on demographics.
- Req. 4: Identify passenger movement models and patterns.
- Req. 5: Assess and predict time to reach the gate.
- Req. 6: Identify transfer passenger late arrivals.

Concretely, two main outcomes were delivered from the pilot to achieve these objective: an operation management predictive optimization module and a descriptive passenger system (Fig. 7.12), each of both being structured in sub-objectives. We focus in this chapter on one concrete sub-objective, which consists in reducing the delays in departure flights caused by late passengers. Due to the many possibilities, which can affect a passenger's transit in the airport, passengers may arrive at the boarding gate later than the scheduled boarding time. This delay implies a reduction of revenue for the parties involved, a reduction of the SLA expectations, and a negative perception of the airport and airline. To anticipate these flight delays, the airport together with the airline try to identify the passengers and their movement in the airport and to carry out preventive actions to facilitate passengers in reaching their gate on time. Practically, this sub-objective is achieved by realizing the above functional requirements 1, 2, 4, 5, and 6.

Figure 7.12, modeled with the e3value language proposed by Gordijn and Akkermans (2001), portrays the exchange of value between involved stakeholders (depicted by the links between the actors). The airport systems support the complete operations of the airport, including in particular arrival and departure control system (such as assignment of planes to gates), on-site check-in, baggage handling, and security control. The airline management systems support the activities of the airline companies in offering transport services to its customers and in particular support ticketing, online check-in, and passenger management. Both airport and airline systems are essential for supporting the execution of the air transport. As part of the aforementioned pilot, these systems continuously provide data

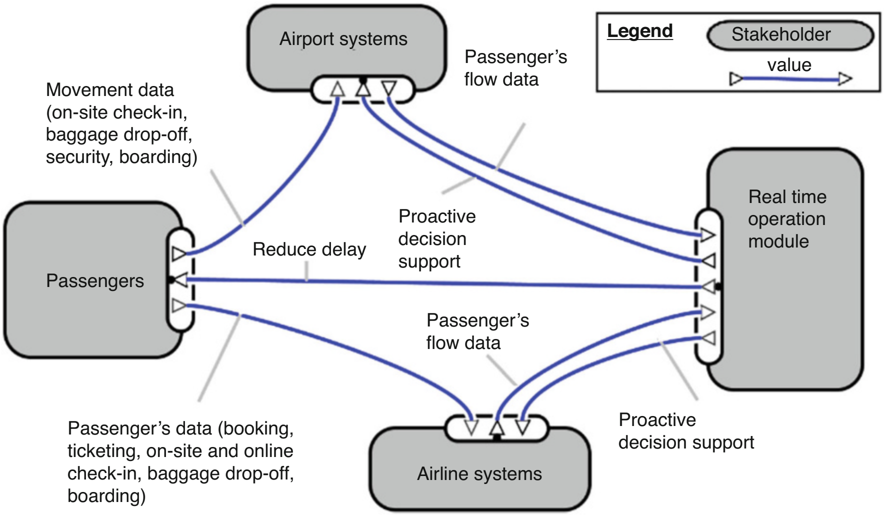


Fig. 7.12 Value co-creation case study summary—e3value model (Published before under nonexclusive copyright (https://fedcsis.org/for_authors/publication) in Feltus et al., 2018c)

to facilitate proactive decision-making based on the real context. The real-time operation module developed by the pilot provides this proactive support based on real-time information about passenger flow from the airport and airline systems. The operation module only uses anonymous passenger data to trace passenger flow, and does not use any personal-related information. Passenger movement is traced by means of when a passenger passed each of the different checkpoints (booking, ticketing, check-in, baggage drop-off, security, and boarding). Note, however, that this passenger movement is never matched with the personal data of passengers in the airline system.

7.5.2 Value Co-creation Language

As explained in the introduction of this chapter, the air transport case study illustrates the process of co-creation of value between the passengers and the airport/airline companies. During that co-creation, anonymized data about passenger position in the airport is shared with the airport/airline companies in order to improve their travelling experience. In turn, the airport and airline companies also exchange data among them in order (1) to improve the passengers' satisfaction and (2) to save operational efficiency and by the way improve financial return.

Figure 7.13 clearly highlights the advantages of using a language to express the value creation. The suggested ArchiMate extension for that matter offers the following facilities:

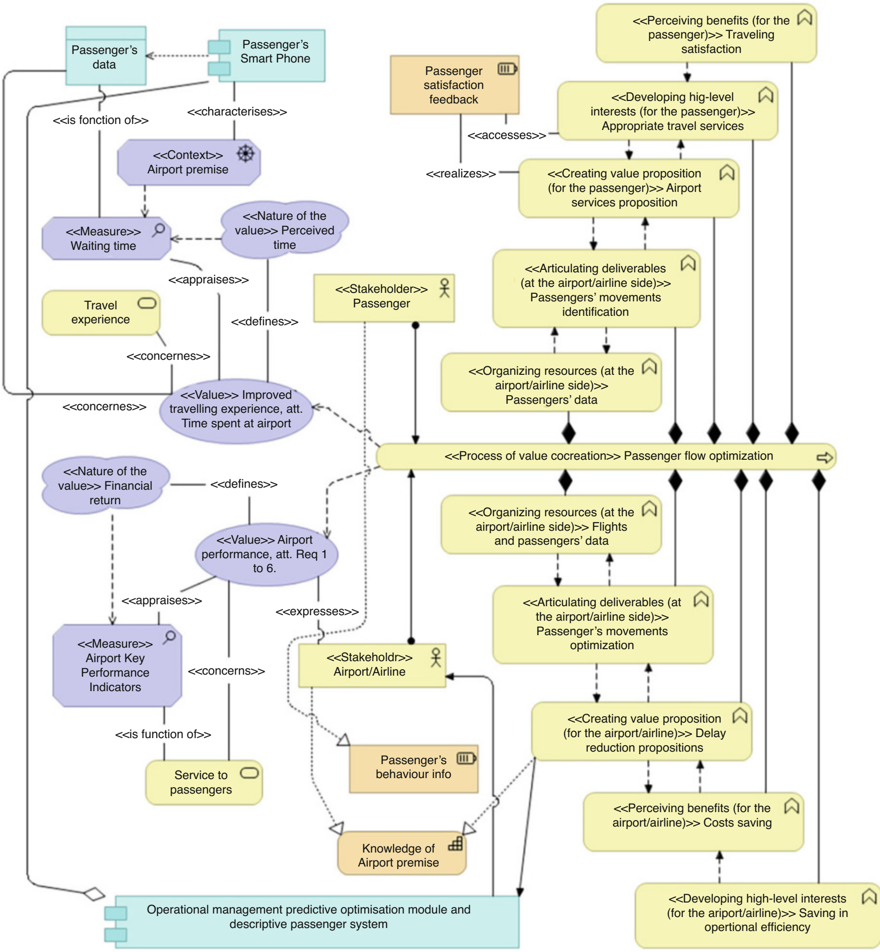


Fig. 7.13 Illustration of the VCC process language

- The elements expressed in the model are classified using a code of colors. That is, business concepts are in yellow, IS technical assets are in light blue, and value-related concepts are in purple. The latter are mainly specializations from the motivation extension of ArchiMate, which means that the co-creation of value is something that may be perceived in parallel to the information system but that motivates the design of the latter.
- Concept reading is facilitated using the shapes of the symbols. For instance, value elements are rapidly detectable on the model because they are oval. The nature of this value is also easily isolated because they are clouds, etc.

Using this ArchiMate extension to value creation thus may facilitate communication about the creation among all stakeholders (IT, business, operation, etc.) and to understand the relationships between the VC elements, e.g., the ≪*activities*≫ compose the ≪*method*≫, the ≪*stakeholder*≫ is assigned to the execution of the ≪*method*≫, etc. Moreover, ArchiMate allows us to benefit from the fact that concepts can have an explicitly attached meaning. For example, a task that realizes a capability is illustrated using a dot line with a white arrow, the flow between the activities is illustrated in dashed line with a black arrow, and the generic association is illustrated using a plain line. To improve the semantics of the latter, this association has also been specialized. For example, the ≪*measure*≫ ≪*appraises*≫ the ≪*value*≫. Finally, the diagram of Fig. 7.13 also allows clearly distinguishing the activities of value co-creation assigned to the passengers (upper part of the diagram) and assigned to the airport/airline companies (lower part). It is also worth noting that this case study has the particularity of combining performance (of the services offered to the passengers) and quality (of the travel experience offered by the airport/airline companies). Such a co-creation of value of different natures (performance and quality) is coherent with the semantic of the value concept (see Sect. 7.3.2).

7.6 Conclusion

The increase of competitions and the arising of new forms of communication between companies generated new types of collaboration during which providers and customers need to join their forces to cocreate value. Value co-creation is a concept developed by the marketing theory (e.g., Vargo and Lusch, 2004; Grönroos, 2008; Vargo and Lusch, 2008; Wille et al., 2013; Frow et al., 2015), which has progressively been integrated in the field of computer and service science (e.g., Weigand, 2009; Chew, 2016; Razo-Zapata et al., 2016; Gordijn et al., 2000; Feltus and Proper, 2017a). Although a plethora of research exists aiming at depicting the fundamental of VCC, few contributions have been poured so far in the area of language to support a method for VCC design and deployment. Nevertheless, such a language is necessary to describe and to visualize different components of the information system, as well as their underlying relationships and dependencies.

Acknowledging that, this chapter has proposed firstly to extend ArchiMate enterprise architecture language to express the creation of value following the value creation model proposed in Feltus and Proper (2017a). This extension was realized by exploiting the two ArchiMate extension mechanisms, to know the specialization and the addition of attributes. Secondly, the chapter has proposed an ArchiMate extension to express the process of value co-creation. Therefore, we have considered value co-creation as an instance of value creation and based on the observation that the process of value co-creation is a type of KIBS (Lessard, 2015). Finally, we have illustrated the designed ArchiMate extension with a case study from a smart airport.

This chapter also illustrated the value co-creation regarding two types of value: the *performance* of the airport and the quality of the travel experience. More recently, value co-creation has also been considered of relevance for the field of

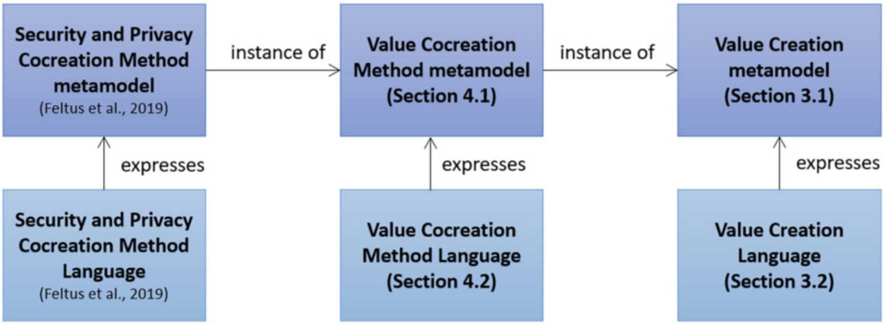


Fig. 7.14 Modeling approach and language extension design of SPCC

information security (e.g., Hawley et al., 2013; Vicini et al., 2016; Bennaceur et al., 2018). In that field *security* and *privacy*, when rightly deployed on the IS, also bring value for the enterprise. The reason is that security and privacy are two characteristics of elements of the information system that improve the stability and reliability of the latter. Furthermore, both security and privacy, according to Feltus et al. (2018b), are themselves defined by the following characteristics: availability, confidentiality, integrity, non-repudiation, etc. (for security) and anonymity, pseudonymity, access to resources, etc. (for privacy). Finally, just like all types of value, security and privacy are also created by dedicated methods (like risk assessment, cryptography, packet filtering, etc.). Based on that statement, we have also investigated how security and privacy co-creation process may be considered as an instance of value co-creation, itself being an instance of value creation (Fig. 7.14). Furthermore, considering security and privacy activities as similar to knowledge-intensive business services (KIBS), we will further specialize the process of value co-creation proposed in Lessard (2015) in a process of SPCC.

In that field of SPCC, some preliminary works have been achieved so far. Vicini et al. (2016) have highlighted that the challenge of security co-creation is twofold: first, to extract the value of the enormous amount of data available in distributed environment and, second, to improve the perception that these data are handled by a trusted system to store privacy-protected content. This challenge is especially important when end-users are directly engaged in the co-creation process (Prahalad & Ramaswamy, 2004). Hawley et al. (2013) show how it is possible to integrate practical co-creation processes into security and privacy by design methodologies and propose a methodology and guidelines to translate high-level requirements into verifiable low-level and technological ones. Bennaceur et al. (2018) address the support of collaborative security in the field of Internet of Things and explain how the collaborative security tends to exploit and to compose the capability of the connected device to protect assets from potential harm. The authors propose an approach supported by a dedicated tool to support the above composition using a combination of feature modeling and mediator synthesis. Hawley et al. (2013) stress the importance of the collaborative approach to security management in the area of air traffic management, due to the fact that operations and systems become increasingly integrated. Accordingly, they claim that for a successful collaborative approach, security managers need to adopt collaborative leadership skills and approaches. More recently, Garrido-Pelaz et al. (2016) propose a collaborative security approach through the perspective of information sharing which can help to develop early prevention mechanisms. Therefore, they exploit a model for sharing cybersecurity information between dependent organizations that are impacted by different cyberattacks. Finally, an ArchiMate-based language to express SPCC was proposed in Feltus (2019).

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