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VALUE MODELING IN ARCHIMATE

INTEGRATING THE VDML AND ARCHIMATE LANGUAGE

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Used abbreviations

VDML	= Value Delivery Modeling Language
VMP	= Value Management Platform
MSP	= Maintenance Service Provider
VP	= Value Proposition
S-D logic	= Service-Dominant logic
G-D logic	= Goods-Dominant logic
OMG	= Object Management Group
CBMP	= Continuous Business Model Planning
BMC	= Business Model Canvas
OMG	= Object Management Group

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1 Introduction

1.1 Motivation

Currently business operate in a fast-changing environment where many opportunities arise because of new information technologies (e.g. cloud computing). These technologies could enable businesses to significantly improve their service offerings while not requiring a huge capital investment simultaneously lowering their own operation cost. On the other hand, the complexity of the business environment increased significantly over time where business esare not considered as separate islands but as engaged within a complex value creating network. Within this network business will corporate with other businesses, governments, customers, etc. thereby creating/delivering and capturing value from and to each other. In order to graphically represent this complex value creation, the VDML can be used. VDML is a standard modeling language introduced by the OMG that enables enterprises to perform a detailed value delivery analysis. However, the VDML is a language that is not easy to understand for business-oriented people. This is where VDMbee provides a solution, through the use of their Value Management Platform they provide an easy to understand graphical user interface based on well-known modeling techniques such as a value stream or a business model canvas. Multiple graphical models will be created in order to clearly understand the value creation of a business integrated within a complex value network. These views will be mapped to corresponding VDML shapes in order to provide a detailed value stream analysis that clearly represents how values are received from partners and customers and how these are aggregated up to values that the business itself captures and provides to its customers. This will create a blueprint of the business and support businesses for future decision making. However, the implementation of a particular initiative is not supported by the VMP. This is where the use of an Enterprise Architecture can provide insights. An enterprise architecture provides an overview of the different layers that constitute the enterprise in order to enable alignment between them. This will often result in a complex enterprise model however an enterprise architect will define certain viewpoints in order to graphically represent only those elements of the architecture that matter to a certain stakeholder. Hence, when one might be interested in implementing a new idea that requires new capabilities to be implemented within the enterprise. These capabilities might be provided by specific business processes that are in turn supported by the right applications and technology. Therefore, an integration between both languages might provide benefits for at one hand taking decisions for future direction and at the other hand implement these decisions within the existing enterprise architecture. This will be the topic of this master dissertation where research will be conducted to see how the VDML and the ArchiMate language can be integrated with each other.

1.2 Problem definition and research question

In order to investigate this integration a research question will be defined. The main research question with three sub-questions are described below. The three different sub-questions are defined in order to provide a good basis for the general one. Since this integration is involved with value modeling it is important to first define the value concept. This will make sure that value within both languages is understood and contextualized in a bigger frame. The second research question is involved about the representation of value. Since the main topic is about two business modeling languages both of them might have another visualization of this value. In order to find answers to this question both the VMP,

based on the VDML, and the ArchiMate language will be subject of the literature research that will provide insights into the representation of value. Finally, the third sub question is faced toward the integration of the two languages and mainly the integration of the VMP within the ArchiMate langue. Once value is conceptualized and it is clear how it has to be represented, attention is focused on representing a value model in ArchiMate.

Research Question: "How can we integrate Value Modeling in ArchiMate?"

Sub-Question 1: "What is value?"

Sub-Question 2: "How is value represented?"

Sub-Question 3: "How can we represent a value model in ArchiMate?"

1.3 Scope

This master dissertation will focus on the integration of the VDML as implemented in the Value Management Platform (VMP). The Value Management Platform is used for strategic planning and will therefore only support a partial implementation of the VDML focused on the high-level strategic constructs. Additionally, the VMP will support the use of other models such as business model canvases. Also, here a limitation is made with regard to the scope of this research. Where the VMP enable the implementation of multiple canvases (e.g. lean canvas, business innovation canvas) the only canvas considered is the Business Model Canvas of Osterwalder and Pigneur. Moreover, the VMP implemented the transformation of value stream maps to business- and case models. These are also considered to be out of scope.

With regard to the ArchiMate language only those concepts that are considered to be relevant for the mapping will be described in detail, therefore the focus will be mainly on the aspects of the business and strategy layers (incl. motivation aspect). In order to investigate the mapping the ArchiMate language will be used. Note that this language is based on the TOGAF framework. A detailed description of this framework is not considered an only the ArchiMate language will be discussed.

1.4 Research Methodology

The research methodology below will be applied in order to conduct the research in a structured way. The different steps from problem identification to reporting the research findings are presented on Figure 1. The methodology provides an overview of where and how information is collected, and results are obtained. In the end a final conclusion is made along with some recommendations for future research.

Figure 1 - Research Methodology

Problem Identification

The first step of the methodology is to identify the problem, since without a problem there would be no subject to investigate. This step has already been introduced in the motivation part at the beginning of this paper. During the motivation, the main research question was introduced and divided into a set of sub-questions. In addition, the context in which the research will be carried out was defined together with an indication of why this research is important.

Data Collection and Selection

Before starting the literature study, a list of relevant key words is created in order to search for relevant articles/books/journals within different databases. The following key words were defined: Value Modeling, VDML, ArchiMate, Value and ArchiMate, VDML and ArchiMate. The databases used for searching relevant articles were Google Scholar, ScienceDirect and Biblio Ugent. In addition to these sources, the website of VDMBee is used to find relevant articles and research papers about the VMP. Additionally, VDMBee also provided access to slides and learning videos that clearly explained the platform and the method applied within it.

Since time was not unlimited, a selection of relevant articles was made based on publishing date. Hereby it was taken into account that the VDML was only introduced by the OMG as a standard in 2015. Similarly, the ArchiMate language was published in 2008 by the Open Group. Besides publishing date, the number of citations and the credibility of the source where also taking into account. It was assumed that the more citations a certain article has to more interesting it would be for the research conducted within this dissertation.

Insights

Based on the data collection some relevant insights into the field of Value Modeling and Enterprise Architecture will be created. Based on these insights' answers will be provided for the first two sub-questions, namely "what is value" and "how is value represented". This will also provide a good starting point for the research since a good foundation is needed to analyze the different constructs, compare them and identify gaps and similarities between the two languages.

Case Study

In order to illustrate the mapping between the VMP constructs and ArchiMate, a case study will be introduced. This case study is defined by VDMbee in order to guide value management professionals through the platform for continuous business model planning. The Case Study will provide multiple models that are constructed within the VMP, the shapes and the underlying VDML constructs will be mapped to corresponding ArchiMate concepts.

Findings and Future Research

Based on a comparison between VMP and ArchiMate constructs starting from the VMP some findings will be reported. Therefore, the VMP will be used as a starting point to see how the different concepts and shapes illustrated within the different diagrams can map to ArchiMate models and shapes. However, since this is only a first comparison based on one use case some limitations will be discussed. To finalize the results from this research will provide a basis for future research. Accordingly, some recommendations will be made.

2 Literature Research

2.1 Value Modeling

2.1.1 Value

According to Andersson, Guarino, Johannesson, & Livieri (2016) today's value models emphasize on the value exchange between subjects without understanding the real meaning behind the concept of value (e.g. what is it and why does something have a specific value). Besides, they state that "in order to exploit the benefits of value analysis and avoid communication problems, a precise and rigorous conceptualization is needed" (Andersson et al., 2016, p.2). Therefore, a deeper understanding of the value concept is essential before starting the study on the concepts of 'value modeling' and 'enterprise architecture'.

Looking up a first general definition of value in the Cambridge Dictionary the following result was obtained:

"to give a judgment about how much money something might be sold for".

This definition states that the value of an object is represented by the amount of money it is worth. Based on this description it might seem that value is a clear concept. However, the following example will illustrate how diverse it actually is and why it is so difficult for many authors to define it properly.

Let's look at the value of a simple tangible object such as a ring. Based on the above definition it could be stated that a ring of $78 is more valuable than one of $34. However, there are a lot of situations that could change this valuation. The ring could hold some emotional attachment (e.g. a wedding ring, a present from a good friend) or historical background (e.g. the ring of Queen Elizabeth II), making it more valuable. It could also be that an individual is willing to pay more for a ring in a small shop on a vacation then for the same ring in the local supermarket. Additionally, two rings of the same price could be valued based on the personal preferences of an individual (e.g. design, color, size). Or an individual might even not value a ring at all since they don't like to wear it. Hence, determining the value of a ring is based on a lot of factors such as the price, emotional attachment, personal preference, place, time or value of use.

The aim of this part is to provide a clear understanding of the value concept within the scope of Enterprise Architecture and Value Modeling. This will be done by briefly introducing the history of the concept and comparing the different definitions over time to arrive at some general characteristics. Next, a comparison will be made between these characteristics and value as described and used within the two languages of interest – the ArchiMate language and the Value Delivery Modeling Language – resulting in a conceptualization of value as maintained within this master dissertation.

2.1.1.1 The Concept of Value

Value is a concept that has attracted philosophers' interest since ancient times. Hence, to understand the nature of value we have to go back to the 4th century BC when Aristoteles made a first distinction between things (e.g. automobile) and their attributes, which included the qualities (e.g. red, fast, safe, capacious), quantities (e.g. one car) and relations

(e.g. lease, ownership) of such things (Fleetwood, 1997). Based on this distinction he declared that a product could be used in two ways: in use (e.g. driving a car) or for exchange (e.g. exchanging a car for something else)(Eggert, Ulaga, Frow, & Payne, 2018).

Adam Smith – also known as the father of economics – made the same distinction thereby introducing the complementary terms 'value in exchange' and 'value in use' in his seminal work on the 'Wealth of Nations' as follows:

> "The word value, it is to be observed, has two different meanings, and sometimes expresses the utility of some particular object, and sometimes the power of purchasing other goods which the possession of that object conveys. The one may be called 'value in use;' the other, 'value in exchange.'" (Smith, 1963, p.13).

Vargo et al. (2008) define use value as "a collection of substances or things and the qualities associated with these collections" thereby clearly indicating the relation between the use value of a substance and the qualities associated with it. Moreover, Bowman & Ambrosini (2000) state that these qualities are perceived by the individual customers in relation to their specific needs, putting the emphasis on the subjective judgement of value. Hence, use value is subjectively determined by an individual based on the qualities associated with a substance in relation to their specific goals/needs. Accordingly, an automobile (i.e. object) can be seen as a collection of a qualities, both specific (e.g. orange and fast) as generic (e.g. transportation and status) (Vargo et al., 2008). The use value of an automobile depends on these qualities and the extent to which they can fulfill someone's personal needs/goals.

Exchange value, at the other hand, is characterized as "the monetary amount realized at a single point in time when the exchange of the good takes place" thereby highlighting the quantity of an attribute (Bowman & Ambrosini, 2000, p.3 ; Vargo et al., 2008). This interpretation of value, which will be explained in an instant, roots the traditional customer-firm relationship, where each party exchanges one type of value for another (Bagozzi, 1975; Ng, Smith, & Vargo, 2012). For an automobile the exchange value is characterized by the price a customer is willing to pay (Bowman & Ambrosini, 2000). More specifically, an exchange will take place when a customer willing to pay a price (exchange value captured by car manufacturer) in exchange for the car (product containing use value to the customer).

Smith recognized use value as 'real value' in the shape of labor while exchange value was the 'nominal value' that represented the amount of money a person is willing to pay (Vargo, Akaka, & Vaughan, 2017; Vargo et al., 2008). However, from an economic perspective Smith shifted his emphasis to value-in-exchange and focused on what he deemed 'productive activities' as "those activities that resulted in exchange value through the manufacturing and distribution of tangible goods" (Vargo et al., 2008, p. 147). Ultimately Smith's vision was accepted by most scholars and became a grounded foundation of economic science resulting in a goods-dominant logic view when conceptualizing value, value creation and economic exchange (Vargo et al., 2008). According to this logic, value is created by the firm in the form of tangible resources (i.e. products) embedded with utilities and expressed by the price customers are willing to pay for it (i.e. exchange value) (Vargo et al., 2008). Hence, value is determined and produced by the firm, inherently embedded in goods and defined in terms of its exchange value(Vargo, Koskela-Huotari, & Vink, 2020). Hereby, the main purpose of value was to increase the wealth for the firm that mainly focused on the production and exchange of

goods(Vargo et al., 2020). Use value, at the other hand, was considered of very little interest to firms since it was privately experience by customers after the transaction (Ng et al., 2012). Value propositions in this context where therefore mainly seen as "communication-to-transfer"; a unidirectional offer of value where the firm determines the value and the value proposition sets out a promise of value (Eggert et al., 2018, p.87). Applied to the example of the automobile, it could be stated a manufacturing firm creates value for the customer by transforming raw materials (using its own resources and those from other firms) into something they want (e.g. an automobile). The automobile (i.e. product embedded with utilities) will be delivered to the market where customers can buy it resulting in exchange value captured by the manufacturing firm (Vargo et al., 2008).

While economic studies emphasized the objective conceptualization of value, marketing studies focused more on the subjective character of value (i.e. value in use) as an ultimate driver of exchange (Eggert et al., 2018). This resulted, around the year 2000, in a new vision on value and the value creation process. The focus was hereby no longer on the objective character of value but more on its contextual, experiential and subjective nature (i.e. use value) putting the emphasis on satisfaction and experiences (Vargo et al., 2017). This thought was characterized by Vargo and Lush (2004) as the service-dominant (S-D) logic. The S-D logic evolved over time to "a metatheoretical framework that identifies service (singular[1]) – the process of using one's resources for the benefit of another actor (or oneself) – rather than goods, as the fundamental basis of economic exchange"(Vargo et al., 2020; Vargo & Lusch, 2004a, 2017). Goods are merely seen as service delivery vehicles that are used for the delivery and application of resources (Vargo et al., 2008). Value is no longer created and delivered by firms but co-created through the integration of resources by multiple actors[2] (e.g. firms, employees, customers, government agencies) always including the beneficiary(Vargo et al., 2008). Similar, value is no longer embedded in goods but conceptualized as something that is determined by the beneficiary on the basis of the "value in use" that results from the beneficial application of resources (e.g. knowledge and skills) exchanged (Vargo et al., 2020, p.7). A value proposition is therefore a proposal of value rather than a proposition of value, this emphasizes reciprocity between engaged actors (Eggert et al., 2018). So, value can be proposed by one actor to another one in the form of a value proposition but there is no value until an offering is used – experience and perception are essential to value determination (Lusch & Vargo, 2008; Vargo & Lusch, 2004a). Applied to the automobile it can be stated that the automobile has no value until it is integrated with other resources both private (e.g. driving skills), market-facing (e.g. value received from partners) and public (e.g. public roads)(Vargo et al., 2020)(Vargo et al., 2008). Hence, with this new logic a shift from value-in-exchange to value-in-use was introduced thereby "transforming our understanding of value from one based on units of firm output to one based on processes that integrate resources (i.e. service offerings)" (Vargo et al., 2008, p.149).

[1] Services plural is used to denote intangible goods while service (singular) is the process of using one's resources for the benefit of another actor (or oneself). Hence, the S-D logic does not emphasize on services over goods (i.e. outputs) but rather on the process of serving. (Vargo et al., 2020)

[2] Actors are characterized in terms of resource integration and resource exchange thereby avoiding the traditional "consumer" "buyer" "seller" terms. For example, in a B2B market, an actor (i.e. enterprise) can perform a customer role in one resource integration relationship as well as a buyer or selling in another one. (Vargo et al., 2020)

One of the last extensions of the S-D logic involves the inclusion of a wider configuration of actors resulting in a systems orientation (i.e. service systems[3]) (Vargo et al., 2020).Vargo and Lush (2011) state that this macro systemic view allows a clearer look on the participation of one single actor within this system. Moreover, institutions[4] were introduced as the mechanisms that guide actors' resource integration processes. Both systemic and institutional extensions are enclosed within the definition of service ecosystems as "relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" (Vargo & Lusch, 2016, p.10-11). Naturally, this also has a great influence on the conceptualization of value. Vargo et al. (2017) state that the nature of value from a systems perspective can be describes as phenomenological, always co-created, multidimensional and emergent. All these characteristics stress the importance of value determination by the beneficiary and bridge the traditional 'value in use' and 'value in exchange' to a more general 'value in context' stating that "value is always uniquely and phenomenologically determined by the beneficiary"(Vargo et al., 2020, p.17). Moreover, value is considered a system-level construct defined as "a change in the viability (well-being) of the system" making value measurements particularly difficult since they are based on the multiple dimensions of value in relation to referents, over time and in a particular context (Vargo et al., 2017).

Additionally, Alter introduces the work system theory introducing a work system as a unit of analysis for understanding systems in organizations as well as systems in value constellations (Alter, 2013, 2014). A work system is defined as "a system in which human participants and/or machines perform work (processes and activities) using information, technology and other resources to produce specific products/services for specific internal and/or external customers" (Alter, 2013, p.75). Accordingly, a service system can be defined as a work system that produces services and is part of large value constellations(Alter, 2013). Note, that the work system definition covers the same ground as the service concept defined in the S-D logic however the work system theory provided by Alter emphasizes operational systems producing services and contributing to the co-creation of value rather than economic exchange as fundamental concepts(Alter, 2014). Value co-creation occurs where activities in customer's value creating work systems and provider's value creating work systems integrate with each other, similarly co-production occurs within a work system activity whose actor role include customer participants and non-customer participants (Alter, 2014, p.10). A value proposition in accordance with the work system theory can be regarded as "a promise of benefits and a contractual arrangement as a specification of deliverables, costs, and other measurable outcomes"(Alter, 2014, p.10). Hence, by using a work system as a service system value can be analyzed in a value constellation where value is co-produced and co-created within and between service systems.

Besides the conceptualization of value in the G-D and S-D logic there are also a number of studies that focus on an ontological analysis of the value concept thereby transcending both logics. Andersson et al (2016) describe value as inherent to the value ascription process depending on the recipient's desire and satisfaction with the provided solution.

[3] A service system is "an arrangement of resources (including people, technology, information, etc.) connected to other systems by value propositions" (Vargo et al., 2008, p. 149). Their function is to use their own resources and those of others to create value defined as "an improvement in the system well-being" (Vargo et al., 2008, p. 149).

[4] Institutions consist of formalized rules and less formalized norms defining appropriate behavior, as well as cultural beliefs and cognitive models, frames and schemas encapsulating the often taken-for-granted assumptions and beliefs fundamental to guiding social action in different situations (Scott in Vargo et al., 2020, p.12).

Moreover, the value determined in the value ascription process depends on the state (e.g. state of having no car might increase the value of a car) and context (e.g. location, product availability, social rules). Moreover, a distinction is made between atomic value and aggregated value, in which aggregated value contains the overall value an agent ascribes to an object resulting from the weighted sum of all the atomic value's weights. For example, the aggregated value of having a car can be the result from the utilitarian value[5] when using it for work and the hedonic value[6] when using it for a joyride. Similar Gailly, Roelens and Guizzardi (2016) considered value as co-created and uniquely determined by the customer based on their satisfaction of the proposed potential value. The satisfaction level is hereby determined by the customers perception of how good their problems are solved (i.e. their goals are achieved) in a given situation (i.e. caused state).

Finally, Axiology – the study of value within the philosophical discipline – contains ethical and aesthetic aspects of value. Value within this context is based on the claims, truth, and validity of value judgements (Hart, 1971). Ethical value is concerned with notions of good versus bad or right versus wrong, why do we perceive one behavior as good while perceiving another as bad (e.g. why is it considered bad to steal something or to punch someone in the face for no reason). Aesthetic value, on the other hand, is more concerned with notions of beautiful versus ugly (e.g. why is one piece of art perceived as beautiful and another one as ugly). Within this context, value is related to judgements based on the cognitive intuition or right love which grasps the rightness of an object (Hart, 1971). Therefore, value is often related to desire, emotion, cultural acceptance, passion, interest, etc. While this study of value is an important aspect of 'the theory of values' it is considered to be out of scope for this master dissertation. Taking all the above insights together it can be concluded that:

- Value can only be determined by the beneficiary (Andersson et al., 2016; Bowman & Ambrosini, 2000)
- Value has to be co-created (Ng et al., 2012; Vargo & Lusch, 2004b, 2008; Woodall, 2003)
- Value is always associated to a value object (tangible/intangible) (Allee, 2008; Bowman & Ambrosini, 2000; Ng et al., 2012; Woodall, 2003)
- Value has the purpose of fulfilling some need or desire (Andersson et al., 2016)

According to this conceptualization of value it can be stated that at one hand value is co-created within a large value network involving multiple actors (i.e. service ecosystem) and at the other hand value is associated to a value object delivered by a particular actor within this complex value network. Within the scope of this master dissertation, as will be clear in the next part, both perspectives are important since alignment between them is necessary to create and deliver valuable products/services to the recipients.

[5] Utilitarian value is the value that a customer receives from the functionality of a purchased product (Babin, Darden, & Griffin, 1994)
[6] Hedonic value is the value that a customer receives in terms of subjective experiences of fun and playfulness (Babin et al., 1994; Holbrook & Hirschman, 1982)

2.1.1.2 Making the Link with VDML and ArchiMate

VDML defines value as "a measurable factor of benefit delivered to a recipient in association with a deliverable. Examples of value include the fitness of a product for a purpose, a measure of product reliability, a probability of production defects, a commitment to future delivery of another deliverable, a measure of product or brand prestige, information that provides a business advantage, or any other feature or benefit that would affect the desirability of a product, service or economic exchange" (Object Management Group, 2011, p.2). This definition of value is in line with the four characteristics defined before but also states that value should be measurable. Accordingly, only values that can be measured used and represented within the VDML. Note that this does not mean that only price related values are included. For example, a value 'CO^2 emission' can be represented in the VDML since it represents a measurable factor expressed in kg CO_2/km and influenced by factors such as fuel (e.g. diesel, petrol, LPG) and fuel consumption. Moreover, VDML states that "a measurement represent the degree to which a property is present and may be either an objective or subjective measure"(Object Management Group, 2011, p.12). This clearly indicates that the definition of value in the VDML includes value-in-exchange as well as value-in-use.

ArchiMate defines value as "the relative worth, utility or importance of a core element or an outcome. Value can go two ways: it may apply to what a party gets by selling or making available some product or service or to what a party gets by buying or obtaining access to it" (Lankhorst, 2016, p.84). This definition clearly covers both value-in-use and value-in-exchange conceptualizations of value. In relation to the four value characteristics defined before, ArchiMate states that value (i.e. value element) is; (1) associated with the beneficiary (i.e. stakeholder element) indicating that this value is defined from their perspective and (2) associated with the result being produced (i.e. a particular outcome, product, service or deliverable) and (3) represents the worth, utility or importance of a concept. This latter one is consistent to 'value as the fulfillment of some need' as is represents the importance or utility of some result for a particular stakeholder. However, the value co-creation aspect is not clearly defined in the ArchiMate model since it mainly serves the purpose of understanding the interconnections and interdependencies between different enterprise elements.

Since the objective of this master dissertation concerns the integration of both languages, a definition of value consistent to the one of VDML will be maintained.

2.1.2 Value Delivery Modeling Language

2.1.2.1 Introduction

Organizations operate in a continuously changing environment, as should be more than clear in the current situation where COVID forces many organizations to reconsider the way they are doing business. However, when considering the implementation of a new strategy it must be clear how a company creates and exchanges value. This value exchange, as discussed in the previous part, involves a complex and dynamic network including multiple actors (i.e. service-for-service exchanges in a service ecosystem). Value models can be helpful in analyzing a business within this complex environment thereby supporting the implementation of strategy and the design of these complex value networks. More concretely, it can help to determine what an enterprise must do (i.e. activities) and needs (i.e. capabilities, resources) to create value for itself as well as for its customers.

Therefore, it might be useful to first have a brief look into the value creation process as described in an ecosystem involving multiple interconnected actors. Vargo, Maglio, & Akaka (2008) describe this value co-creation process, as represented in figure 2, as several service systems connected to each other through value propositions.A service provider will propose value based on its competencies and capabilities (knowledge and skills) and this proposed value will be accepted/rejected or stay unnoticed by other service systems in need of resources (Vargo et al., 2008). However, value will only be realized when the resources of the provider are integrated with the resources of the beneficiary (e.g. value is only realized when a car provided by a car manufacturer is integrated with the driving knowledge of the beneficiary). Hence, service systems use their own resources as well as those provided by other to improve their own well-being and those of others(Vargo et al., 2008). Note that resources as applied in the S-D are defined as "anything, tangible or intangible, internal or external, operand or operant, an actor can draw on for increasing viability" (Vargo et al., 2020, p.17). Accordingly, value in use is expressed as the systems well-being and the driver of value co-creation while value-in-exchange is expressed as "the negotiated measurement offered and received among exchange partners" and therefore it can "provide a way of measuring relative value within a context of surrounding systems"(Vargo et al., 2008, p.150).

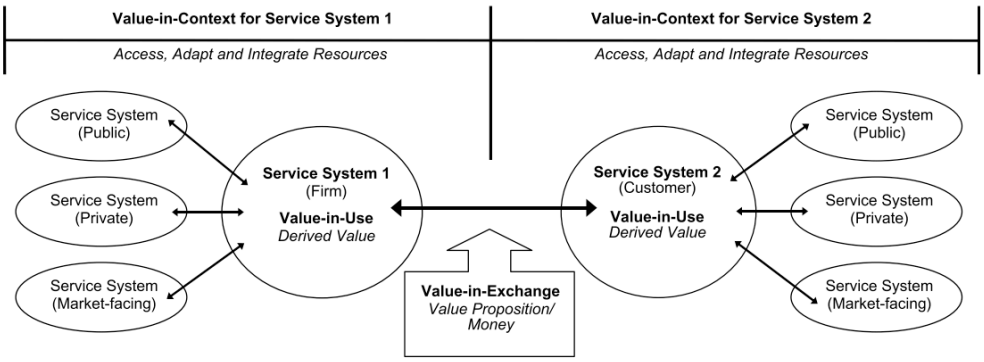


Figure 2 - Value co-creation amongst service systems (Vargo et al., 2008)

When conceptualizing the value concept in the previous part, it was mentioned that the value as co-created within a complex and dynamic value network can be complemented with a more internal perspective. This internal perspective consequently considers the internal value creation process within one service system in relation to their specific role.

Hence, what does a service system in a particular role (e.g. customer supplier) internally do in order to deliver a value proposition within this ecosystem. Bowman & Ambrosini (2003) state that organizations, in their role of supplier, seek to optimize the exchange value captured from its customers and, in their role of customer, seek to optimize the use value of the acquired inputs. Based on this distinction they identify activities that contribute to the creation of these values and combine them as 'value creating' activities. Similarly, Porter (1985) developed the 'Value Chain Model' that served as a tool for understanding how firms create, sustain and maximize value for their customers (Ricciotti, 2020, p.193). In his book, 'Competitive advantage. Creating and sustaining superior performance', he investigated why certain companies failed in gaining competitive advantage in comparison to others (Eylenbosch, 2013). According to his research this failure was mainly determined by the fact that these companies were unable to properly convert their business strategy to the supporting business activities. With the introduction of the Value Chain Model, he identified primary activities as value-adding activities and secondary activities as necessary but non-value adding activities. He believed that by focusing on the former one firms would be able to better align activities with the overall strategy thereby maximizing value and minimizing costs (i.e. achieve competitive advantage). Accordingly, enterprises are seen as creators of new use value that can be offered to the market in the form of a value proposition and, if accepted, result in exchange value captured by the firm resulting in internal use value.

In line with these perspectives numerous value models have been developed, some are oriented towards a more inherent perspective aligning a business strategy with the enterprise (e.g. business model, value chain) and others are more oriented towards an external perspective considering the business as an actor within a complex ecosystem (e.g. value network, REA, E^3 value modeling). However, all of them are important to consider when implementing a strategic initiative and therefore a standard modeling language integrating these perspectives could provide a lot of benefits. The Object Management Group (OMG) realized this need and launched the VDML specification as a value modeling standard that integrated all the different views into one coherent unambiguous language.

2.1.2.2 Core Concepts

The Value Delivery Modeling Language (VDML) is a modeling language that provides an abstraction of the enterprise linking strategy and business models to the operations expressed by its activities, capabilities, resources and roles (Object Management Group, 2011). Its purpose is to support the analysis and design of the operation of an enterprise emphasizing value creation and value exchange (Object Management Group, 2011). Therefore, VDML was developed to support multiple viewpoints consistent to existing modeling languages. This explains why VDML is capable to provide a complete enterprise-level overview on the operation of a business (Object Management Group, 2011). Moreover, using existing modeling technique makes it easier for business people to get familiar with the new language since they are already familiar with the existing modeling techniques (e.g. Business Model Canvas).

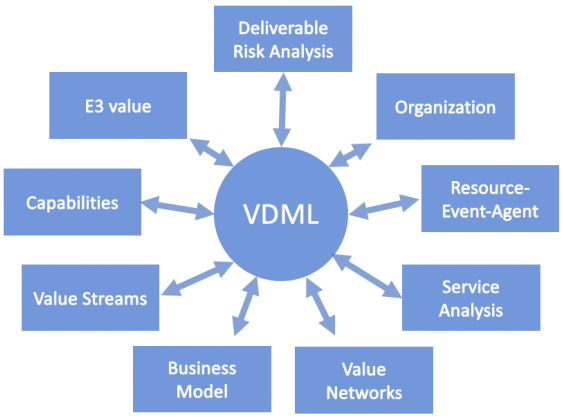


Figure 3 - VDML viewpoints (Object Management Group, 2011)

Within the scope of this master dissertation the focus is on the VDML as applied in the Value Management Platform (VMP). The VMP, introduced in the next part, includes a subset of VDML concepts since its main focus in on creating a high-level strategic tool to support business people in making better and more informed strategic decisions. Therefore, only the core VDML meta-model will be introduced in this section while the specific description of the VDML concepts implemented within the VMP will follow in the next one.

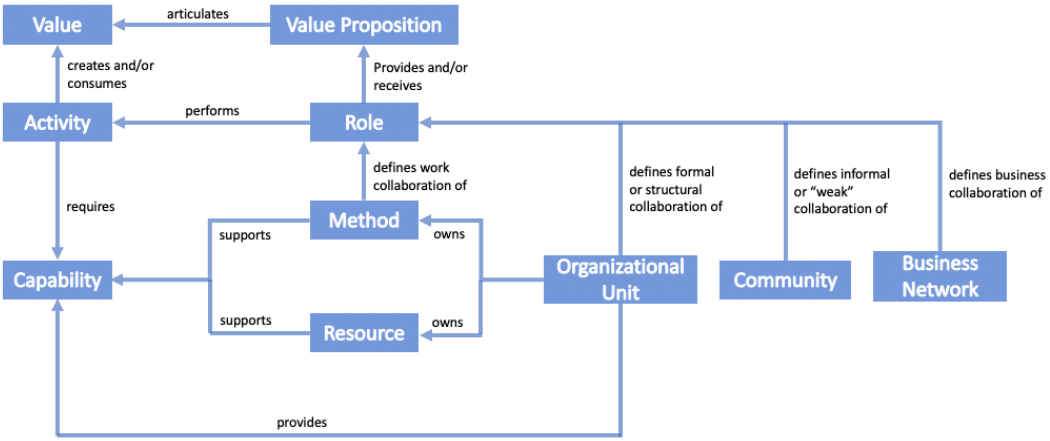


Figure 4 - Core Concepts of the VDML and their relationships

Based on the VDML meta-model, included in figure 4, it can be stated that value is created by activities performed by participants in roles representing collaborations. In order to perform these activities, the right business capabilities are required. Business capabilities represent "the ability to perform a particular kind of work and deliver desired value" (Object Management Group, 2011, p.97). Capabilities are provided by Organizational units (e.g. department, business unit) that have, or have access to, the necessary resources that support this capability (Object Management Group, 2011). Resources can be tangible (e.g. skills, knowledge) or tangible (e.g. facilities, tools, equipment) (Object Management Group, 2011). Additionally, capabilities can also be supported by capability methods A capability method represents an activity pattern that can be used over and over again in different contexts in order to produce some specific deliverables and associated values (Object Management Group, 2011, p.17). Finally, a value proposition is articulated by the values that are created by the different activities. As mentioned, the value concept within the VDML should be measurable. This measurement is operationally the same for all recipients (e.g. speed) but different recipients will have different measurements with regard to their level of satisfaction (e.g. the slower the better, the faster the

better). A value proposition "embodies the values associated with the deliverable(s) and provides a transformation from a Measurement of each value concerned to a level of satisfaction of that value for the particular recipient (e.g., customer or market segment)" (Object Management Group, 2011, p.12). Hence, in general it can be stated that collaborations include participants in roles performing activities that require capabilities, supported by resources and capability methods, in order to produce deliverables and create (or contribute to) value as articulated in a value proposition.

2.1.3 The Value Management Platform

The VDML is able to provide complete picture on the value creation process that can guide the future direction of the enterprise, enable enterprises to compare multiple alternative scenarios and encourage overall innovation (Van Donge, 2016). However, there was no tool available that enabled enterprises to work with the language in a user-friendly way. Recognizing this need, de Man and Van Donge founded in 2004 their own company, VDMbee[7] and introduced the Value Management Platform (VMP) as the first strategic tool that applies the VDML specification for continuous business model innovation and transformation (Poels, Roelens, De Man, & Van Donge, 2018). Therefore, the VMP supports a partial implementation of the VDML focusing on the high-level constructs such as business networks, business models and business value streams (VDMbee, 2018a).

The main purpose of the VMP is to create a blueprint of the business describing how it creates value for its customers, itself and other partners that can be used for future decision making (VDMbee, 2018a). Therefore, a structured method – the continuous business model planning method - was developed in order to guide users correctly through the platform. This method contains three stages – discover, prototype and adopt – emphasizing on the discovery of new business ideas, rationalization of strategy, analyzation of scenarios and monitoring the business by using real-life performance data (VDMbee, 2018a). Throughout the stages multiple graphical models will be created and linked to business objectives as well as overall ecosystem objectives in order to create a complete value creation story of the business as embedded in a business ecosystem. While using the VMP the underlying complexity of the VDML constructs, or more specifically the complex mapping of the graphical VMP models into more formal VDML models, is hidden from the user. Hence, the VMP provides user-friendly tool of working with complex VDML constructs thereby mainly targeting business-oriented people, allowing them to take informed decisions guiding the enterprise into the right direction (Poels, Roelens, de Man, & van Donge, 2019).

As it is the year 2020, it cannot be failed to mention the COVID-19 crisis that currently prevails all over the world. Due to the emergence of this crisis, many companies are forced to rethink their strategy and adapt their existing business models in order to fit within this new environment. To handle this crisis, the VMP could enable enterprises to compare different alternatives and help managers to analyze the impact of these alternatives so that the right one can be chosen. A simple example can illustrate this, imagine the owner of a restaurant proposing value to his customers by making a tasty meal that can be consumed in a pleasant environment. However, due to the pandemic and the corresponding

[7] VDMbee stands for 'Value Delivery Modeling by Business Enterprise Engineering'

lockdown this is no longer possible. Therefore, the owner must consider other ways of creating value for his customers as well as for himself. After a brainstorming session with some customers, employees, family and friends, the owner came up with the following ideas:

- The restaurant could offer take-out meals at a significantly lower price, which could then be picked up by the customer to be consumed at home. Therefore, they could use an already existing platform to reaches as many customers as possible (e.g. Deliveroo, UberEats).
- The restaurant could offer semi-finished meals thereby giving instructions to the customer for the final preparation to create the ultimate taste experience. Moreover, this meal would be accompanied by a matching playlist, some flowers and candles to create the ultimate restaurant experience. To offer this meal, they would focus on targeting existing and new customers using their own resources (e.g. Instagram, facebook, website) and the meals would also be offered at a higher price, however still lower than the price customers would pay when consuming the meal in the restaurant itself.
- The restaurant could close down for the period of the lockdown and afterwards continue business as usual. However, this is an alternative that has a lot of uncertain factors since it is not clear how long the lockdown will last and if it might even be possible to return to business-as-usual.

By using the VMP these alternatives (i.e. scenarios) could be compared to each other as scenarios in one phase. Moreover, different phases could be constructed based on the direction that has been taken. Suppose that the best alternative is the first one, then the next phase could consider staying here or moving to another platform/creating an own platform, creating new partnerships, etc... Hence, the VMP is a tool that supports continuous business model planning (and improvement) by looking into the value creation story of your business model embedded within an environment where it interacts with other business models and participants.

In what follows the different graphical models created in the different phases of the CBMP method will be described in more detail thereby highlighting the underlying VDML constructs. Note that not all models created within the VMP originate within the VDML since it also supports other modeling techniques (e.g., strategy map of Kaplan and Norton, Business Model Canvas of Osterwalder). When this is the case, a clear reference will be made to the origin of the models and how they are represented in the VMP (and mapped to corresponding VDML constructs).

2.1.3.1 The General Structure of the VMP

The CBMP method follows a planning approach based on the concepts as defined within the Business Motivation Model (BMM). The BMM, another OMG standard, provides a structured framework for the development, management and communication of strategic business plans describing the why, what and how of an organization. Complementing the BMM with VDML provides a connection between a strategic plan and the implementation of it in an existing business model. Accordingly, a strategic plan is defined in terms of 'means' that lead to an 'end' as indicated in figure 5. An end indicates what the enterprise wants to achieve (i.e. vision, goals, objectives) and means indicate the things the enterprise will do to achieve these ends (i.e. mission, strategies, tactics)(OMG, 2014). Hence, a strategy is a component of the plan that guides the enterprise towards the achievement of its objectives that quantify the enterprise goals.

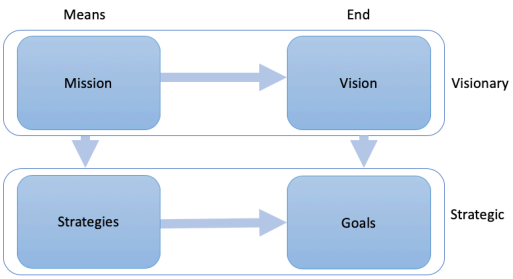


Figure 5 - Strategical Concepts VMP

The VMP implements this by developing a plan in a certain scope[8] where there is a certain mission in order to achieve a certain vision (VDMbee, 2018a). The basic plan structure is represented in figure 6 representing *a plan* in a mission and the different phases in which one or more alternatives can be compared to each other. The definitions of these general concepts are included in Appendix 1.1. At the plan level, values are defined and represent what matters most to the enterprise and its stakeholders (e.g. Key Performance Indicators, Key Business Indicators). These will be used to measure whether you are going into the right direction when doing business (i.e. measuring the success of plan outcomes). A plan will contain one or multiple phases (as-is, to-be, to-be next, etc.). These phases define the different steps that you will take in order to achieve your goal (VDMbee, 2018a) and thereby your vision. For each phase value objectives will be defined and managed, which are in line with the values defined on the plan-level (VDMbee, 2018a). Finally, within each phase different alternatives can be defined to explore different approaches for achieving the phase's value objectives (VDMbee, 2018a).

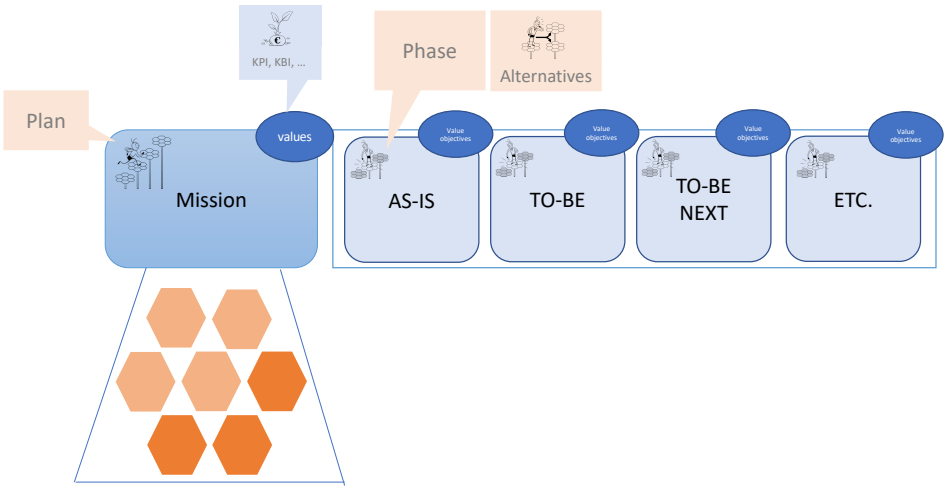


Figure 6 - Basic elements of the VMP (VDMbee, 2018a)

[8] The OMG (2011) declares that the scope of a VDML model, and therefore the scope of a model made within the VMP, will depend on the purpose of the model. Often a VDML model will be created to address a specific problem and afterwards this model will be used and updated in order to maintain business performances and quickly respond to problems and opportunities encountered in the future.

In order to reach the defined value-objectives over time, strategies need to be incorporated into the plan describing how these value-objectives will be achieved. The incorporation of these strategies within the VMP will be done by using the business model concept (hexagon in figure 6). Zott et al. (2011) state that business models are a source of competitive advantage and that the value creation process defined within them is not linear but "involves a more complex, interconnected set of exchange relationships and activities among multiple players" (Zott, Amit, & Massa, 2011, p. 1032). Moreover, it is important to emphasize that a business model is not just a product-market strategy (e.g. cost leadership, product differentiation) or corporate strategy but describes a firm's value proposition to the customers and mechanisms to capture value (Poels et al., 2018; Zott et al., 2011). Accordingly VDML defines a business model as "a description of the rationale of how an organization creates, delivers and captures value" (Object Management Group, 2011, p.97). This is also consistent to the implementation of the business model concept within the VMP. Additionally, VDMbee (2018) states that in order to understand how a business really works you need to consider your business environment that can be described as an ecosystem of interacting business models. Hence, within the VMP the mission can be decomposed into multiple interaction business models of the business, its customers and its partners. These business models will define how the business operates in each phase (i.e., business model evaluation) and alternative (i.e., business model variation) in order to continuously improve value creation and value delivery. Note that multiple business models can exist within one organization, some might focus on the internal customer (i.e. internal business models) while others focus on the final customer (i.e. customer-facing business models) (VDMbee, 2018a). In order to consider a business model within this complex environment, where it is related with many other business models, the VMP uses the Business Model Cube framework of Lindgren & Rasmussen (2013) as a unit for analysis, simulation and prototyping. This is also where the VDML is integrated within the platform, VDML operates as the data model for the VMP, hence it defines the different elements and the relationships between them (VDMbee, 2018a).

2.1.3.2 The Continuous Business Model Planning Method

The Continuous Business Model Planning (CBMP) method is about making a closed-loop plan for innovation or transformation of the business thereby expressing it as an ecosystem of interacting business models (VDMbee, 2018a). The CBMP method contains three stages (i.e., adopt, discover and prototype) that will be followed within each phase of the plan. For each stage a role (i.e., workshop leader, analyst, change agent) will be assigned representing its specific responsibilities. In the appendix 1.2 an overview of the different stages is provided as indicated on figure 7. The focus of this master dissertation will be on the different models created within these stages.

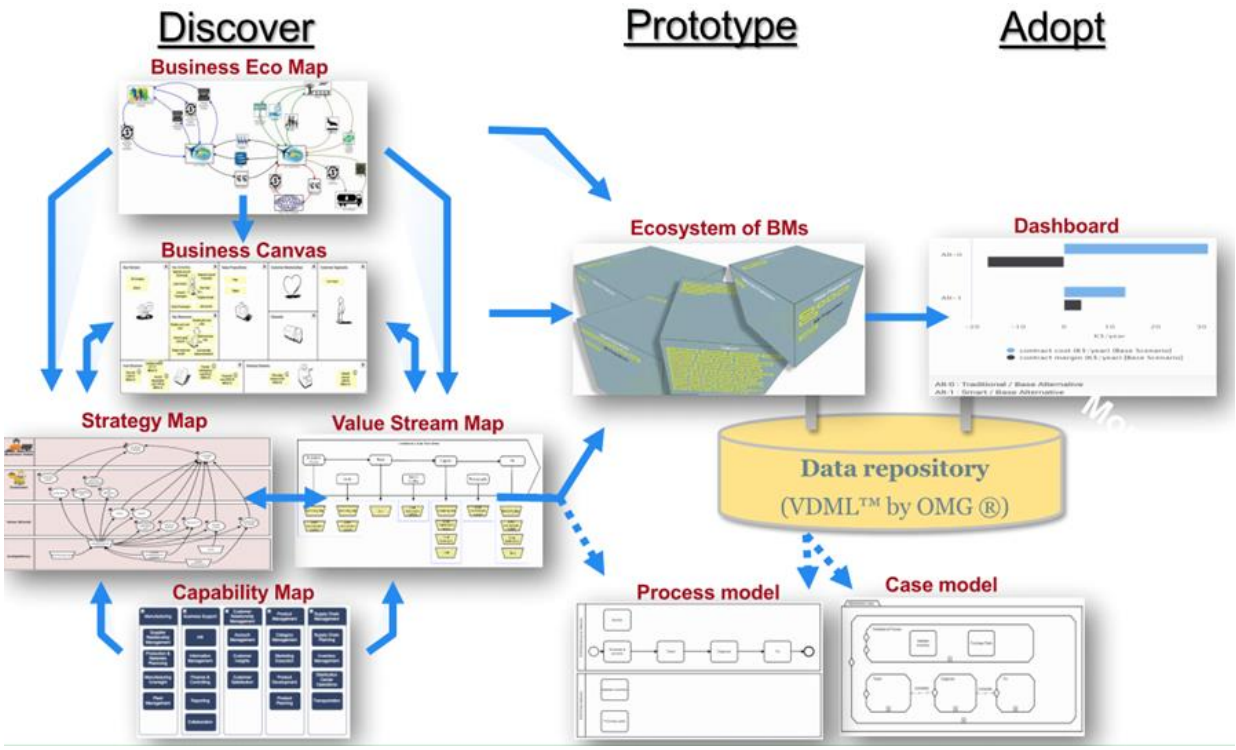


Figure 7 - The different stages of the CBMP with their conceptual models

2.1.3.3 Models of the Discover Stage

In this part a description of the different models from the discover-and prototype stage will be provided. For each of these models, the original methodology/framework will be described and afterwards its implementation in the VMP. Hereby the correspondence to VDML constructs will be emphasized.

2.1.3.3.1 Capability Map/Capability Library

2.1.3.3.1.1 Capability Map/Library in VDML

A CapabilityLibrary as defined in the VDML provides "a taxonomy of Capabilities, consisting of CapabilityDefinitions and categories of them, and is applied to enforce consistency in the definition of Capabilities"(Object Management Group, 2011, p.67). Hence, within a capability library two levels can be distinguished: Capability Definitions and Capability Categories. The first provides standardized definitions for capabilities provided by multiple organizations (i.e. Organization Unit), the latter groups similar Capability Definitions into categories (e.g. business areas) which can be part of a hierarchy of capability Categories (Object Management Group, 2011).

As indicated in the definition, the main purpose of a Capability Library is to enforce consistency in the definition of Capabilities(Object Management Group, 2011). More specifically, a Capability Library link multiple Capability Offers of organizations and Capability Requirements of Activities to the same Capability Definition (Object Management Group, 2011). A Capability Offer represents the ability of an organization to provide a specific capability and therefore they can use and/or own capability methods capable of delivering this capability offer. The definitions of CapabilityOffer, CapabilityMethod and Capability are included in table 1. A capability library can therefore be used to get a better

understanding of which organizational units perform similar capabilities with the purpose of consolidation (Object Management Group, 2011). Moreover, when implementing a new initiative that requires a certain capability a capability library can be used as a reference to existing CapabilityOffers of this specific capability(Object Management Group, 2011).

Similarly, a Capability Library can link multiple Capability Requirements of activities to the same Capability Definition. Activities are performed by participants in roles within a collaboration and in order to perform these activities capabilities are required (Object Management Group, 2011). Therefore, a reference will be made to a capabilityDefinition describing a general definition of this capability requirement. This provides insight into which capabilities are required for which activities and accordingly which capabilities are required to create the value associated with the activities.

Based on the Capability Library VDML also provides the construction of CapabilityLibrary diagrams and Capability Heatmaps. A Capability Map "defines a hierarchy of capabilities required for the enterprise to deliver the desired results along with assessment of the importance and performance of these capabilities" (Object Management Group, 2011, p.107). Hence, a capability map visually represents the different capabilities and capability categories using a nested box structure as represented in figure 8. There is no general specification of additional detail to a capability map model, however the VDML suggest some concepts that can support it; the organization(s) that have and offer the capability the activities performed to deliver the capability, the capabilities/organizations that use the capability, the resources consumed and deliverables produced by the capability, and the values contributed (at the activity level) by the capability (Object Management Group, 2011, p.108).

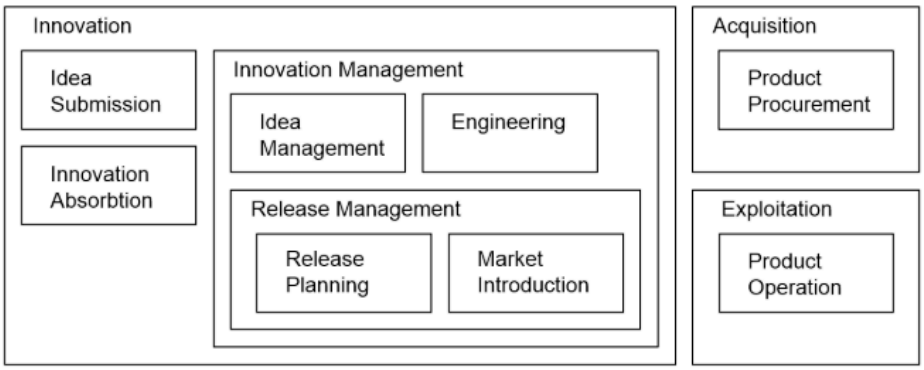


Figure 8 - CapabilityLibrary diagram (Object Management Group, 2011)

VDML concept	VDML definition
Capability	A capability represents "the ability to perform a particular kind of work and deliver desired value" (Object Management Group, 2011, p.97).
Capability Method	A capability method is "a collaboration specification that defines the activities, deliverable flows, business items, capability requirements and roles that deliver a capability and associated value contributions. For each application of the capability method, within a scenario or in multiple scenarios, there may be distinct measurements of performance and value contributions and role assignments suitable to the application context. A capability method does not own resources but receives them from other sources in the course of performing its activities. An activity does not delegate directly to a capability method but engages it through its organization unit based on a Capability Offer." (Object Management Group, 2011, p.97).
Capability Offer	A Capability Offer "represents the ability of an organization to perform a particular type of work and may involve people with particular skills and knowledge, intellectual property, defined practices, operating facilities, tools and equipment"(Object Management Group, 2011, p.13).

Table 1 - VDML capability related definitions

2.1.3.3.1.2 Capability Map/Library in VMP

The VMP will also support the use of Capability Libraries and Capability Maps. Similar to the VDML, VDMbee specifies a capability library as an industry reference model that contains textual taxonomies of capability definitions that are common to an industry (VDMbee, 2018a). Hence, a capability library contains industry-specific capability reference models published by industry organization such as the Business Architecture Guild (VDMbee, 2018a). However, they can also define enterprise-specific subsets or tailored versions of such reference models (VDMbee, 2018a).

Capability Libraries can be visualized in a Capability Map, either partly or fully, indicating the capability hierarchy by using a nested box structure similar to the CapabilityLibrary diagram of the VDML (VDMbee, 2018a). Both concepts are shown in Figure 9, the arrows in the middle represent the conversion between both concepts. Note that multiple capability libraries can be represented in the same capability map.

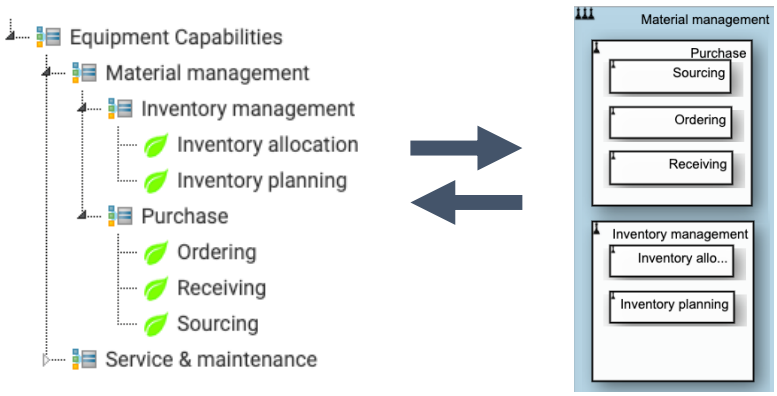


Figure 9 - Capability Library (left) and Capability Map (right) in the VMP (VDMbee, 2018a)

Capability libraries are used within the VMP to make modeling during the discover stage more productive by enforcing the use of industry-standard and/or enterprise standard vocabulary for capabilities (VDMbee, 2018a). In the context stage they can be used to get a more complete picture on what the business and its partners do without thinking about defining and naming these capabilities (VDMbee, 2018a). Moreover, in the value stream map capability libraries can be used to provide consistency between CapabilityRequirements of multiple activities. Capability Maps and Libraries implemented in the VMP are consistent to the ones defined in the VDML, they are built on the same concepts and use the same definitions. However, within the VMP a capability map/library is mainly used for the purpose of linking CapabilityDefinitions with CapabilityRequirements while a capability map in the VDML provides a more thorough analysis of capabilities including multiple levels.

2.1.3.3.2 Ecosystem Map

2.1.3.3.2.1 Value Proposition Exchange Diagram VDML

Within the VDML a business network is defined as "a collaboration between independent business (or economic) entities, potentially companies, agencies, individuals or anonymous member of communities of independent business entities participating in an economic exchange"(Object Management Group, 2011, p.97). In order to display the exchanges between roles within a business network the VDML describes two type of diagrams: a role collaboration diagram and a value proposition exchange diagram. The main difference between both diagrams is their level of abstraction. Where a role collaboration diagram focuses on the flow of deliverables between participants, the value proposition exchange diagram provides a more abstract level representing the exchange of value propositions(Object Management Group, 2011). A deliverable is "the product or service defined by an associated business item that is produced by an activity or delivered from a store that can be conveyed to another activity or store" (Object Management Group, 2011, p.98). Hence, both diagrams align to each other since value propositions correspond to the delivery of multiple deliverables represented within a role collaboration diagram (Cummins, 2017). A simple example of the value proposition exchange diagram defined in the VDML is represented on figure 10. In this example there are two different roles - assigned to a participant in a collaboration - that exchange value propositions with each other. Each value proposition contains a provider and a recipient. However, a role can receive multiple value propositions from multiple other roles. The definitions of role, participant and value proposition applied within the VDML are defined in table 2. As discussed in the next section only the higher aggregation level (i.e., value exchange diagram) is implemented within the VMP.

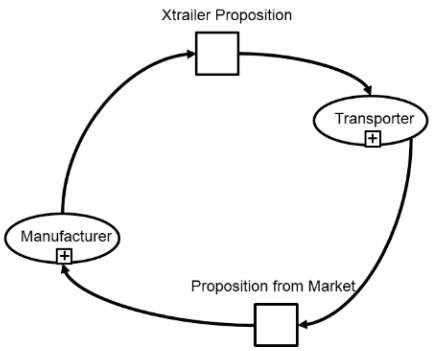


Figure 10 - Value Proposition Exchange Diagram (OMG, 2011)

VDML concept	VDML definition
Role	A role is "an expected behavior pattern or capability" (Object Management Group, 2011, p.97).
Participant	A participant is an "anyone or anything that can fill a role in a collaboration. Participants can be actors (human or automations) or collaborations or roles of actor or collaborations. They may be named in the model, or dynamically determined in run-time." (Object Management Group, 2011, p.98)
Value proposition	A value proposition is an "expression of values offered to a recipient evaluated in terms of the recipient's level of satisfaction" (Object Management Group, 2011, p.99).

Table 2 - VDML definitions of concepts in the value proposition exchange diagram

2.1.3.3.2.2 Ecosystem Map in the VMP

The Business Ecosystem Map is the first graphical diagram that will be created within the CBMP method. It provides a graphical specification describing how participants in Business Models collaborate by exchanging value propositions with each other (VDMbee, 2016a). The main purpose of this visualization is to provide a high-level overview of the Business Ecosystem in which Business Models live thereby identifying key participants (e.g. business model owning participants) and the relationships between them. In line with this definition, Peltoniemi & Vuori (2004) declare that a business ecosystem is "a dynamic structure which consists of an interconnected population of organizations. These organizations can be small firms, large corporations, universities, research centers, public sector organizations, and other practices which influence the system" (p.13). The way these organizations work together can be compared to a biological ecosystem where the different individual species (i.e. interconnected participants) depend upon each other for their survival and effectiveness (Iansitia and Levien, 2004). If the ecosystem is healthy the species will grow, but if the ecosystem is unhealthy the individual species will detoriate. This vision on the business ecosystem is similar to the one represented in the VMP where each participant has to get something in return for what they provide in order to stay in the ecosystem. In other words, they must gain something from it. This reciprocity does not have to be bilateral but can also happen in a triangular or multilateral way involving other participants (VDMbee, 2018a). Figure 11 shows a simplified example of a Business Ecosystem Map as presented in the VMP where two value propositions are exchanged between two participants (i.e. enterprises).

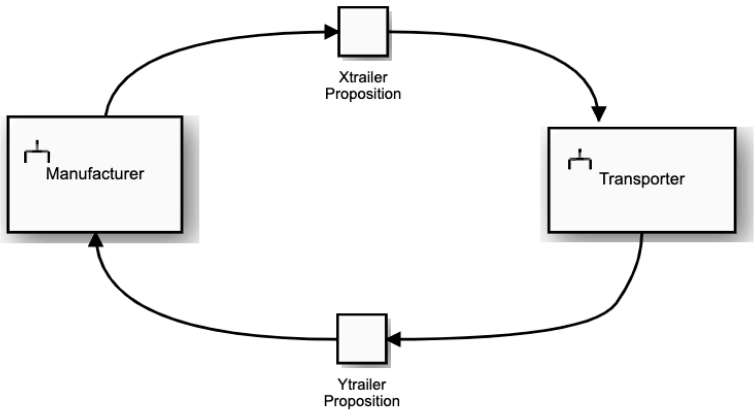


Figure 11 - Ecosystem Map in the VMP

This representation is similar to the value proposition exchange diagram as defined in the VDML. However, a business ecosystem map goes beyond the scope of a business network since it not only represents independent business entities, but also dependent business entities embedded within the same organization. Hence, an ecosystem can be used to represent a value constellation[9], as is the case in this example, a corporation[10] or a combination of both (VDMbee, 2018a). In order to provide a clear coherence between the VMP concepts and the VDML concepts the different elements defined within the VMP will be discussed.

An ecosystem map will represent how multiple participants in business model(s) collaborate by exchanging value propositions with each other (VDMbee, 2018a). Participants implemented within the VMP are consistent to the participant concept of the VDML defined in table 3. In the VMP participants can be expressed as an enterprise (real world or prototypical ones), a market segment or an individual (person, robot, intelligent agent) (VDMbee, 2018a). All these concepts refer to similar VDLM concepts as is described in table 3. Note that participants as defined within the VMP, and VDML, represent different departments within an organization and therefore also include participants that does not assume financial responsibility on their own.

Participants are connected through the exchange of value propositions. More specifically, participants are involved in one or more participant network(s) where they are assigned specific roles through which they provide and receive value propositions from other participants in roles. As indicated in table 3, a value proposition implemented within the VMP is consistent to the VDML definition. Note that values embodied within a value proposition represent those values that are of importance to a recipient. For example, a car manufacturer offers a value proposition to its customers including values like purchase price, CO_2 emissions, number of seating places. However, all these value propositions are appreciated in a different way by different customer segments since it is about the values delivered to the recipient and not the product/service(i.e. DeliverableFlow) delivered to the recipient. For example, the customer segment 'family cars' might attach a higher value to the number of seating places and might not care that much about the CO_2 emissions. Therefore, each value proposition always has to be associated with one customer segment. For example, a car manufacturer will have a separate value proposition for different customer segments (e.g., family car, environmentally friendly car). Moreover, the VMP (implementing the VDML) measures these values in an objective way (e.g., value formula to calculate CO_2 emission in kg/km) as well as in a subjective way. This subjective measurement is expressed in terms of 'satisfaction', 'weight' and 'recipient opinion'. These concepts will be further introduced when explaining the structured business model cube in the next section.

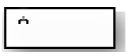
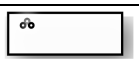
The interpretation of value within the VMP clearly underlines some of the characteristics that have been derived in the previous part; value is determined by the beneficiary (e.g., customer satisfaction, recipient opinion); it is associated to a value object (e.g. product or service); is has the purpose of fulfilling some need (e.g. gain creators, pain resolvers).

[9] A value constellation describes an ecosystem where different corporations (or parts of corporations) collaborate together for some common purpose (VDMbee, 2018a).
[10] A corporation describes an ecosystem between different divisions or departments within one enterprise where each of them could have its own business model (VDMbee, 2018a).

Moreover, by looking at the exchange of value propositions within an ecosystem it is also clear that the co-creation aspect of value is present within the VMP. Remember the example of the car within the S-D logic, a car has only value when customers know how to drive it and have roads to drive on. So, when looking at value exchanges in an ecosystem a firm can understand its offering as an input into the customer value creation process thereby also including inputs offered by other firms (Patrício, Fisk, e Cunha, & Constantine, 2011).

Within the ecosystem multiple participant networks can be distinguished from each other. The main purpose of identifying the different participant networks is to componentize the integrated ecosystem business model and identify those networks on which the structured business models are based. A participant network defines "which participants, in which roles collaborate with each other, by creating and delivering value and exchanging value with each other"(VDMbee, 2016b, p.8) and is consistent to the VDML business network concept.

Additionally, role shapes can be represented within a business ecosystem map. The role shape can be used out of preference or whenever a more detailed description is needed within an enterprise (e.g. model the value propositions exchanged between the roles within a department of your organization). This often results in the creation of multiple ecosystem maps on different levels of abstractions (e.g. market level, enterprise level, department level). Besides the role shape, there is also a Business Model shape available in the VMP. This shape is only used after the mapping of the Business Model Ecosystem map and it will visually represent which participants of the ecosystem is included with its Business Model (i.e. key participants). The role shape and business model shape as implemented within the VMP corresponds to the role as defined within VDML as described in table 3.

Shape	Concept	description
	Enterprise	An Enterprise as used in the VMP corresponds to an Organization Unit in the VDML. The VDML specification (2011) describes an Organizational Unit as an "administrative or functional organizational collaboration, with responsibility for defined resources, including a collaboration that occurs in the typical organization hierarchy, such as business units and departments (and also the company itself), as well as less formal organizational collaboration such as a committee, project, or task force". Hence, this type of participant can own resources (e.g. people, machines, intellectual property) and provide sharable capabilities (Object Management Group, 2011). Therefore, it is only for this shape that a business model can be defined.
	Market Segment	Within the VMP a market segment represents an unstructured group of people that share a common interest, they primarily represent customer segments but could also refer to users, partners, supply markets, political action groups, … (VDMbee, 2018a). This concept is consistent to the Community concept defined in the VDML as "a loose collaboration of

		participant with similar characteristics or interests" (OpenGroup, 2011, p.98).
	Individual	An individual corresponds to an actor in the VDML described as "an individual (indivisible) participant, which might be human (a person) or non-human (e.g. a software agent or machine)" (Object Management Group, 2011, p.97).
	Value Proposition	A value proposition is described in the VMP as an expression of the values offered to a recipient, based on a product or service or a bundle of product(s) or service(s)(VDMbee, 2016b, p.10). These values are evaluated from the perspective of the provider as well as, and most importantly, from the perspective of the recipient's opinion and/or level of satisfaction(VDMbee, 2016b). This is consistent to the VDML definition of a value proposition.
	Role	A role within the VMP is "a part that a participant plays in a participant network, and by that, in a business model" and "Through roles participants perform activities and provide and receive value propositions"(VDMbee, 2016b, p.10). Hence, this is consistent to the VDML definition of a role.
	Business Model	A Business Model defines how a Business, in particular product-market combination, creates and delivers value for the stakeholders involved (VDMbee, 2016b). A product-market combination is typically defined as the combination of a Value Proposition provided to a Customer (VDMbee, 2016b). This is consistent to the VDML definition where a business model is described as "the rationale of how an organization creates, delivers and captures value(Object Management Group, 2011, p.97).

Table 3 - Concepts Business Ecosystem Map

2.1.3.3.3 Value Stream Map

2.1.3.3.3.1 Value Stream

A Value Stream has been described by Martin (1995) as "an end-to-end collection of activities that creates a result for a 'customer', who may be the ultimate customer or an internal 'end user' of the value stream. The value stream has a clear goal: to satisfy (or, better, to delight) the customer."(Brown, 2009, p.6). Accordingly, VDML defines a value stream as "the network of activities that includes resources, value contributions and capabilities to determine a value proposition for a customer who may be the ultimate customer or an internal end user of the result"(Object Management Group, 2011, p.99) and value contributions are the "measurable effect of an activity that affects the level of satisfaction of one or more values in a value proposition" (Object Management Group, 2011, p.99). The VDML itself does not describe a value stream diagram but supports value stream mapping by identifying "the network of capabilities and their activities that contribute to the values and deliverables identified in a value proposition"(Object Management

Group, 2011, p.108). Accordingly, the value stream implemented within the VMP is based on the BizBok guide of the Business Architecture Guild but under the hood this value stream will be mapped to corresponding VDML concepts. Note that the VDML activity network diagram might be considered as similar to the value stream representation however this diagram defines a sequence flow of deliverables between activities while the implementation of the Value Stream diagram within the VMP doesn't map the sequence flow between the different value stream stages. Hence, it provides a higher aggregation level than the activity network diagram indicating the most important, high-level, activities that need to be performed in order to deliver the corresponding value proposition.

2.1.3.3.3.2 Value Stream Map in the VMP

The VMP describes a value stream as "the set of activities (and their values), that contribute to a value proposition (and its values)" (VDMbee, 2016b, p.10). This is in line with the descriptions of the value stream concept above. In the VMP a value stream will be created in relation to a value proposition defined in the business ecosystem map. As stated, the Value Stream is not a VDML concept but is introduced in the VMP based on a standard published in the BizBok guide. The main purpose was to provide a well known user-friendly interface that is - under the hood - mapped to corresponding VDML concepts in a structured business model. The value stream is considered to be initiated by the stakeholder receiving the value created by the value stream VDMbee, 2018b). Moreover, the different capabilities and resources used and applied by the activities are also indicated in the value stream (VDMbee, 2018b). This makes it possible to clearly indicate how a business delivers value to its customer and what they need and must do in order to perform these activities. A simple example of a value stream as included within the VMP is represented in figure 12. Within this example three activities are identified indicating their importance for delivering the value embedded within the value proposition that is realized by the value stream. Moreover, each of these activities is connected within a competency container in which competencies and resources are defined. The same competency can be used or applied by multiple activities and similarly the same activities can be contained in multiple value streams. Note that value objects of activities and value streams are not graphically represented in the value stream (and ecosystem) maps. However, they can be consulted by going into the details of a specific shape. The different definitions of the VMP concepts are included in table 4 where their similarity with the VDML is described

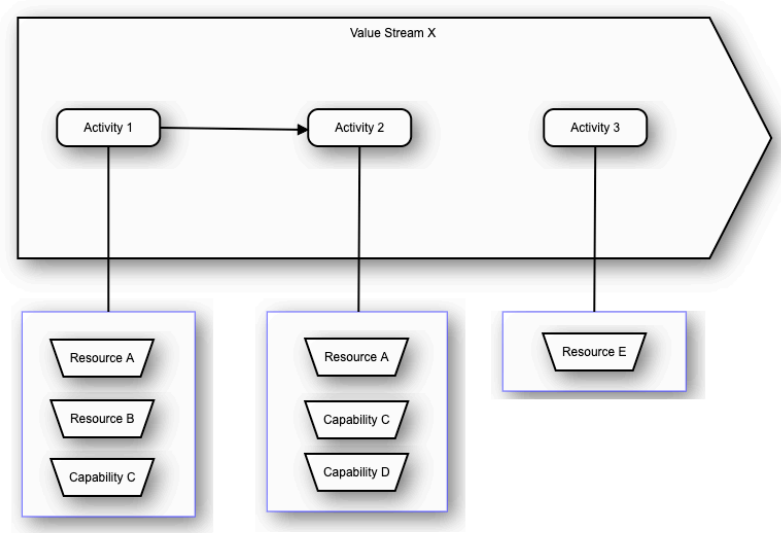


Figure 12 - Value Stream Map in the VMP

In order to provide the connection with the VDML the mapping from the different shapes represented in the Value Stream Map will be shortly described. As can be seen in figure 12 different activities are defined within the value stream where each activity is connected to a competency box in which resources and capabilities are listed. A value stream activity corresponds to the VDML activity concept as indicated in table 4. However, under the hood there is a delegation from this activity to a CapabilityMethod that defines, lower-level, activities that are associated with each of the capabilities defined within the competencycontainer. These lower level activities are at one hand connected to a CapabilityDefinition and at the other hand to a CapabilityOffer for the capability contained in the competency container. A capabilityMethod can be used by multiple stages, however the delegationcontext of these capabilities will each time be different. A delegationContext is defined in the VDML as "a specialized AnalysisContext, set by an activity and in which the activity delegates its work to a collaboration. A delegationcontext also defines the delegations of activity inputs and/or outputs to/from collaboration inputs and/or outputs, and may define assignments of roles within the collaboration"(Object Management Group, 2011, p.98). Hence it enables the VDML to consider different measurements when an activity delegates to the same CapabilityMethod (e.g. different role assignments, different costs, …). Note that these activities could also delegate to another capabilityMethod. Similarly, Resources will be mapped by creating a store with a deliverable for this resource to serve as an input for the activity.

As mentioned, the different values associated with the activities (and value proposition) are not graphically represented in the value stream but can be consulted within the details of the shape. These value objects are consistent to the VDML ValueAdd and ValuePropositionComponents where a ValueAdd indicates the value contribution of an activity (i.e. activity values) and a ValuePropositionComponent the recipient perspective on a particular value associated with the value proposition (i.e. value proposition values)(Object Management Group, 2011). As is the case in the VMP, ValuePropositionComponents are aggregated from ValueAdds of activities in a network of activities that result into the business item that is delivered to the recipient of the value proposition (Object Management Group, 2011, p.41).

Graphical representation	Element Type	Definition
	A value stream	A value stream of a value proposition defines the set of activities (and their values), that contribute to that value proposition. Considering that they also include the definition of resources and competencies the value stream as implemented is consistent to the value stream as defined in the VDML. (VDMbee, 2016b)
	An activity	An activity "represents work performed by a Participant in a Role in a Participant Network" (VDMbee, 2016b, p.10). This is consistent to the VDML activity concept defined as "work contributed to a collaboration by a participant in a Role of the collaboration" (Object Management Group, 2011, p.97).
	A competency	A competency is "an ability that the Business has and applies in order to perform the work as represented by an Activity" (VDMbee, 2016b, p.11). A competency is represented within the VMP as a Resource or a Capability. A capability is the ability to perform a type of work (e.g. concept drafting, hydraulic engineering, liquidity management) (VDMbee, 2016b). A resource are things used by an Activity to produce an outcome (e.g. patent, system) (VDMbee, 2016b). The competency concept is not included within the VDML, however it does define both capability and resource concepts. A capability is defined as "the ability to perform a particular kind of work and deliver desired value)" (Object Management Group, 2011, p.97). And a resource as "anything that is 'used' or 'consumed' in the production of a deliverable" (Object Management Group, 2011, p.99). Hence, both VMP and VDML concepts are consistent.

Table 4 - Value Stream concepts and shapes in the VMP

2.1.3.3.4 Strategy Map

2.1.3.3.4.1 Strategy Map - Kaplan & Norton

In the 1990's Kaplan and Norton introduced the balanced scorecard with the aim of linking measurements to the strategy (Kaplan et al., n.d.). These measurements are defined in a top-down way, starting from the strategy of the business to arrive at high-level measurements related to the performance of customers, internal processes, innovation and improvement activities (Kaplan et al., n.d.). Besides the traditional financial measures Kaplan and Norton also introduced three additional ones. This made is possible for companies to track their financial results while also managing their capabilities(Kaplan et al., n.d.). Moreover, by translating vision and mission statements into these four measurements, enterprises are able to align long-term strategic objectives with short-term actions (Kaplan et al., n.d.).

Kaplan and Norton explain that "balanced scorecards tell you the knowledge, skills, and systems that your employees will need (their learning and growth) to innovate and build the right strategic capabilities and efficiencies (the internal processes) that deliver specific value to the market (the customers), which will eventually lead to higher share- holder value (the financials)" (Kaplan et al., n.d., p.52). Notice that a Balance Scorecard has to be developed for each specific business since different market situations, product strategies and competitive environments result in different scorecards tailored to this specific context(Kaplan et al., n.d., p.52). Based on the analyzation of multiple Balanced Scorecards developed in multiple industries, Kaplan and Norton introduced the strategy map. The strategy map is a framework that translates the different items defined in a balanced scorecard into a cause-and-effect chain thereby connecting outcomes with their drivers (Kaplan et al., n.d.). A strategy Map includes four different perspectives and are often constructed using a top-down approach. The four different perspectives are shortly described in table 5, note that these are only perspectives that are most common and strategy maps can also include other perspectives.

Perspective	Description
Financial	This perspective includes financial strategy aimed at increasing shareholder value and faced towards revenue growth and productivity improvement (Kaplan et al., n.d.). Revenue growth is determined by increased revenue (e.g. new products, markets and customer) and increased customer value. While productivity improvement is achieved by cost reduction and improved asset utilization (Kaplan et al., n.d.).
Customer	This perspective is related to the value propositions offered to customers, hence how will a company be able to deliver value to the customer thereby differentiating itself from its competitors (Kaplan et al., n.d.). Three main differentiators are usually considered: operational excellence, customer intimacy and product leadership(Kaplan et al., n.d.).
Internal Process	The internal process will describe how a business will achieve the elements defined in the two above perspectives (i.e. differentiated value propositions and financial improvement) (Kaplan et al., n.d.).These internal processes are often categorized based on the perspective they support (e.g. increased customer value, productivity improvement) (Kaplan et al., n.d.).
Learning and Growth	This perspective forms the foundation of the strategy map and defines the core competencies and skills, technologies and corporate culture that realize and support the strategy (Kaplan et al., n.d.).

Table 5 - Perspectives of the Strategy Map (Kaplan et al., n.d.)

2.1.3.3.4.2 Strategy Map in the VMP

From the previous maps – ecosystem, value stream – it was already clear that values are exchanged between participants, created by activities, delivered by the value proposition and received/captured by participants. The most important values that are included in the value propositions delivered to customers and partners are defined in the VMP as Outcome I type of values (VDMbee, 2018a). Outcome II values on the other hand, represent the most important values that are captured by the enterprise itself as owner of the business model (VDMbee, 2018a). All the values that

are created by activities and included within the value propositions received from customers and partners aggregate up to these two values. Hence, values influence each other and can aggregate in various directions (VDMbee, 2018a). The strategy map will make an abstraction of these value aggregations by focusing on the most important values that defined the value creation story from the perspective of the business model (VDMbee, 2018a). Hence, it defines how value is created for the business as well as for customers. The Strategy Map implemented within the VMP is based on the Strategy Map as defined by Kaplan and Norton. The value stream map as represented within the VMP is represented in figure 13.

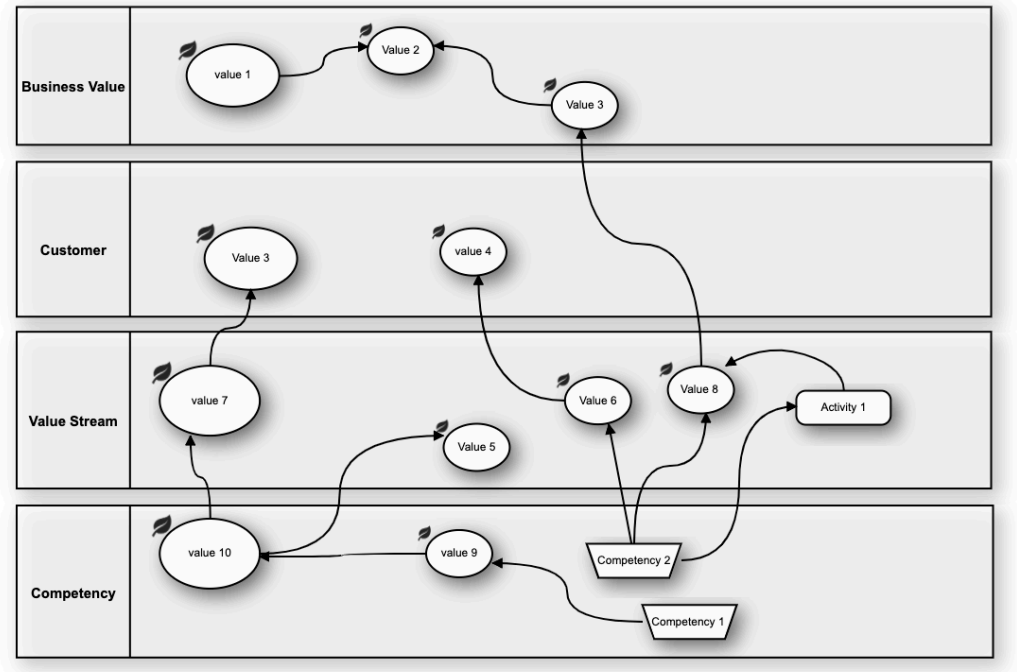


Figure 13 - Value Stream Map VMP

Whenever a map is created the four perspectives will already be pre-defined, but the use of these perspectives is not mandatory. These four pre-defined perspectives correspond with perspectives defined by Kaplan and Norton: business value (i.e. financial), customer (i.e. customer), value stream (i.e. internal processes) and competency (i.e. learning and growth). Value shapes, competency shapes and activity shapes can be placed in each of these perspectives. However, it is recommended to place competency shapes only in the competency lane and activity shapes in the activity lane.

The business value lane includes those values that are most important to one's business. These values include outcome II values that the business captures itself (e.g. revenue and cost values) and values that are received from customers sizing the business volume (e.g. sales forecast) (VDMbee, 2018a). The second lane is the customer lane where the values most interesting for the customers, hence the values included in the value propositions that are delivered to them. These values will often be price values or gain creator/pain resolver type of values (VDMbee, 2018a). The value stream lane will include values and activities that are important to deliver the above customer and business values (VDMbee, 2018a). The values defined within this lane are often activity bound KPIs that are aggregated into customer values and gain creator/pain resolver type of v values received from partners (VDMbee, 2018a). Outcome II values might also be

included within the value stream lane whenever they are not aggregated enough to be a business value but important to consider in the value creation story (VDMbee, 2018a). Finally, the competency perspective (VDMbee, 2018a) will include resources, capabilities and their related values. Values that are included within this perspective often include price related values that you receive from participants, hence the price a business has to pay in order to get access to technologies/competencies owned by the participant. Moreover, competency shapes defined in the value stream can be re-used together with competency related values. The shapes included within this lane are often considered to be the drivers of innovation (VDMbee, 2018a). Hence, the business- and customer perspective describe the most important values that are generated by the business model and the two bottom layers describe how these values are supported by activities and competencies provided by the company or obtained from other participants in the ecosystem (VDMbee, 2018a).

2.1.3.3.5 Business Model Canvas

2.1.3.3.5.1 Business Model Canvas - Osterwalder and Pigneur

Alexander Osterwalder describes a business model as "a conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic of earning money. It is a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams."(Osterwalder in Meertens et al., 2012, p. 1695). The Business Model Canvas of Alexander Osterwalder and Yves Pigneur (2013) describes a business model using nine building blocks: customer segments, customer relationships, channels, value propositions, key resources, key activities, key partners, revenue streams and cost structure. The Business Model Canvas is represented in figure 14 and the different building blocks are described in Appendix 1.3.

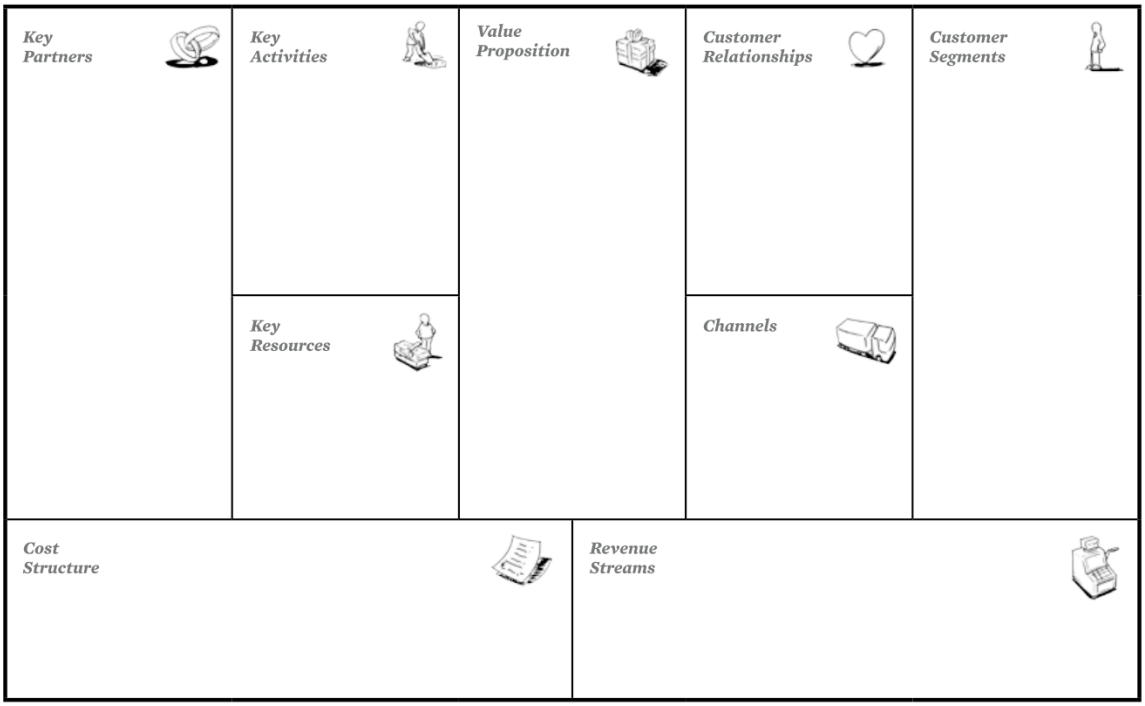


Figure 14 - Business Model Canvas(Osterwalder & Pigneur, 2013)

2.1.3.3.5.2 Business Model Canvas in VMP

Whenever an ecosystem map has been constructed the key participants will be determined. These are the most important participants for the value creation process and therefore it might be useful to define or import their business models. This enables the business, implementing the initiative, to look at the consequences of this implementation from the perspective of their most important participant(s). The VMP supports multiple business model representations (e.g. Lean Startup Canvas, Business Model Innovation Canvas). However, for the scope of this master dissertation the focus will be on the Business Model Canvas of Alexander Osterwalder and Yves Pigneur since this is one of the best-known models used by managers and businesspeople.

A Business Model Canvas provides a static representation of a business model of a single firm (VDMbee, 2018a). Hence, the business model canvas does not consider the business model as embedded within an ecosystem interacting with one or more other business models. Moreover, the Business Model Canvas emphasizes the internal value creation for customer by focusing on value propositions offered to customer, customer relationships and customer segments. However, the VMP does considers business models embedded within an ecosystem thereby integrating value propositions received from partners as well as offered to customers as well as captured by the business itself. Therefore, the business model canvas will be mainly used in early stages of the CBMP method to capture ideas or other information early on in a business innovation or transformation initiative (VDMbee, 2016b). Moreover, the Business Model Canvas can be used to represent different business model concepts defined in the Business Model Cube (i.e. provide a view on the business model cube).

Within the discover stage it is recommended by the VDMbee to let the Business Model Canvas evolve during the different sub-stages. Hence, different elements discovered in the other graphical models can be simultaneously represented within the Business Model Canvas. For example, as represented in figure 15, a value proposition exchange defined in the ecosystem will consider several elements that also can be represented within a Business Model Canvas. However, note that this is only a recommendation and that the Business Model Canvas can also be used to define additional elements that can be mapped to structured data elements.

When representing elements discovered in the different models – ecosystem, value stream, strategy map – it should be noted that not all the discovered and mapped elements can be represented in the Business Model Canvas. As can be seen in figure 15 the business model canvas defines key resources, therefore only the most significant competencies of the resources type can be represented within the canvas. Moreover, the Business Model Canvas will only represent cost and revenue related values often represented in the value stream- and business value lane.

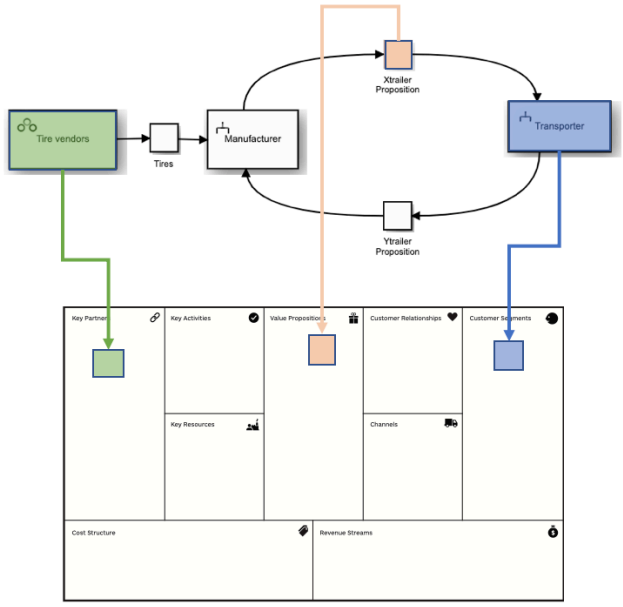


Figure 15 - From Business Ecosystem Map to Business Model Canvas

2.1.3.4 Models of the Prototype Stage

2.1.3.4.1 Business Model Cube

2.1.3.4.1.1 Business Model Cube - Peter Lindgren and Ole Horn Rasmussen

In today's globalized world business models are highly interdependent and connected in physical, digital and virtual networks (Lindgren & Rasmussen, 2013). Therefore, Chesbrough (2007) suggested that business models should no longer be regarded as closed but as open thereby utilizing the dimensions and components of business models of other businesses within their own business models. As a reaction, Peter Lindgren and Ole Horn Rasmussen introduced the Business Model Cube, represented on figure 16, as a generic framework for working with any business model (Lindgren & Rasmussen, 2013). Within the Business Model Cube 7 dimensions are distinguished from each other. Each of these dimensions is necessary in order to describe how a business is operating today and how it should/can operate tomorrow. Accordingly, Lindgren & Rasmussen (2013) make a distinction between "the core business model" and "the business model". A core business model describes how a business wants to construct and intends to operate its main and essential business related to the seven dimensions, while the business model refers to how the business model actually operates (i.e. AS IS business model) or it is intended to be constructed (i.e. TO BE business model) related to the seven dimensions (Lindgren & Rasmussen, 2013). These dimensions will be discussed in the next section.

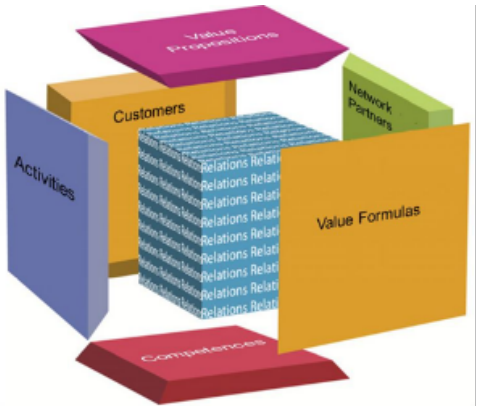


Figure 16 - Business Model Cube(Lindgren & Rasmussen, 2013)

Important to notice is that a business can be described by multiple business models. Each of these business models is described using the same seven generic dimensions but they all will have different characteristics (e.g. different value propositions, users and customers, value chains with different functions). They exist and coexist within the core business but also outside the business (Lindgren & Rasmussen, 2013).

2.1.3.4.1.2 Business Model Cube in VMP

Within the VMP a structured business model is based on VDML concepts and relations. Since the tool is mainly focused toward business-oriented people, they decided to implement the Business Model Cube of Peter Lindgren and Ole Horn Rasmussen as a graphical user interface of this less straightforward VDML model. The Business Model Cube implemented within the VMP provides an integration between the different maps constructed in the discover stage. However, it is faced towards the implementation of a business initiative within real life and the impacts of this implementation. Therefore, the business model will include detailed value aggregation relationships that eventually add up to Outcome I and Outcome II type of values. Moreover, value measurements are associated with these value elements in order to calculate the specific influences of the input values on the business-, customer- and plan values. Therefore, the different connectors defined in the strategy map are further refined by indicating the type of connector and consequently define additional values. For example, looking back at figure 13, there is a relationship from 'value 8' to 'value 3' representing that value 3 is aggregated from 'value 8'. However, this aggregation might include many other values that are not explicitly defined in the strategy map. These values, and value aggregation relationships will all be defined within the prototype stage.

The value measurements associated with the different values define how the values are calculated. These measurements include objective measurements (e.g. cost value formula) but also subjective measurements that include the value from the perspective of the recipient. The subjective measurements are expressed within the VMP as satisfaction, weight and recipient opinion. The weight represents the importance of the different values from the perspective of recipient. For example, the family car segment might assign a weight of 50% to number of seating places, 45% to price and only 5% to CO_2 emissions. Secondly, a recipient opinion can express the perceived value from the perspective of a recipient. For example, a car manufacturer might promise that only 0,01% of the cars will break down in the first 20 years but customers perceive that this is not the case and it is rather in 10% of the cases that a car will break down in the first 20 years. Finally, the satisfaction will express how pleased a customer is with the received value.

This is often expressed by using intervals. For example, for the value number of seating places the customer satisfaction of the 'familiy car' segment will be 90% when there are 7 or more seating places, a satisfaction of 80 when the number of seating places is between 4-6 but only 20% when the number of seating places is lower than 4. By including subjective measurements, it is possible to look at values being created not only from the perspective of the business but also from the perspective of the recipient.

Figure 17 shows the Business Model Cube representation with the VMP. Besides the graphical representation the VMP also supports insight into the story of the different elements within the cube by defining 6 tabs; participants (network partner and customer dimension), value proposition (value proposition dimension), my proposition (value proposition dimension), activities (activities dimension), values (value dimension) and competencies (competencies dimension). Hence, as indicated between brackets, the six tabs refer to the different business model cube dimensions and the relations are described by the stories within these tabs. Table 6 describes the different dimensions of the Business Model Cube (Lindgren & Rasmussen, 2013) in relation to the VMP. Note that 'the business' always refers to the owner of the business model.

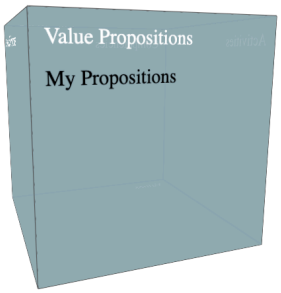


Figure 17 - Business Model Cube representation in the VMP

Dimension	Definition
Value Proposition	This dimension describes the values that a business – as owner of the business model – offers to its stakeholders (Lindgren & Rasmussen, 2013). Hence, this block defines the value propositions that are offered to customers in the ecosystem and to the business itself (i.e. my proposition type of value proposition). Note that within the VMP these values result from value aggregation relationships indicating exactly how this value is created.
Customers and/or User	Within this dimension – and according to the Business Model Cube – a distinction is made between users and customers. Customers represent those that pay for a service/product with money while users pay with other values (e.g. information, feedback) (Lindgren & Rasmussen, 2013). In the VMP this is similar to a participant receiving a value proposition (i.e. recipient). Hence, when a business – through its business model - provides a value proposition to a participant this participant is considered to be within the customer dimension of this business model.

Activities	This dimension defines the functions that the business needs to have in order to provide a value proposition, hence deliver the right values to customers/users (Lindgren & Rasmussen, 2013). Hence, it relates to the value chain concept introduced by Porter. Where a value stream defines those activities in relation to a value proposition the value chain defines all activities (i.e. functions) that are performed by an enterprise in order to create value. Within the VMP these activities were already defined in the value stream maps, they are performed by the participant in roles and require capabilities.
Competences	This dimension describes how activities will be carried out and who will do this(Lindgren & Rasmussen, 2013). Hence, the different activities of the activity dimension are coupled to participants that perform the activities through particular roles and to competencies (i.e. capabilities and resources) that these activities require or use. Note that an enterprise responsible for the activity can apply its own competencies or those of network partners(Lindgren & Rasmussen, 2013).
Network	Lindgren & Rasmussen (2013) state that no business model stands on its own but is considered to be 'a networked-based business model'. This dimension includes the business model partners that provide value to the business model in order to enable the business model to create value for itself and others. In the VMP these networks are the participant networks that are defined within the business ecosystem model. Note that these networks "could either be physical, digital and/or virtual" (Lindgren & Rasmussen, 2013, p.142).
Relations	This dimension provides or describes the connections between the other dimensions: the value proposition, users/customers, value chain functions, competences and network are all connected to each other. For example, value chain functions are needed in order to deliver the value proposition. Hence, relations between the dimensions enables a business model to create, capture, deliver, receive and consume value(Lindgren & Rasmussen, 2013). Within the VMP these relationships are provided within the different maps and the structured business model.
Value Formula	A value formula shows how value and costs are calculated within the business model(Lindgren & Rasmussen, 2013). Note that these values are not only the values delivered to customers but also includes the value delivered to the business itself based on a network of aggregated values. A business model can include multiples value formulas that are not only calculating profit but also other nonmonetary values (Lindgren & Rasmussen, 2013). Within the VMP these value formulas are defined during the protype stage by including objective and subjective measurements.

Table 6 - Dimensions of the Business Model Cube

2.2 Enterprise Architecture

For this part a similar approach as with VDML will be used. First, a general introduction will be given explaining what an enterprise architecture exactly is. Next, the main objectives of an enterprise architecture will be shortly explained and finally we will focus on the main language used for constructing an integrated enterprise architecture, namely the ArchiMate language.

2.2.1 Enterprise Architecture

The world we live in today is driven by the implementation of Information Technology including novel digital technologies such as 'Internet of Things', 'Robotic Process Automation', 'Artificial Intelligence' and 'Blockchain'. However, implementing such initiatives within an existing business structure is a complex task since it involves multiple business domains that speak different languages. Moreover, the implementation of these initiative should be in line with the overall strategy that guides the enterprise towards reaching its strategic goals that are in line with the enterprise vision.

An Architecture can often provide useful insights into the complexity of a large organization, and is defined as "fundamental concepts or properties of a system in its environment, embodied in its elements, relationships, and in the principles of its design and evolution" (Lankhorst, 2016, p.2) However, in practice it is often the case that many architectures exist answering to the concerns of the different stakeholders involved. Hence, each of these architectures will focus on a different part of the enterprise using their own conventions and description techniques (Lankhorst, 2016). This is represented on figure 18. For example, an application architecture will focus on the relations between software applications and the global structure of these applications with UML as dominant language (Lankhorst, 2016). A process architecture, on the other hand, will rather focus on relations between processes and the sequence of activities within these processes using BPMN. However, as can be seen on the figure the different architectures are also connected to each other. For example, the main objective of a business process (i.e. process architecture) is the realization of products and services. Therefore, they are supported by the right applications (i.e. applications architecture) that are in turn supported by the necessary technical infrastructure (i.e. technical architecture) (Lankhorst, 2016). This clearly demonstrates that the different architectures all have their own view on the organization but that they are also highly interconnected with each other. A good communication between these different architectures is therefore significant for achieving alignment.

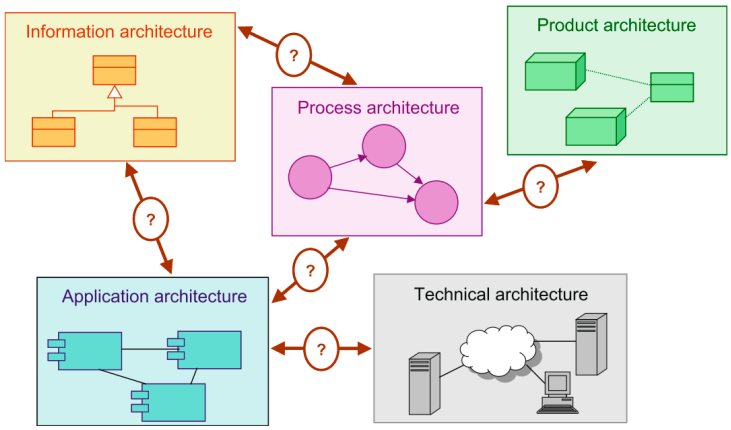


Figure 18 - Architectural Domains within an enterprise (Lankhorst, 2016, p.44)

An enterprise architecture will provide this communication, providing the relationships between the different architectures represented in figure 18. At one hand it is a product for alignment and at the other hand it is a process to clearly communicate the objectives to the different stakeholders (i.e. employees, managers, society, governments). Lankhorst (2016) defines enterprise architecture as "a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure" (Lankhorst, 2016, p.3).

So, an enterprise architecture provides a holistic view of the enterprise providing some frame of reference to facilitate communication of the architecture with all relevant stakeholders. A stakeholder is "an individual, team, or organization (or classes thereof) with interests in, or concerns relative to, a system" (Lankhorst, 2016, p.2). Stakeholders are not interested in the full architecture but only on those parts that have an impact on their specific concerns. Consequently, the enterprise architect needs to provide a partial overview of the architecture – selecting only certain concepts – in line with the specific interest/concerns of the different stakeholders(Lankhorst, 2016).

This will be supported by creating views specified by viewpoints. A view will describe the architecture of a system from the perspective of one or more stakeholders, thereby addressing their specific concerns. It is specified by a viewpoint that describes the concepts, models, analysis techniques and visualizations that will be used in the construction of the different views. Hence, viewpoints can be used in order to view certain aspects of the architecture in more isolation or to indicate the relationships that exist. For example, a process manager is interested in the different processes within a particular department and the relations between them. Therefore, a Business Process Viewpoint can be applied to an Architectural model describing a particular system to create a business process view of this system that clearly demonstrates which processes are present and how they are related to each other. The process manager has no interest in the internal application structure supporting the different business processes and therefore these concepts won't be represented in the process viewpoint. Hence, a viewpoint distinguishes between the relevant and irrelevant concepts of the architectural model in line with stakeholder concerns. Accordingly, viewpoints all result from the same architectural model and therefore an overlap between two or more viewpoints often exists(Lankhorst, 2016).

Over the last years, several architecture frameworks, standards and approaches have been developed (e.g. IEEE 1471-2000/ISO/IEC 42010 Standard, the Zachman Framework, TOGAF). A framework identifies and relates different architectural viewpoints and their associated modeling techniques in order to structure the architecture description techniques. Note that frameworks don't provide the concepts themselves but are sometimes in line with one or more specific modeling languages. To ensure the quality of the Enterprise Architecture model, frameworks are often complemented by a method that assists architects through the different phases of the life cycle[11] of architectures(Lankhorst, 2016). Iacbo et al. (2012) stated that in order to evaluate these frameworks several ingredients need to be present in order to construct a high-quality Enterprise Architecture:

- A process to create the architecture (i.e. guidelines, techniques and best practices)
- A set of classification of viewpoints that shows the different concerns of the stakeholders
- A language for describing the architecture (i.e. metamodel)
- A repository to store architectural artefacts and that can contain predefined reference models

When evaluating the different frameworks based on these ingredients, the Open Group Architecture Forum (TOGAF) standard was the one that came closest in covering all four of them. TOGAF is a standard published by the Open Group with as core component the Architecture Development Method (ADM). This method defines "a stepwise circular approach for the development of the overall enterprise architecture" (Lankhorst, 2016, p.26). The only missing element was a language for describing the architectures across domain borders. Therefore, the Open Group published the ArchiMate 3.0 specification as an enterprise architecture modeling language. ArchiMate is "a visual language with a set of default iconography for describing, analyzing, and communicating many concerns of Enterprise Architectures as they change over time. The standard provides a set of entities and relationships with their corresponding iconography for the representation of Architecture Descriptions."(The Open Group, 2019, p.1). The combination of both TOGAF and ArchiMate provides a clear EA approach covering a process, language, repository and viewpoints. Figure 19 provides an overview of the TOGAF standard together with the compatible Layers present in ArchiMate.

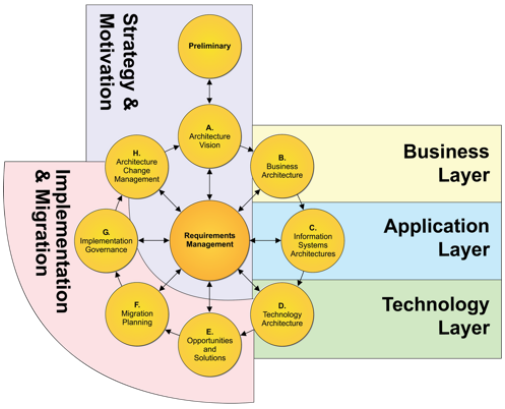


Figure 19 - Mapping of the Archimate 3.0.1 specification to the TOGAF ADM (OpenGroup)

[11] The life cycle of an architecture includes the idea – design – use and management phases. Hence, one starts form an idea that will be translated into formal models for analysisThis analysis will provide insights into the implementation of the idea leading to the development of an operational system. Whenever the system is changed or replaced the cycle is closed. Note that throughout the different steps there should be a good communication with the different stakeholders(Lankhorst, 2016).

The scope of this master dissertation doesn't include a detailed analysis of the TOGAF standard. However, when it comes to describing the different viewpoints a reference will be made to the TOGAF framework since it provides a set of classification viewpoints. Hence, each ArchiMate viewpoint is defined within the TOGAF framework. Additionally TOGAF provides guidelines for the development and use of new architectural viewpoints and views(The Open Group, 2019).

Note, that the aim of an enterprise architecture is not to replace the existing languages and modeling techniques but to connect them in such a way that one model can be easily transformed into another model .This means that visual modeling standards such as UML and BPMN can be integrated with the ArchiMate language in order to provide different levels of abstraction within the overall architectural description(Walters, 2017).

2.2.2 ArchiMate

The ArchiMate language classifies the elements of the core language through the use of layers and aspects as indicated in figure 20 (The Open Group, 2019). The different layers represent the different levels at which an enterprise can be modeled, and the aspects classify the elements within a layer based on layer-independent characteristics. The different elements are connected with each other through relationships that indicate how elements within one layer, as well as between multiple layers, influence each other. The different relationships are defined within Appendix 2.1.3. Note that many of these relationships are similar to the UML relationships (e.g. composition, aggregation, access).

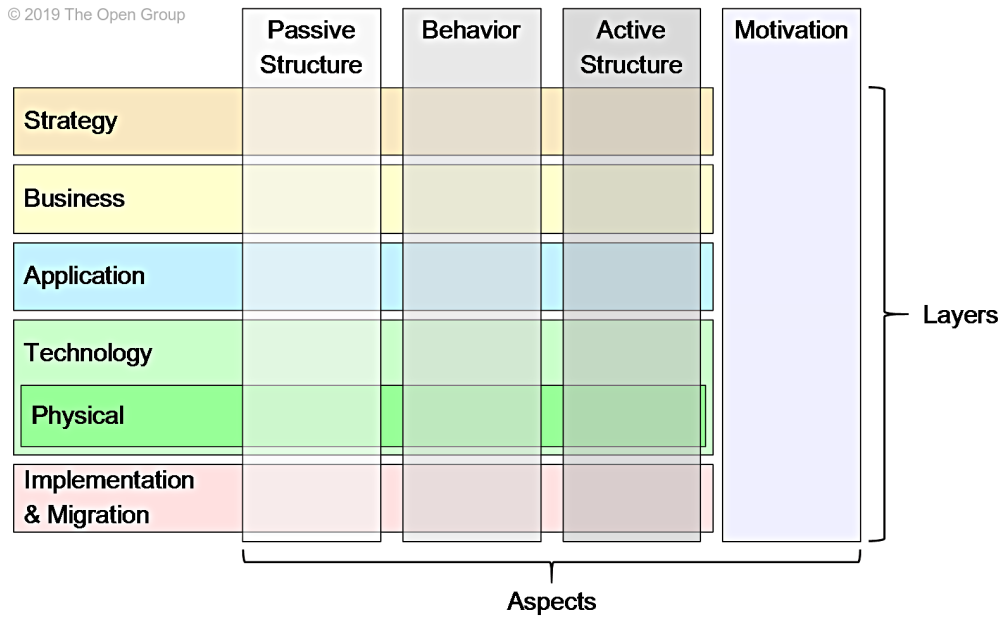


Figure 20 - ArchiMate Full Framework (The Open Group, 2019, p. 9)

since, ArchiMate is a service-oriented language where service is "a unit of functionality that some entity (e.g., a system, organization, or department) makes available to its environment, and which has some value for certain entities in the environment (typically the 'service users')" (Lankhorst, 2016, p.75). The different layers are therefore connected to each other by service relationships. More specifically this means that each layer contains an inner-service layer that provides a service to a higher layer and an inner-implementation layer that realizes the service. In this way each layer realizes a service and provides it to a higher layer. Note that services within one layer can also be provided (i.e. internal services)

(Lankhorst, 2016). Figure 21 displays the general structure observed within each of the different layers. As can be seen, there is a distinction between external versus internal. The external elements focus on 'what' a system needs to do in its environment thereby abstracting from the internal details (The Open Group, 2019). Accordingly, the internal elements describe how these services are realized (The Open Group, 2019). Moreover, there is a distinction between behavior, passive and active structure elements. These correspond to the aspects mentioned before and can be understand in a similar way as the subject-verb-object structure found in all human languages. In this case the active structure refers to the subject, the behavior to the verb and the passive structure to the object. For example, a business actor (i.e. activity structure element) is responsible for performing a business process (i.e. behavior element) and therefore it needs to access a business object (i.e. passive structure element).

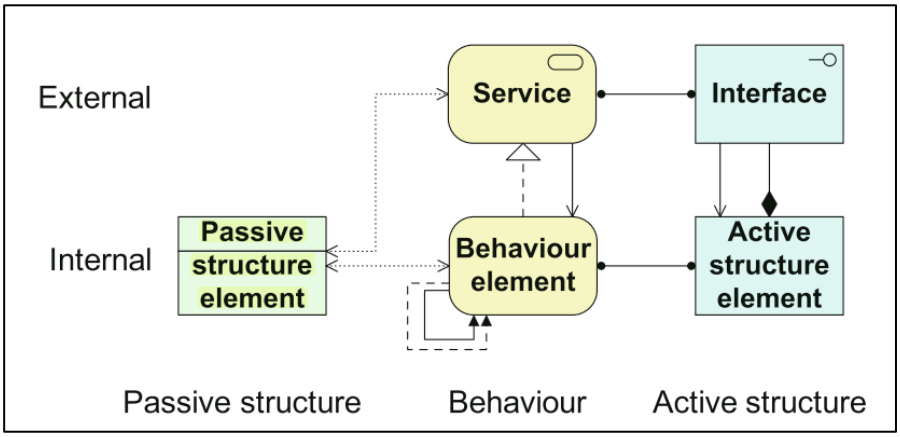


Figure 21 - The core concepts of the ArchiMate language(Lankhorst, 2016, p.77)

For the scope of this paper not all the business layers and aspects from figure 20 are important. When considering that the VMP provides a high-level strategic overview emphasis will be on the business and strategy layers with all the aspects. Hence, also the motivation aspect. In what follows the different layers will be shortly described and afterwards the ArchiMate viewpoint mechanism will be described. Additionally, the full ArchiMate 3.1 notation is included in Appendix 2.1 together with a description of the elements from the business and strategy layer as well as the elements from the motivation aspect.

2.2.2.1 Motivation Layer

The Motivation Layer contains Motivation Elements that "represent the context of or reason behind the architecture of an enterprise" (The Open Group, 2019, p.19). The metamodel for the Motivation- and Strategy Layer elements is included in figure 22. This figure results from an aggregation of the different metamodels defined within the ArchiMate 3.1. It clearly indicates the connection between the two layers and the different concepts of the layers itself. The colors indicate to which layer the different concepts belong (i.e. purple for motivation concepts, orange for strategy concepts). The location concept is also presented in the metamodel, this is a composition element that can be used to model the places where (active and passive) structure elements are located (OpenGroup, 2019).

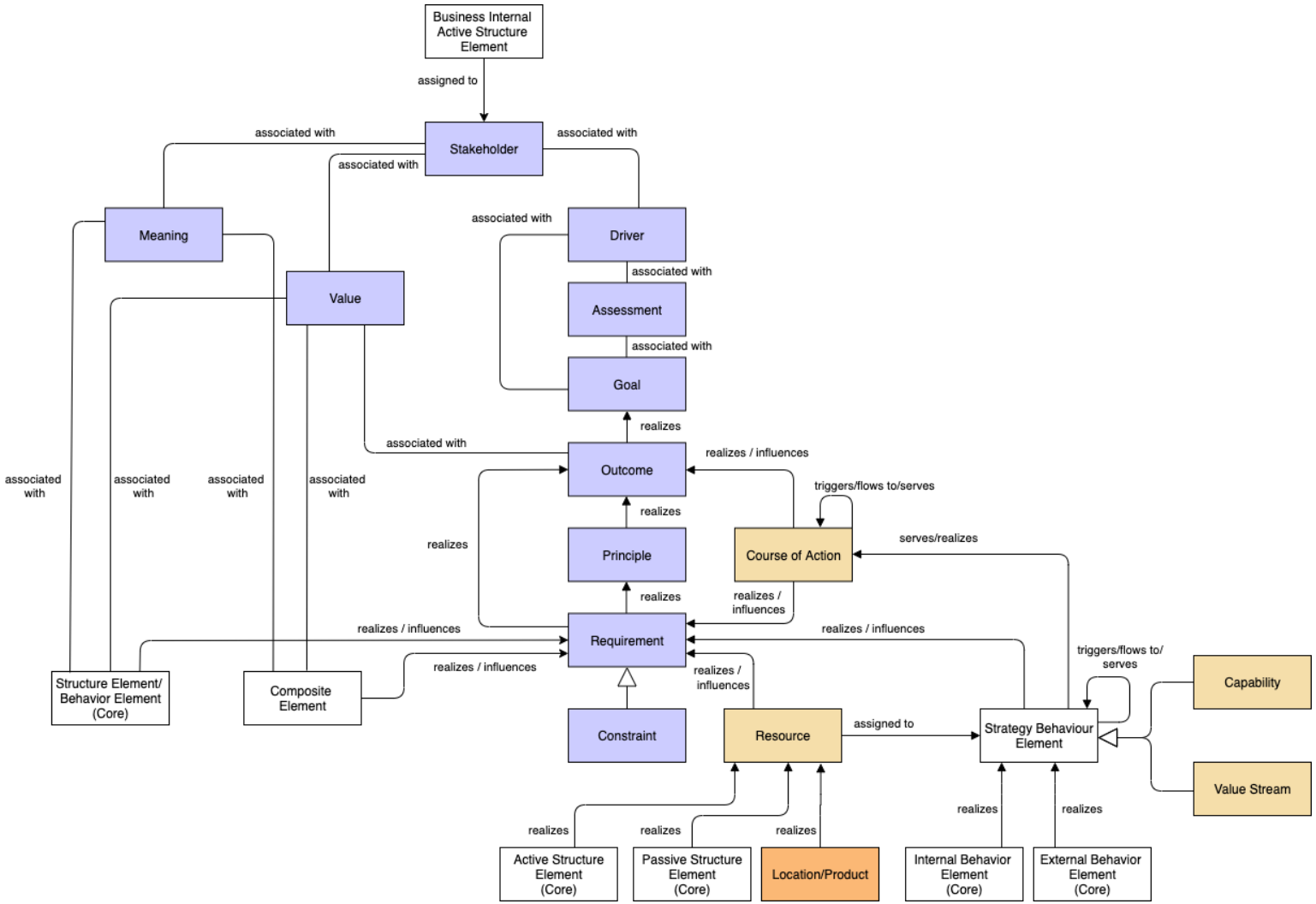


*Figure 22 – Strategy and Motivation elements Metamodel and their Relationships (*The Open Group, 2019)[12]

[12] This figure does not contain all the permitted relationships, additionally composition, aggregation and specialization relationships are permitted between elements of the same type. Additionally there are also indirect relationships that are defined in the ArchiMate 3.1 specification (The Open Group, 2019).

Shareholder, Driver, Assessment, Outcome

Stakeholders (e.g. shareholders, society, customers) are concerned with certain drivers. These drivers can be internal drivers (e.g. costs) as well as external drivers (e.g. changing legislation). Taking into account the mission of the organization, an assessment will be made that reveals the strengths, weaknesses, opportunities or threats for this specific driver. Based on these assessments, goals will be set by the stakeholders in order to neutralize weaknesses and threats or to take advantage of opportunities and strengths. A goal is realized by an outcome representing the final desired result. Note that also unexpected or undesired outcomes might be relevant within the architectural model(Lankhorst, 2016).

Principle, Requirement, Constraint

Further refinement of the desired outcomes results in principles, requirements and constraints. Both principles and requirements define intended properties of the architecture that are needed to achieve the outcomes modeled by the goals. The main difference is that principles define a more general intent relating to any architecture in a certain context while requirements are related to a specific need that the architecture must address (Lankhorst, 2016).

Value, Meaning

Finally, value and meaning concepts are defined within the motivation layer. Within the ArchiMate 3.1 Specification the following statements are made about the value concept as implemented within the ArchiMate language: "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", "it is most typically applied to external appreciation of goods, services, information, knowledge, or money, normally as port of some customer-provider relationship" and "where the functional value of an architecture element is concerned it is recommended to try and express it as an action or state that can be performed or reached as a result of the corresponding element being available"(p.47). This clearly refers to the value-in-use and value-in-exchange concepts introduce in the value part of this master dissertation. From the descriptions it can be assumed that within the Enterprise Architecture value is the result of making available some product or service. Within figure 22 this is represented by the association with the composite element (i.e. passive structured product element of the business layer). Next to value, also meaning is defined within the ArchiMate language. Meaning "represents the knowledge or expertise present in, or the interpretation given to, a concept in a particular context" (The Open Group, 2019, p.47). Hence, a meaning refers to the specific intent of a passive structure element specific to a particular stakeholder (OpenGroup, 2019). Sometimes is might be handy to relate the stakeholder with the meaning but this is not always necessary.

2.2.2.2 Strategy Layer

The Strategy elements model the strategic direction and choices of an enterprise. This includes defining how the enterprise wants to create value for its stakeholders, the capabilities required to create this value, the resources to support these capabilities and the use and configuration of these capabilities and resources to achieve defined goals and outcomes (The Open Group, 2019). Figure 22 contains the metamodel of the strategy elements and their connections with the motivational elements.

A course of Action is defined in order to determine the strategic plan of the enterprise, which should be in line with the achievement of the different goals of the organization. The defined courses of actions are realized by the actual capabilities and resources present within the organization and its ecosystem. Resources refer to tangible assets (e.g. financial assets, physical assets), intangible assets (e.g. technology assets, reputation assets, culture assets) and human assets (e.g. skills/know-how, capacity for communication and collaboration) (The Open Group, 2019). Besides resources, an organization also needs the right capabilities in order to successfully accomplish the defined outcomes. Capabilities represent "the current or desired abilities of an enterprise, realized by its people, processes, information and technology, but defined independently from the structure of the organization" (Lankhorst, 2016, p.87). Capabilities are often considered - together with the resources - as sources for competitive advantage since they determined what is actually available within the enterprise and its ecosystem (e.g. partners, society, government) in order to achieve the organizational goals and mission.

In November 2019 the Open Group launched the ArchiMate 3.1 specification thereby introducing a new behavioral strategy element (i.e. the value stream). A value stream will define a sequence of value-creating activities aggregated within value stages that all add incremental value from one stage to another. Therefore, it will show how an enterprise will organize its activities in order to create value for the stakeholder.

2.2.2.3 Business Layer

The business layer contains elements that describe the operational part of the organization while abstracting from the technological elements. The metamodel is represented in figure 23. Notice that the structure within the business layer is similar to the representation on figure 21.

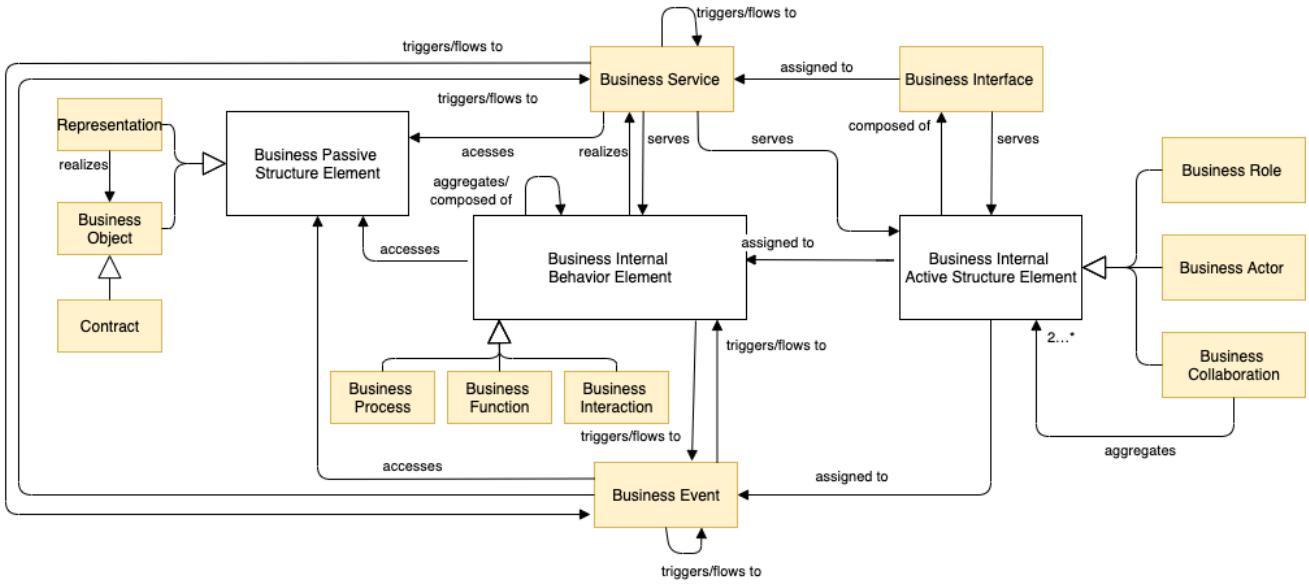


Figure 23 - Business Layer Metamodel (The Open Group, 2019)[13]

[13] This figure does not contain all the permitted relationships, additionally composition, aggregation and specialization relationships are permitted between elements of the same type. Additionally there are also indirect relationships that are defined in the ArchiMate 3.1 specification (The Open Group, 2019).

Active structure elements

As mentioned, the active structure elements are the ones performing behavior and in the context of the business layer these elements describe the static structure of an organization. A distinction is made between internal and external active structure elements. The internal elements can perform behavior such as business actors or roles to which business actors are assigned. Moreover, multiple business actors and roles can work together to perform some collective behavior (i.e. collaboration). The external active structure elements expose behavior; hence they describe a point of access where service(s) are exposed to the environment (e.g. telephone, local office) (The Open Group, 2019).

Behavior elements

The behavior elements don't describe the static enterprise structure but the dynamic structure. Also, here a distinction is made between internal and external behavioral elements. The external behavior business element is the business service. This "represents a coherent piece of functionality that offers added value to the environment, independent of the way this functionality is realized internally". Accordingly, the internal behavior elements will describe the behavior that realizes the service(The Open Group, 2019). These include the business processes, business functions and business interactions. The business processes and functions correspond to two different views on the internal behavior. Business process describe a workflow of smaller processes/functions that ultimately serve the satisfaction of the – internal or external – customer. Business functions offer functionality to one or more processes, hence business functions are used by business processes. The business interaction is the corresponding behavior of the business collaboration. Finally, a business event is defined to represent a state change (e.g. business event 'claim filed' will trigger a process 'accept claim') (The Open Group, 2019).

Passive structure elements

Active structure elements perform behavior exposed by services and described by internal behavior elements. This internal behavior might need to access passive structure elements such as a business object, a business representation or a contract. As can be seen in figure 23, a contract is a specialization of a business object and a business object is realized by a business representation.

Composite element

Finally, the business layer also contains a composite element. The product business element represents "represents a coherent collection of services and/or passive structure elements, accompanied by a contract/set of agreements, which is offered as a whole to (internal or external) customers" (The Open Group, 2019, p.70). Hence it contains an aggregation of multiple other elements from the business layer and from other layers.

2.2.2.4 ArchiMate Viewpoints

As mentioned before, stakeholders are often not interested in the entire enterprise architecture but only in specific elements of it and the relationships between these elements. Therefore ArchiMate provides a flexible approach in which stakeholders can define their own views on the Enterprise Architecture (The Open Group, 2019, p.111). This approach includes the specification of architecture views by describing architectural viewpoints(The Open Group, 2019).

ArchiMate defines both concepts as follows: “A view is a part of an Architecture Description that addresses a set of related concerns and is tailored for specific stakeholders. A viewpoint prescribes the concepts, models, analysis techniques, and visualizations that are provided by the view. Hence, a view is what you see, and a viewpoint is where you are looking from”(The Open Group, 2019, p.112).

The purpose of designing viewpoints is to provide an abstraction from the entire enterprise architecture in order to support a clear communication about certain aspects of the architecture. Therefore, it is important to consider the stakeholders for which the viewpoint is designed and the concepts that are most important to them. What is shown in a viewpoint is therefore determined by the concerns of the stakeholder and on the scope of the viewpoint(Lankhorst, 2016). This means that the different concepts in an enterprise architecture can be shown or included in multiple viewpoints depending on the purpose of the viewpoint. For example, a business process element can be included within a business process viewpoint that shows “the high-level structure and composition of one or more business processes”(Lankhorst, 2016, p.201). But, the same element can also be included within the application usage viewpoint that describes “how applications are used to support one or more business processes”(Lankhorst, 2016, p.204). This also indicates that different viewpoints can be related to each other as well as integrated into a consistent whole”(Lankhorst, 2016).

In order to help the architect in selecting the right viewpoints based on the specific concerns it needs to address, ArchiMate provides a framework for the definition and classification of viewpoints. This framework is called the viewpoint mechanism and will also be used within this master dissertation. Figure 24 illustrates how this viewpoint mechanism can be used by an Architect to create , and classify, a viewpoint in line with stakeholder concerns.

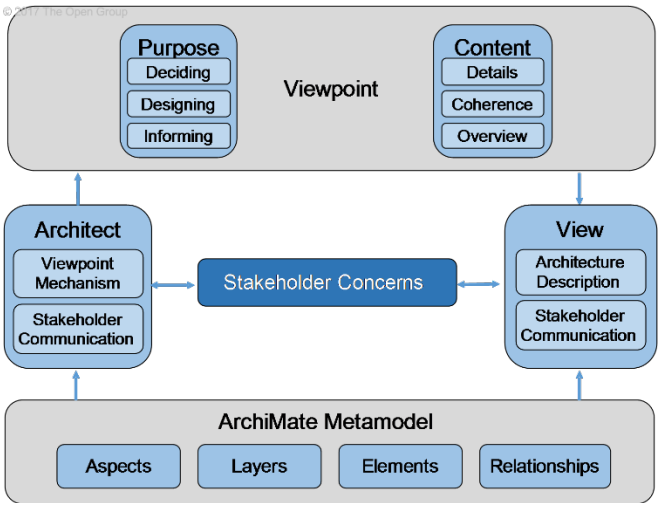


Figure 24 - Framing Stakeholder Concerns using the Viewpoint Mechanism (The Open Group, 2019)

As can be seen from this figure, the ArchiMate Metamodel contains all aspects, layers, elements and relationship defined within an enterprise architecture. However, the Architect needs to communicate with multiple stakeholders involving only a subset of these concepts and therefore a viewpoint needs to be defined in relation to the stakeholder concerns. The viewpoint mechanism will define and classify viewpoints based on two dimensions, purpose and content,

described in table 7. Whenever a viewpoint is defined the architect will be able to create a view using different visualizations (e.g. table, cartoons)(The Open Group, 2019).

The different viewpoints included within the ArchiMate language are consistent to the TOGAF viewpoints. However, ArchiMate also supports the creation of new viewpoints additional on those defined in TOGAF (Lankhorst, 2016). The main difference between ArchiMate and TOGAF lies in the observation that ArchiMate provides the creation of viewpoints over multiple layers while the TOGAF viewpoints are more restricted to one layer(Lankhorst, 2016).

Purpose Dimensions (Lankhorst, 2016, p.184)	
Designing	Design viewpoints support architects and designers in the design process from initial sketch to detailed design. Typically, design viewpoints consist of diagrams, like those used in UML.
Deciding	Decision support views assist managers in the process of decision making by offering an insight into cross-domain architecture relations, typically through projections and intersections of underlying models, but also by means of analytical techniques. Typical examples are cross-reference tables, landscape maps, lists, and reports.
Informing	These viewpoints help to inform any stakeholder about the enterprise architecture, in order to achieve understanding, obtain commitment, and convince adversaries. Typical examples are illustrations, animations, cartoons, flyers, etc.
Content dimension (Lankhorst, 2016, p.185)	
Details	Views of the detailed level typically consider one layer and one aspect from the framework that was introduced in Chap. 5. Typical stakeholders are a software engineer responsible for the design and implementation of a software component or a process owner responsible for effective and efficient process execution. Examples of views are a BPMN process diagram and a UML class diagram.
Coherence	At the coherence abstraction level, multiple layers or multiple aspects are spanned. Extending the view to more than one layer or aspect enables the stakeholder to focus on architecture relations like process–use–system (multiple layer) or application–uses–object (multiple aspect). Typical stakeholders are operational managers responsible for a collection of IT services or business processes.
Overview	The overview abstraction level addresses both multiple layers and multiple aspects. Typically, such overviews are addressed to enterprise architects and decision makers such as CEOs and CIOs.

Table 7 - ArchiMate Viewpoint dimensions

2.3 Conclusion

The conducted literature study first discovered the value concept thereby introducing the service dominant logic and the goods dominant logic based on the concepts of value-in-exchange and value-in-use introduced by Aristoteles. Additionally, some ontological studies on the concept of value and the axiology where discovered in order to derive some general characteristics of the value concepts. Hence, this part mainly focused on answering the first research question - "What is value?" - and concluded that (1) value can only be determined by the beneficiary, (2) value has to be co-created, (3) value is always associated to a value object (tangible/intangible) and (4) value has the purpose of fulfilling some need or desire.

Moreover, in the next part of the literature research the co-creation of value was further discussed resulting in the introduction of the VDML. The VDML considered value as created within a collaboration and therefore acknowledged that value doesn't involve one business in one business model but multiple businesses that work together through one or more business models. Based on the VDML the Value Management Platform was introduced and finally the ArchiMate language was described. In both the VMP and the ArchiMate language value was represented in some way. In order to answer the second research question, the different characteristics of value will be listed and for each characteristic the "representation" dimension will be described.

(1) Value is always determined by the beneficiary. Within the VMP this is indicated by connecting a value proposition with a recipient and a provider in the ecosystem. thereby indicating the relationship 'provider provides value proposition to the recipient'. Within the ArchiMate language this is done by connecting a value shape with a stakeholder shape.

(2) Value has to be co-creation. Within the VMP this is represented by using the value proposition concept embedded within the ecosystem and by involving a business model that includes values received from other participants within the ecosystem. Hence, value is included within a value proposition thereby indicating that value is proposed to a recipient and not delivered. Within the ArchiMate language this is not clearly indicated since the value element definition involves a very brought conceptualization. The concept of value proposition is also not defined within the ArchiMate language.

(3) Value is always associated to a value object. Within the VMP this object is not directly defined within the User Interface. However, under the hood the shapes are mapped to VDML concepts that include the deliverable flow which is defined as "the transform of a deliverable from a provider (or producer) to a recipient (or consumer"(Object Management Group, 2011, p.98). Additionally, a deliverable is defined as "the product or service defined by an associated business item that is produced by an activity or delivered from a story that can be conveyed to another activity or store" (Object Management Group, 2011, p.98). This clearly illustrates the relation of a value with a deliverable however, this is not graphically represented. Within ArchiMate the metamodel defines value as being associated with composite elements and structure element/behavioral elements. In this case, a product element is consistent to the products/services that a business provides to a customer.

(4) Value has the purpose of fulfilling some need. In the VMP this need is indicated by the subjective measurements associated with the value, customer perceive some satisfaction level and opinion. Therefore,

the value can be considered to contribute to the needs they have and the extent to which the values provide a solution to these needs. In ArchiMate the need can be considered by the 'outcome' element that is associated with the stakeholder receiving this outcome. Hence, an enterprise performs activities to deliver value related to the outcome however this outcome has to be in line with the values the recipient wants.

These insights can provide an answer to the second research question: How is value represented? Within the VMP value is represented in two ways, explicitly modeled with a value shape or defined within the details of shapes that contained or created value. Activities produced values, values where obtained from value propositions received from partners and customers in the ecosystem, value was aggregated to values that in turn where provided to customer and participants and moreover value was captured by the business model itself. In order to perform value measurements values where associated with measurements. The values included within the value proposition delivered to participants also included, next to the objective measurements, subjective measurements indicating the perspective of the recipient. Within the ArchiMate language a value element was also introduced, moreover ArchiMate supports analysis including different measurements within the different shapes. However, ArchiMate doesn't provide as much detail as the VMP.

3 Case Study: Maintenance Service Case

3.1 Introduction

In order to guide the integration between the VMP and ArchiMate language the 'Maintenance Service Case' will be introduced, this case is constructed by VDMbee to train professionals in the use of CBMP as supported by the VMP. The case involves two organizations: A Maintenance service provider (MSP) called "Equipment Care" and an Operator Company called "Ground Works". Equipment Care represents a prototypical maintenance service provider company that is providing maintenance services for heavy machinery such as excavators, bulldozers, dump trucks, … . Its customer is represented by the Ground Works company, a prototypical operator Company, that will make use of this heavy machinery to do some construction work for its own customer (e.g. digging sand). Hence, the Ground Works Company owns and uses the heavy machinery to do business while the Equipment Care company provides maintenance for this machinery. In order to face some issues, the MSP would like to analyze the use of Internet of Things technology to support the transition from traditional to smart maintenance. This transition could drastically change the way an organization is doing business and the way it is achieving it's objectives, therefore the VMP can provide support to analyze the impact of this transition on the most important values for the business itself (i.e. the Equipment Care Company) as well as for its customers (i.e. the Operator Company).

In the following sub-sections the context for the Maintenance Service case will be clearly described by (1) looking into the issues the MSP faces, (2) the transition it wants to implement (3) the business case based on this transition (4) important measurements to consider when evaluating the initiative and (5) assumptions that have been made to increase the understanding of the different models. Note that all information described in these sub-sections is included within the context sub-stage of the CBMP method.

3.2 SWOT analysis

For the maintenance service case the context stage starts with a SWOT analysis in order to explore the possible future strategic directions of the Maintenance Service Provider (MSP). The SWOT template as incorporated within the VMP is shown in figure 25.

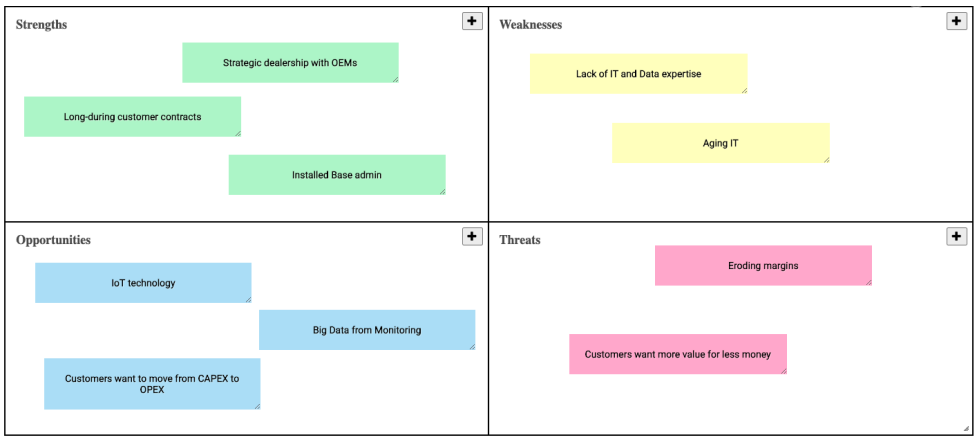


Figure 25 - SWOT analysis Equipment Care

From the SWOT analysis it can be concluded that the MSP has strong customer relationships (e.g. strategic dealership with operating equipment managers, long-term customer contracts) but faces eroding margins and customers that want more value for less money. Besides, there are also some opportunities arising within the maintenance market such as Internet of Things (IoT) technology, the incorporation of Big Data to obtain more insights into the gathered data and the observation that customers rather move from a CAPEX to an OPEX model[14]. These opportunities could already tackle some of the observed threats by providing customers a better service while increasing internal efficiency. However, in order to take advantage of these opportunities the internal structure of the MSP should also be considered. The SWOT analysis hereby clearly indicates that the MSP company has outdated IT and, moreover, does not have the right competencies to implement IoT or Big Data. Build upon these insights the MSP decides to use the VMP in order to discover the impact of implementing the Internet of Things technology within its current business model (i.e. Maintenance Business Model). Since the MSP is aware of the outdated IT and the lack of knowledge for the correct implementation of the new IoT technology, it will consider a new partnership with a third party that has the necessary IT infrastructure and competencies. Hence, the strategic initiative will consider the shift from a traditional maintenance model to a smart maintenance model.

3.3 Assumed business case

A maintenance service provider such as Equipment care traditionally combines multiple qualitative and quantitively techniques to predict when maintenance needs to be provided in order to decrease, among others, the downtime of the machinery. However, large fluctuations in the time to failure for identical components can occur resulting in a trade-off between providing more maintenance than needed or detecting failing components too late (Mattsson, Zachariah, & Bjorsell, 2019). Hence, the choice between replacing components that still have some excess lifetime in order to maximize machine uptime or maximizing the lifetime of a components thereby increasing the risk of a breakdown and increasing machine downtime (Colemen, Damodaran, Chandramoulin, & Deuel, 2017).

With the use of new connected technologies such as Internet of Things machines can provide data that can increase the accuracy of predictions maximizing both the lifetime of machine components while avoiding machine failure (Colemen et al., 2017). For the maintenance service case this will be done by implementing internet of things technology. Internet of Things can be defined as "a global, invisible, ambient networked computing environment built through the continued proliferation of smart sensors, cameras, software, databases, and massive data centers in a worlds-spanning information fabric"(Ayad, Terrissa, & Zerhouni, 2018, p.210). Hence, it builds upon the idea that every physical object can be connected to the internet by installing sensors on these physical objects transmitting real-time data (Ayad et al., 2018). Whenever implementing IoT technologies it is important to think about the different sources of data that can be identified (Colemen et al., 2017). For the MSP of heavy equipment this could be data about the machinery (e.g. temperature, vibrations, energy consumption) and about the components produced in the factory or stored in the

[14] The shift from CAPEX (Capital Expenditure) to OPEX (Operating Expenditure) within the context of equipment maintenance means that customers would prefer a monthly payment for the maintenance they actually consume instead of an annual upfront payment for the maintenance that might occur during the coming year.

warehouse (e.g. number of components in storage, speed, pressure). All this data can be collected by the installed sensors and transmitted to a secure database. Finally, all of this data will be analyzed and displayed through a user-friendly platform to the end-user (e.g. the operator working with the heavy machinery). Hence, when a deviation is observed, data will be transmitted to the database and a notification will be sent to the operator through the platform. In the same way it will be possible to already assign a mechanic to the specific construction site, order the necessary parts from the warehouse and send them to the right location. So, through the implementation of IoT it is possible to predict which parts need maintenance, when this maintenance needs to be provided and where it needs to be provided thereby potentially maximizing the lifetime of the components and minimizing machine downtime(Colemen et al., 2017). Moreover, the collection of this data makes it possible to pinpoint defects to possible production sites or possible materials thereby preventing future failure of components.

Accordingly, the business case assumes a win-win situation for both the Operatory Company and the MSP. At one hand, IoT technology will make it easier for the MSP to replace the right part, at the right time, in the right place, enabling them to do things faster with less cost and less waste. And as a result, contract margins (k$/year) will go up. At the other hand, there will be a better cost performance ($/ton) for the Operator because of a higher uptime, availability and a reduced maintenance cost. Note that these 'wins' are the most important concerns of both the Operator and the MSP within the context of the smart initiative and hence within the context of their business models through which they provide value to themselves, each other and other participants.

Note that the implementation of IoT technology requires knowledge about the implementation of this new technology within the organization together with the development of new capabilities for creating, handling and making use of this gathered data. This is where a cloud-platforms provide many benefits. Instead of buying all the necessary IT yourself and training or hiring new employees in order to obtain the necessary capabilities, you can make use of cloud services offered by third parties following a pay as you go model. This makes is possible to decrease your own capital investment and invest in alternative projects. Note that if you want total control of the data you could also create an in-house cloud, but this requires an additional investment that might not be that beneficial to your company.

3.4 Ambition level

The transition from traditional to smart maintenance in a company can be established at different levels going from 'connected', where remote access is used to do some basic monitoring, to fully 'coordinated' where the whole supply chain is connected using Internet of Things, Big data and Artificial Intelligence. For the Maintenance Service the ambition level is indicated with the red arrow in figure 26. As mentioned before Equipment care, in its role of MSP, has a business model 'Maintenance'. In relation to the ambition level the as-is business model includes visual inspections of the machinery where technicians travel to the construction sites to determine certain parameters (e.g. temperature, oil dart, vibration, …). Based on these measurements, deviations will be determined, and maintenance will be scheduled. By implementing IoT technology the business model will undergo some radical changes (i.e. to-be business model), the MSP will gather real time data using sensors instead of travel to the construction site for the inspections. This makes it

possible to continuously monitor equipment performance and detect defects before they result in failure of the machinery.

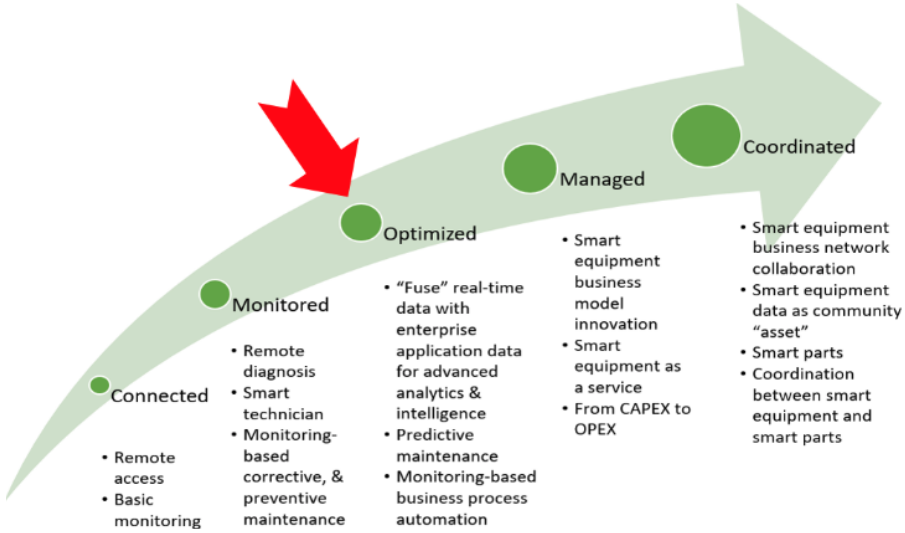


Figure 26 - different levels for using Smart Maintenance (VDMbee, 2018a)

3.5 Important Influencers

When implementing an initiative, like the smart maintenance imitative discussed here, it is important to have some domain-specific knowledge. For the maintenance service domain there already exist some well-known formulas that describe the main priorities of the business and its customers. For the maintenance service case the most important value for the Equipment Care Company is the 'contract margin'. With the implementation of IoT they would like to improve their profit margin as well as the value they offer to their customers. This latter one is described by the 'production cost' of the operator company.

<u>Production cost</u>

Since the customer is the main priority for a lot of companies it is of utmost importance to understand what "value" means to them and what factors influence this value. As can be seen in the equation below the main concern of the Operator is the Production cost describing what cost they incur, expressed in number of dollars, to dig up one ton of sand.

$$Production\ Cost\ \left(\frac{\$}{ton}\right) = \frac{TCO\ (\frac{\$}{h})}{Production\ (\frac{ton}{h})} = \frac{Machine\ Cost + Maintenance\ and\ Repair\ OV + Tire + Fuel + Operators\ Wage}{Payload\ \times\ Cycle\ Time\ \times\ Job\ Efficiency\ (\%) \times\ Availability\ \times\ Utilization}$$

The production cost itself is determined by the Total Cost of Ownership (TCO), expressed in dollars per hour, and the production output expressed in ton dug per hour. Hence, when the cost for ownership per hour goes down or the output per hour goes up, the production cost will go down. Further refinement shows that the TCO is determined by a number of factors such as machine cost, machine repair cost, cost of tires, fuel, operator wages. The MSP can only influence some of these factors (i.e. Machine Cost, Maintenance Repair Overhead Cost) but even then, the impact of this change will be very small since it represents only a small fraction of the TCO. The second factor, production output, is therefore

the main focus of the MSP since this could significantly increase the value observed by the Operator. The production is determined by the following factors:

- Bucket payload (ton) indicating the amount of sand that goes into the bucket of the excavator
- Cycle time (h) describing the time that strikes between dumping two buckets of sand
- Job efficiency (%), the ratio of the time normally needed to perform a certain amount of work to the time it actually takes to perform this amount of work multiplied by 100
- Availability (h), the time a machine is available to do construction work
- Utilization, the ratio of the time the machine is used and the time it is available

Note that all the factors above are multiplied in order to obtain the production per hour, consequently they have a high influence on the production factor and therefore on the production cost. So, if the implementation of the IoT has an influence on one of the above factors the value observed by the operator can be drastically increased (or decreased). This clearly illustrates the importance of these formulas, as they indicate which buttons to push in order to influence the value observed by the customer. In the Service Maintenance Case, production cost and TCO/h are both defined as plan values at the ecosystem level and as business values at the business model level.

<u>Contract margin</u>

Besides from the customer value the Equipment Care Company also would like to capture value for themselves. Therefore, also the most important factors from their perspective should be included within the analysis. The formula below shows the factors that constitute the contract margin.

$$contract\ margin\ \left(\frac{K\$}{year}\right) = contract\ price + dashboard\ price - contract\ cost$$

As can be seen from this formula, contract margin is determined by contract price, dashboard price and contract cost. The dashboard price, expressed in K$/year, is only incurred in the to-be maintenance business model since it indicates the price that the MSP receives for providing the interactive dashboard to its customers (i.e. the Operator). Besides it is assumed that the contract price for both business models stays the same. Consequently, the contract cost will have a lot of influence on the contract margin that will be observed. As seen in the formula below the contract cost can be further refined into more specific cost factors, all expressed in K$/year. These factors will, together with the dashboard price, determine what value will be capture by the Equipment Care Company by implementing the new initiative.

$$\begin{aligned} contract\ cost = {} & inspection\ \&\ repair\ cost + travel\ cost\ (cars) + service\ IT\ cost + service\ admin\ cost \\ & + parts\ expense + inventory\ carrying\ cost + tools\ cost + monitoring\ data\ cost \end{aligned}$$

3.6 Assumptions

Finally, a list of assumptions is included. These assumptions will make the modeling in the different sub-stage more efficient and increase understanding of the models. Whenever phase 2 is mentioned this refers, as explained before, to the second phase of the plan where the Internet of Things initiative is implemented, and its impact will be analyzed.

Assumptions for the Maintenance Service Case:

- All parts covered by contract
- Driver on the excavator is flexibly hired by the operator
- Purchase administration time and cost are taken as part of the service administration time and cost
- All fixes are done on job site by mechanics that travel to it, so whenever interpreting the results you should keep in mind that in reality it might occur that some machinery might be transported to the service center.
- No legacy IT [15] cost or overhead included for the operator
- IT procurement, implementation and training will be implicitly included in the pay-for-use
- Smart technician tools training cost is not significant (or otherwise included in wages), no contract price raise in Phase 2 of the CBMP method
- MSP sells dashboard to operator
- Technician tools as a total set, no differentiation per type of tool, such as old tools versus new smart tools
- No installed base raise in Phase 2 of the CBMP method
- No tool life span change in Phase 2 of the CBMP method
- No overhead allocation to contract
- No additional transformation cost (cost of organizational change effort etc.)

[15] The cost for keeping outdated technology inside your organization (https://www.alvareztg.com/the-risks-of-outdated-technology-why-legacy-systems-cost-you-more-than-you-realize/)

4 Mapping: from VMP/VDML to ArchiMate

In this part an initial mapping will be proposed based on the case study introduced in the previous part. The VMP makes use of different user interfaces that represent views of the under the hood constructed structured business model. Hence, when looking at a mapping from ArchiMate to VDML it is useful to start with these different graphical models – ecosystem map, capability map, etc.- and define corresponding ArchiMate viewpoints for them. These viewpoints will similarly provide abstractions from the constructed ArchiMate model. The business model cube provides an interface for the structured business model that is modeled using VDML concepts, this structured business model will integrate the different graphical models of the discover stage. Moreover, these business models are connected to plan values including multiple aggregation relationships. Therefore, additional viewpoints will be constructed and/or found. As explained before, a viewpoint in ArchiMate has to be in line with specific stakeholders' concerns in order to improve communication about the architecture with these stakeholders. Different views of the same ArchiMate model can be created using multiple visualizations. Hence, each viewpoint that will be defined has to clearly indicate the purpose and content factors.

4.1 Capability Map

4.1.1 Capability Map in the VMP

Remember that a capability map provides a graphical overview of the different capabilities defined in one or more capability libraries containing industry/enterprise standard definitions (VDMbee, 2018a). The capability maps in the VMP are mainly used to cross-reference business capabilities with industry standard capabilities (VDMbee, 2020). This provides a direct mapping from the capability shape in the VMP to a capability definition as defined in the Capability Library (VDMbee, 2018a). For the Maintenance Service Case only one Capability Map is defined as represented in figure 27. This capability map contains two main capability categories 'Service & Maintenance' and 'Material Management' that include more refined capability categories in which finally the capability definitions are represented (e.g. tool scheduling, job reporting). The definitions and concepts of Capability, Capability Category and Capability Definition are consistent to the VDML.

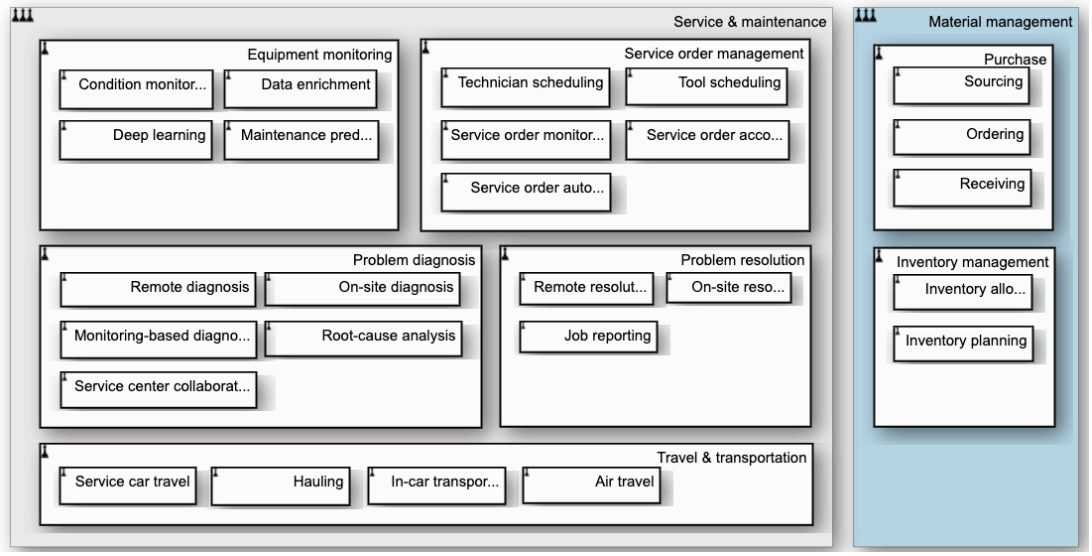


Figure 27 - Equipment Capability Map

4.1.2 Capability Map in ArchiMate

A capability is defined in ArchiMate as “an ability that an active structure element, such as an organization, person, or system, possesses” (The Open Group, 2019, p.52). This is consistent to the VDML implemented within the VMP, where a capability “represents the ability to perform a particular kind of work and deliver the desired value” (Object Management Group, 2011, p.97). Moreover, ArchiMate defines a Capability Map Viewpoint as described in table 8. For the Maintenance service case the capability map viewpoint is represented in figure 28. This viewpoint provides, similar to the VMP, a structured overview of the different capabilities of the enterprise using a nested box structure(The Open Group, 2019). The Capability Map Viewpoint was developed to support enterprise and business architects in the design process and support business manager for decision making. Capabilities describe the ‘what’ of an enterprise and not the ‘how’ therefore these maps are useful as a canvas on which other information can be projected (Lankhorst, 2016). As can be seen in the Elements description, capability elements can be related to the outcomes that they realize or influence as well as to the resources that are assigned to these capabilities. However, in practice a capability map often only contains the hierarchical structure of the different capabilities without any reference to outcomes and resources. This is also the case in the VMP where a capability map only contains Capability Categories and Capability Definitions that are used to make the modeling more efficient. Also note that a Capability element in ArchiMate can be used to represent Capability Categories as well as Capability Definitions since they can be used to represent elements at different levels of aggregation.

Capability Map Viewpoint	
Stakeholders	Business managers, enterprise and business architects
Concerns	Architecture strategy and tactics, motivation
Purpose	Designing, deciding
Scope	Strategy
Elements	Outcome, Capability, Resource

Table 8 - Description Capability Map Viewpoint

When comparing capability elements and the capability concept as defined in the VDML it is important to notice that ArchiMate doesn't differentiate between instances and types(The Open Group, 2019). ArchiMate mainly represents types rather than specific instances of these types. The VDML as implemented within the VMP contains types defined in libraries and instances that connect these types to the implementation within a specific context (e.g. enterprise, department, organizational unit). For example, a capability definition (i.e. type) can be related to different capability offers (i.e. instances) provided by a specific enterprise using and/or owning a capability method. However, in ArchiMate the capability element can be used at different levels of aggregations to indicate capability categories as well as capability definitions as well as capabilities as implemented within a specific enterprise. This will be discussed further in later sections.

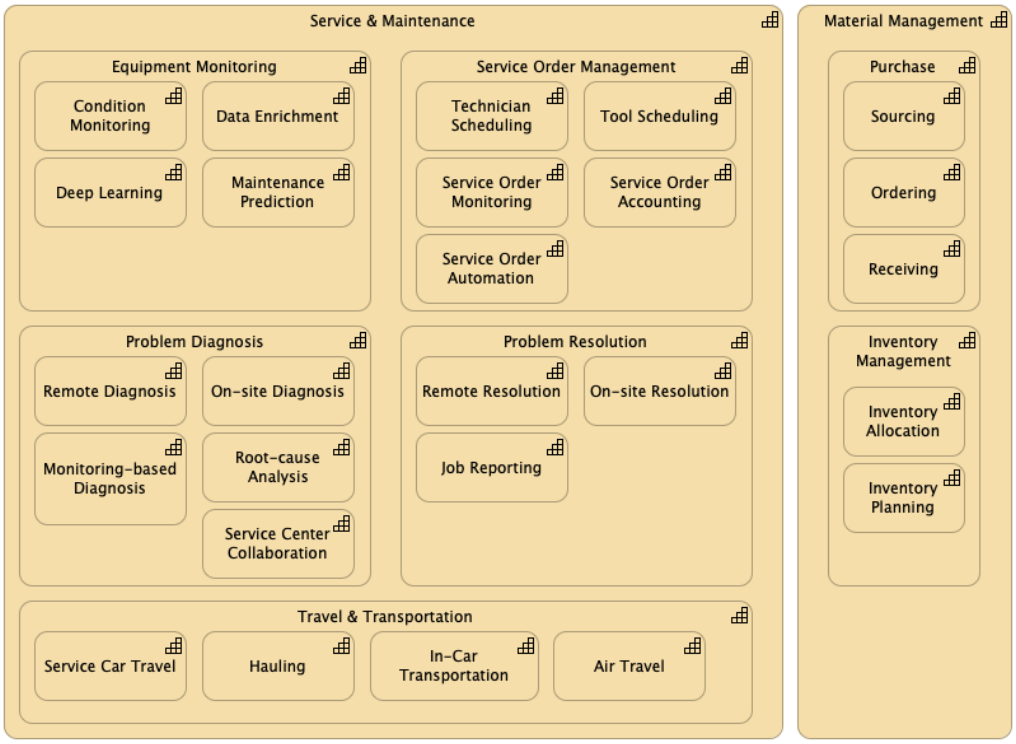


Figure 28 – Equipment Capability Map in ArchiMate

4.2 Ecosystem Map

4.2.1 Ecosystem Map in the VMP

A business ecosystem map provides an overview of how different participants collaborate with each other through their business models by exchanging value propositions with each other (VDMbee, 2016a). The ecosystem map of the Maintenance Service Case is represented in figure 29. Note that this represents the ecosystem when implementing the IoT technology (i.e. Smart Equipment Ecosystem Map).

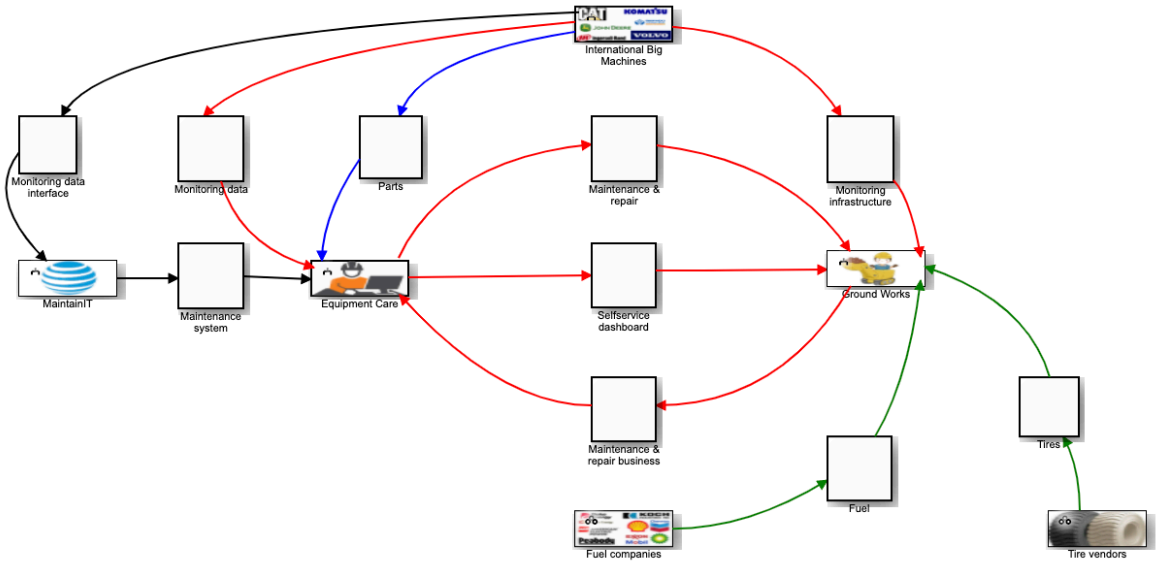


Figure 29 - Smart Equipment Ecosystem Map

In the Smart Equipment Ecosystem Map six different participants can be identified; the Equipment Care Company, the Ground Works Company, International Big Machines, MaintainIT, Fuel Companies and Tire Vendors. Remember that within this case the different participants represent prototypical companies and market segments. For example, the participant 'Fuel Companies' is a market segment representing all prototypical fuel companies (e.g. Shell, Total, Chevron). The different identified participants cooperate in one or more participant networks where they are assigned to specific roles indicating their responsibility. In figure 29 the different colors represent the identified participant networks: the actual maintenance network (i.e. red), the IT network (i.e. black), the parts network (i.e. blue) and the operational network (i.e. green). Within each of these networks a participant will provide or receive a value proposition through one or more roles. For example, the 'Equipment Care' company participates in the 'maintenance network' where it provides a value proposition 'Maintenance & Repair' to the 'Ground Works' Company. However, since both participants are represented with a participant shape (i.e. enterprise) it is not clear through which roles they provide and receive the value proposition 'Maintenance & Repair'. Within the VMP these role definitions can be found in the details of the shape. Figure 30 shows the details for the enterprise shape 'Equipment Care'. From this figure it can be seen that Equipment Care participates in three different participant networks (i.e. parts network, IT network and maintenance network) where it is assigned a certain role (i.e. Maintenance Service Provider, User). Note that the name of the role in the Parts Network and Maintenance Network is the same. However, they do represent different roles since each role is specific for one network.

Enterprise Details

Name	Equipment Care
Description	Equipment Care
Business Model(s)	Maintenance (*business*) Heavy duty (*partner*)

Participant Network	Role(s)
Maintenance Network	MSP
Parts Network	MSP
IT Network	User

Figure 30 - Enterprise Details 'Equipment Care'

Additionally, it can be seen from Figure 30 that the Equipment Care company is associated with two structured business models; the maintenance business model in the role of owner of the BM and the heavy duty business model owned by the Groundworks company in the role of partner to the BM. This representation makes it possible to describe the ecosystem and the further analysis from the perspective of the business model owning participants, which are in this care the 'Equipment Care' company and the 'Ground Works Company'. For both participants a structured business model will be defined, respectively the 'Maintenance' BM and the 'Heavy Duty' business model. The other participants are also represented by participant shapes in the business ecosystem map, however during the workshop sessions the different stakeholders decided to not explicitly define and discover their business models. This can be modeled explicitly by using the Business Model shape instead of an enterprise shape for the business model owning participants, as can be seen in the Ecosystem map in Appendix 3.1.

An ecosystem map can represent different levels of detail (VDMbee, 2016a), it can represent value exchanges between participant shapes, roles and business models. Often, the role shape is used when going into more detail (e.g. in a specific division of an organization). Whenever the role shape is used it is possible to directly model the roles through which the participants interact with each other. However, the participant information is not directly represented in the ecosystem map. Hence, when constructing an ecosystem map in the VMP you either represent a participant via its role shape, via its enterprise shape or via its business model. When using the participant shape it is not directly visible through which role they receive/provide value propositions and when using the role shape, it is not directly visible which participant is assigned to the specific role. However, both can be found when looking into the specific details of the shapes as explained above.

Finally, a value proposition represents the different values offered to a recipient (VDMbee, 2016b). Again, these values are not explicitly modeled within the Business Ecosystem Map. When going into the detail of the value proposition shapes, the different values associated with the value proposition are defined. Figure 31 represents the values associated with the value proposition "Maintenance & Repair". They represent the values that are of importance to the 'Ground Works' company. Remember the formula introduce in the context stage, the values 'cycle time improvement',

‘job efficiency improvement’ and ‘Mean Time Before Failure Improvement’ all influence the production (ton/h) and therefore the production cost ($/ton) which was defined as one of the main concerns of the ‘Ground Works’ company.

Values	Alt-1	Alt-0
contract price (K$/year)	15	15
cycle time improvement (%)	25	-
extended parts life (year)	5	7.5
job efficiency improvement (%)	7.14	-
MTBF improvement (%)	66.7	-
MTTR (corrective) (h)	18.5	11.13
MTTR (preventive) (h)	4	2
parts life extension (%)	0	50
preventive maintenance interval (d)	60	200

Figure 31 - Values embodied by the Value Proposition "Maintenance & Repair"

4.2.2 Ecosystem Map in ArchiMate

Within ArchiMate there doesn’t exist a specific viewpoint to represent a business ecosystem map as expressed in the VMP. Hence, a new viewpoint will be defined later on. First a comparison will be made between the VMP concepts and the EA concepts. For an ecosystem these concepts include participant shapes (i.e. enterprise, market segment, individual), role shapes and value proposition shapes. Also, the representation of participant networks within the ecosystem map and the use of the business model shape will be discussed.

4.2.2.1 Participants

First of all, multiple participants are represented within a Business Ecosystem Map. According to the VDML a participant is defined as “Anyone or anything that can fill a role in a collaboration”(Object Management Group, 2011, p.98). Within the VMP a participant is represented as an enterprise (i.e. VDML organization unit), a market segment (i.e. VDML community) or an individual (i.e. VDML actor). They all have role(s) within the ecosystem through which they provide and receive value propositions to/from each other in one or more participant networks. Hence, the concept of participant as applied within the VMP is consistent with the VDML definition.

Within ArchiMate a participant could be represented by using the actor element of the business layer. A Business actor “represents a business entity that is capable of performing behavior” (The Open Group, 2019, p.59) and is consistent to

both an actor[16] and organizational unit[17] in the TOGAF framework (The Open Group, 2019). Therefore, a business actor can be used to represent entities outside the organization (e.g. partners, customers) as well as inside the organization at different levels of details. Within the ArchiMate specification it is specifically stated that business actors might be individual persons or organizations (e.g. "Shell Company") as well as generic descriptions (e.g. fuel supplier, customer), as well as groups of people (e.g. organization units) and resources that have permanent (or at least long-term) status within the organization (e.g. departments, business unit) (The Open Group, 2019). Hence, all three VMP concepts (i.e. enterprise, market segment, individual) can be represented by the business actor concept in ArchiMate.

In order to indicate that participants have certain roles through which they provide/receive value propositions, the business role element can be used as represented on Figure 32. A Business Role "represents the responsibility for performing specific behavior, to which an actor can be assigned, or the part of actor plays in a particular action or event" (The Open Group, 2019, p.60). A business actor can be assigned to a business role to indicate that this particular actor is responsible for performing the specific behavior associated with it. Therefore, a business actor needs to be assigned to a business role in order to perform behavior, which is in line with the participant concept in the VMP. Moreover, both ArchiMate and the VMP recognize that actors can be assigned to multiple roles representing different types of behavior associated with different value exchanges.

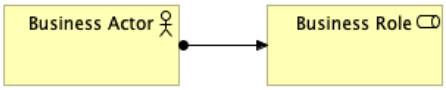


Figure 32 - Business Actor assigned to Business Role

Notice that the VMP also defines a role concept as "an expected behavior pattern or capability profile associated with a participant in a collaboration", this is in line with the role element in ArchiMate. Moreover, in the VMP it is possible to either use a participant shape, thereby not clearly indicating which role the participant performs, or the role-shape thereby not clearly indicating which participant is assigned to that specific role. This is similar in the ArchiMate language where a Business Actor can be assigned directly to a Business Process without explicitly visualizing the Business Role of this Actor or where a Business Role can be represented without explicitly showing the Business Actor that is assigned to this role (The Open Group, 2018).

Another suggestion could be to represent participants via the stakeholder motivational element. A stakeholder "represents the role of an individual, team, or organization (or classes thereof) that represents their interests in the effects of the architecture" (The Open Group, 2019, p.41). Hence, a stakeholder represents an actor that does not has a performing role within the architecture but is interested in its results (Wierda, 2017). Since, all the actors in the

[16] "a person, organization, or system that is outside the consideration of the architecture model but interacts with it" (The Open Group, 2018).

[17] "a self-contained unit of resources with goals, objectives and measures" (The Open Group, 2018).

business ecosystem are defined as “participants” and are therefore participating in the business ecosystem through specific roles it is more appropriate to use the first representation of a business actor assigned to a business role thereby clearly indication their distinction. Wierda (2017) argues that a business role and business actor can be seen or should be seen as specializations of stakeholders where a stakeholder represents a more abstract concept. Therefore, it is recommended to use the stakeholder role when identifying prototypical actors to include this will be done in some of the mappings introduced in the next parts. Note that fuel suppliers, etc. represent prototypical actors but are represented with the business actor element since they participate in a participant network and therefore the role assignment is important to include.

4.2.2.2 Participant Networks

An ecosystem identifies one or multiple participant networks that form the basis of the structured business models constructed in the prototype stage. A participant network defines which participants, in which roles, collaborate with each other, by creating and delivering value and exchanging value with each other(VDMbee, 2016b). Hence, participants collaborate with each other in one or multiple participant networks where they have one or multiple roles. In VDML a collaboration is defined as the fundamental structure of a Value Delivery Model that brings together participants in roles working together to perform activities for a shared purpose(Object Management Group, 2011). These participants can be individuals as well as other collaborations (e.g. organization unit, community) (Object Management Group, 2011). Hence a participant network is consistent to a collaboration that serves as a building block for the structured business models. Within this context a participant is identified as either a customer to the business model, a network partner to the business model or the owner of the business model. The specific implementation of participants within a structured business model will be explained when describing the structured business model.

Within the ecosystem participant networks are mainly identified to support the analyst when mapping the structured business model. Hence, the focus is on the structural combination of the different participants within these participant networks and their roles. Therefore, it is suggested to represent a participant network by using the business collaboration element of ArchiMate. A business collaboration is an internal active structure element that represents the aggregation of two or more business internal active structure elements (e.g. business actor) that work together to perform collective behavior (The Open Group, 2019, p.60). Hence, the business collaboration can be used to aggregate multiple business actors working together. The specific behavior of a business collaboration can be represented by a business interaction element which is an internal behavior element that represents the unit of collective behavior performed by a business collaboration. Hence, business interactions focus on the structural relationships between multiple business actors while business interactions stress the importance of the activities that are performed by the different business actors within the scope of the business collaboration.

Hence, it is proposed to represent a participant network by using the business collaboration element that aggregates multiple business actors assigned to one or more business roles. Figure 33 represents the ArchiMate representation for the Maintenance Network. The Maintenance Network consists out of three business actors that each perform, in this case, one role in order to deliver the value that is associated with the maintenance network. Note that a participant

network is mainly used to define the structured business model therefore the participant network representation will be further discussed in the prototype section.

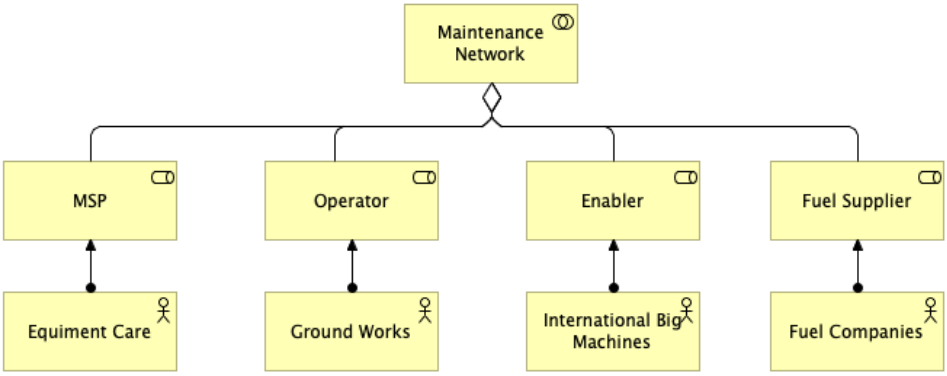


Figure 33 - participant network in ArchiMate

4.2.2.3 Value Proposition

Participants in the ecosystem are collaborating with each other through the exchange of value propositions. Remember that a Value Proposition within VDML was defined as an "expression of values offered to a recipient evaluated in terms of the recipient's level of satisfaction", value as "a measurable factor of benefit, of interest to a recipient, in association with a business item" (Object Management Group, 2011, p.99), and a business item as "anything that can be acquired or created, that conveys information, obligation or other forms of value and that can be conveyed from a provider to a recipient" (Object Management Group, 2011, p.97).

The ArchiMate language doesn't contain a specific metamodel element to represent a value proposition. However, there already have been some suggestions for representing a value proposition in an ArchiMate Model. H. Ding (2015) and Lankhorst (2016) state that a value proposition can be represented by the product element of the business layer associated with the values that stakeholders associate with it. A product within ArchiMate is a composite element, hence consisting of other concepts from multiple layers (The Open Group, 2019, p.19). This is also represented on the Product Metamodel in Figure 34. A product "represents a coherent collection of services and/or passive structure elements, accompanied by a contract/set of agreements, which is offered as a whole to (internal or external) customers" (The Open Group, 2019, p.70). The product element can also be associated with the motivational value element where value "represents the relative worth, utility, or importance of a concept" (The Open Group, 2019, p.47). Moreover, this value can in turn be associated with a particular stakeholder to model to who this value applies.

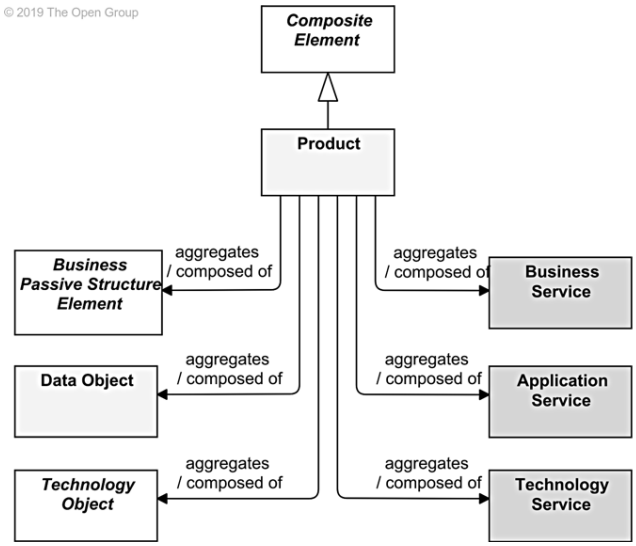


Figure 34 - Product Metamodel (The Open Group, 2019)

However, when looking for a correct representation of a value proposition within the scope of a business ecosystem map, a product element might be used in the context of the role collaboration diagram indicating deliverable flows rather than the value proposition exchanges. Therefore it is proposed to represent a value proposition by the Outcome Motivational aspect element as suggested by Poels, Nollet, Roelens, de Man, & van Donge (2020). An outcome represents an end result (The Open Group, 2019, p.44) and therefore also the end result of a value stream supporting the realization of the value proposition. Outcomes are or should be in line with the defined goals of the organizations and represent the high-level, business-oriented results produced by the capabilities of an organization (The Open Group, 2019, p.44). An outcome can be associated with a motivational value element representing the value of the outcome for a particular stakeholder that can in turn also be associated with this value. Similar as in the VMP, outcomes can also represent unwanted or unforeseen outcomes that should be integrated within an analysis in order to provide a better image on the implications of an initiative on your business (The Open Group, 2019). Figure 35 represents an initial representation of the value proposition exchange within ArchiMate.

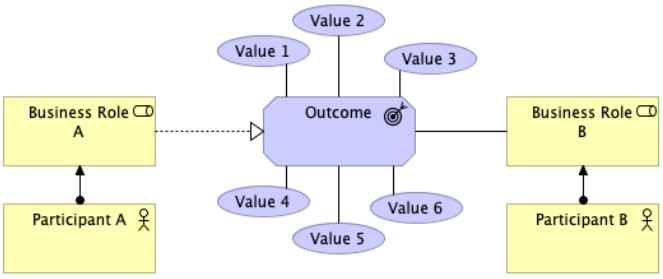


Figure 35 - Value Proposition Exchange in ArchiMate

This figure clearly illustrates that participant A in a role A provides an outcome that is associated with multiple values while participant B in a role B is the one receiving the value and the associated values. Note that one could also suggest representing a value proposition by using the grouping element to group the values provided by one participant and received by another together. However, using the outcome element, associated with value elements, clearly illustrates

the end result a participant wants to achieve. Hence, a participant wants to realize the outcome and therefore it will have to do certain things (i.e. value stream). The realization of this outcome is associated with different values that are associated through the outcome with the recipient participant. Note that ArchiMate states that when two dependency relationships are joining at an intermediate element (i.e. outcome) the two relations could be replaced by one(The Open Group, 2019). Hence, values are directly associated with the participant associated with the value proposition.

The relationships used to connect an outcome with the two business roles are the realization and association relationship. However, many ArchiMate relationships are overloaded and therefore the relationships gain most of their interpretation when connected to a source and destination elements. The realization relationship connects a role to which a participant is assigned with a particular outcome. Hence, it represents that the business role to which a business participant is assigned plays a critical role in the creation, achievement, sustenance, or operation of the outcome. The association relationship connecting the outcome with a busines role represents that the outcome, associated to different values, is associated with a business role that receives the values associated with the outcome.

4.2.2.4 Business Ecosystem Viewpoint

Putting all of these together an Ecosystem Viewpoint can be constructed similar to the VMP Ecosystem Map. Whenever defining a viewpoint, one should think about the purpose and the content of this viewpoint. In the case of the ecosystem map it can be stated that the purpose is to support informing and designing. By creating a high-level overview, different stakeholders will have the same view on how participants work together in an ecosystem and which value proposition are exchanged between them while not providing hiding the details about how these specific value propositions are realized. Therefore, the content will be situated on an overview abstraction level. Moreover, the ecosystem can support designing since it represents the helicopter view serving as an initial sketch from which more detailed views can be created. The Ecosystem Viewpoint is described in table 9. The scope of the viewpoint contains strategy and motivation elements, also note that the stakeholder element can be included within the viewpoint as indicated before.

Business Ecosystem Viewpoint	
Stakeholders	Upper-level management, other important stakeholders (e.g. partners, customers)
Concerns	The value proposition exchange within an ecosystem (i.e. collaboration)
Purpose	Designing, deciding
Scope	Strategy and Motivation
Elements	Outcome, Value, Business Role, Business Actor, Stakeholder

Table 9 - Ecosystem Viewpoint Description

The Ecosystem Map Viewpoint corresponding to the Smart Equipment Ecosystem Map is represented in figure 36. Remember that within the ecosystem participant networks could be identified by assigning colors to the different relationships. the EA tool used for creating the different ArchiMate views included within this master dissertation supports the use of defining your own color scheme and the corresponding Business Ecosystem View is included within Appendix 4.1.

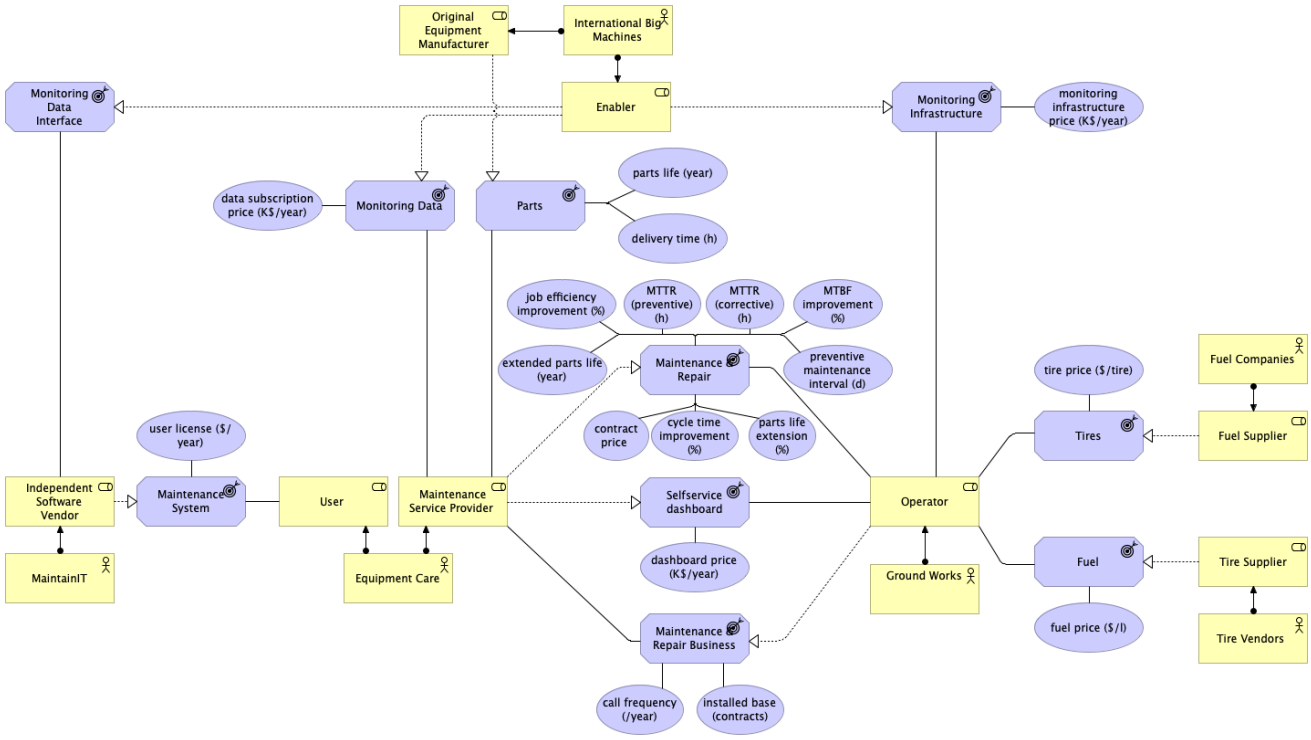


Figure 36 - Business Ecosystem Viewpoint for the Maintenance Service Case

4.3 Value Stream Map

4.3.1 Value Stream Map in the VMP

A Value Stream Map provides a graphical specification and representation of value streams delivering the value propositions as exchanged in the business ecosystem (VDMbee, 2018a). The Value Stream Map of the value proposition "Maintenance & Repair" provided by the "Equipment Care" company to the "Ground Works" Company is presented in figures 37 and 38. For the maintenance service case only one value stream is defined within each value stream map, however it could also be that a value stream map defines multiple value streams. A value stream map defines the activities that need to be performed in order to deliver a particular value proposition to a stakeholder (VDMbee, 2018a). For example, the Equipment Care company provides a value proposition 'Maintenance and Repair' to the Ground Works company including multiple values. Therefore, the Equipment Care Company has to perform the activities defined in the value stream since these activities create value that contributes to the value defined in the value proposition. Some of the activities are connected through sequence connectors indicating the value flows from one activity to another activity. Moreover, two activities defined in two separate value streams can also be connected to each other indicating the value flow between them. Note that connecting activities is not mandatory in the VMP, for example the activity "Monitor" in figure 37 is not connected to any other activity within the same or another value stream defined in the value stream map.

Each value stream defined in a value stream map is directly related to a particular 'value proposition' in the ecosystem. Activities represent "work performed by a participant in the business ecosystem" (VDMbee, 2018, p.10). Hence, the

activities that are defined in a value stream can either be performed by the business itself (i.e. business providing the value proposition), a partner or a customer of the business.

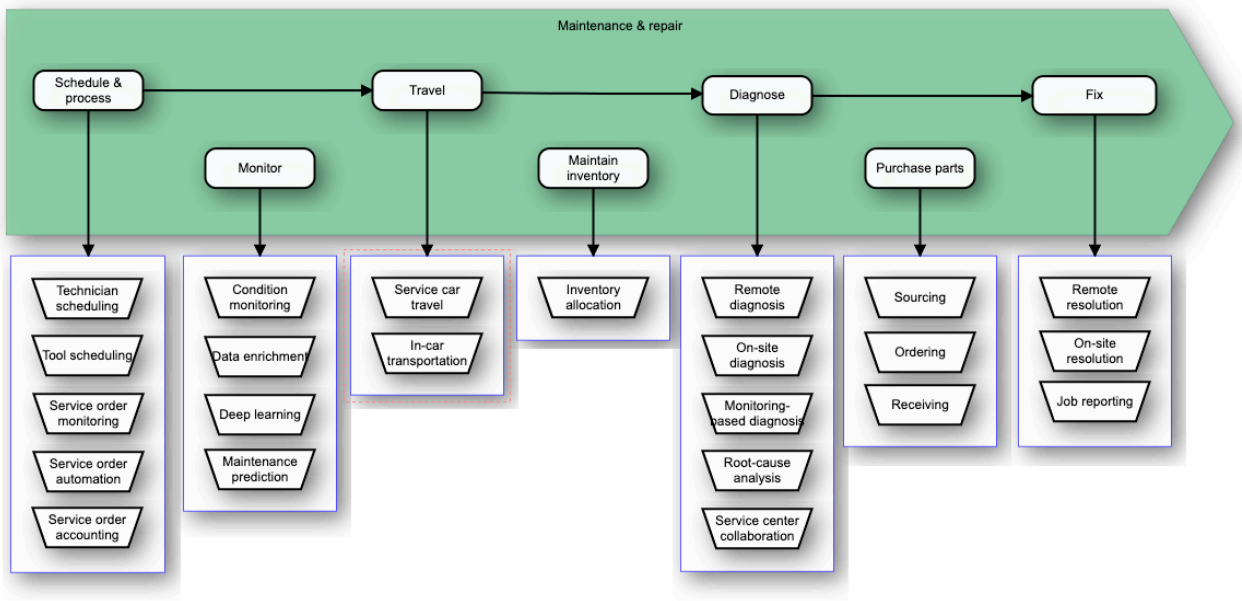


Figure 37 - Value Stream Maintenance & Repair (Capabilities)

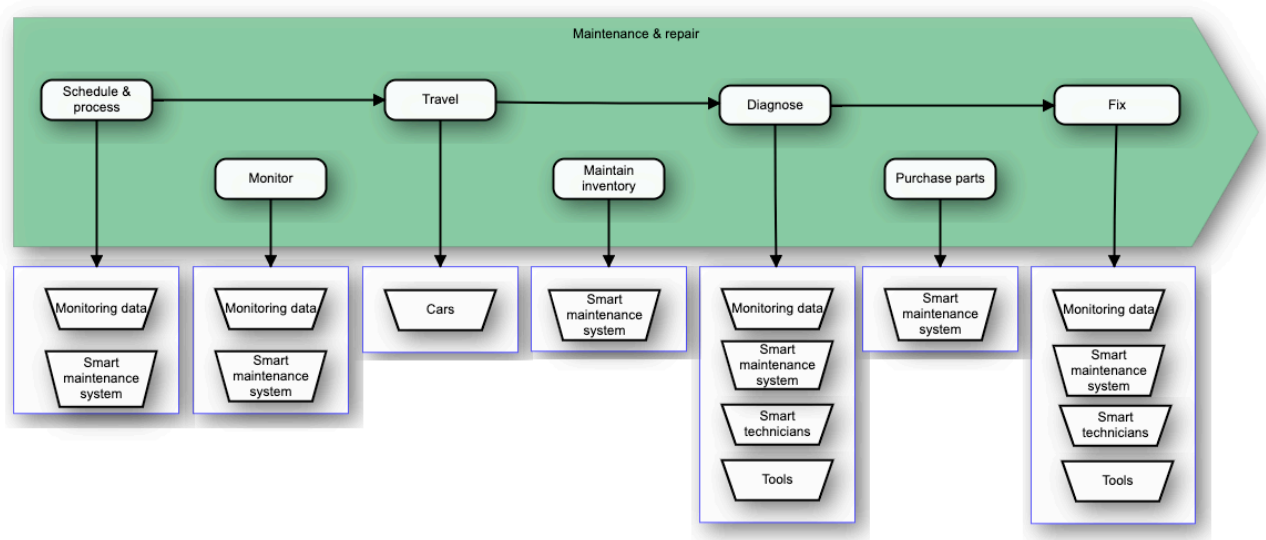


Figure 38 - Value Stream Maintenance & Repair (Resources)

In order to perform activities an organization, or other participants cooperating with the organization, needs to have the necessary competencies. A competency is a construct derived from the Business Model Cube framework where it addresses questions like; How are the activities and functions carried out? Who takes care of the value chain functions?(Lindgren & Rasmussen, 2013; Poels et al., 2020). A competency as implemented in the VMP is consistent to a VDML resource as well as a VDML capability. A capability is the ability to perform a particular kind of work and deliver desired value while resources represent anything that is “used” or “consumed” in the production of a deliverable (e.g. human resources, patents, skills, IT system)(Object Management Group, 2011, p.97-99). Since, activities performed by partners are also included in the value stream, the competencies that this partner needs in order to perform these

activities will also be incorporated in the value stream. This makes it possible to get one integrated overview of the internal and external activities that need to be performed in order to deliver the value proposition as well as the competencies these activities need.

In reality it is often the case that two value stream maps are constructed, separating resources and capabilities (VDMbee, 2019). For example, in the service maintenance case two value streams are constructed on figure 37 and 38 where the first one graphically indicates the different capabilities that the 'Equipment Care' company needs in order to perform the activities defined in the value stream and the second one the resources that are needed to perform the same activities. Graphically it is not clear which competency shape represents a resource or a capability however in the VMP some naming conventions are used to differentiate resources (i.e. indicated by a verbal noun) from capabilities (i.e. indicated by a noun). For example, 'Cars' is a resource and 'Service car travel' is a capability.

In the ecosystem map it was possible to associate value objects with the value propositions that where of importance to the recipient of the value proposition. The same can be applied for the value stream map where activities create values or aggregate to the values delivered by the corresponding value proposition (VDMbee, 2019). Looking at the VMP Value Stream Maps, it is clear that values associated with activities are not graphically depicted within the value stream. However, when looking into the details of the different activity shapes the values created by them are defined. For example, figure 39 shows the values created by the activity "Travel".

Search:

Values	Alt-0	Alt-1
car rate ($/km)	0.25	0.25
travel distance (corrective) (km)	150	100
travel distance (preventive) (km)	75	50
travel time (corrective) (h)	4	3
travel time (preventive) (h)	2	1.5

Showing 1 to 5 of 5 entries Previous 1 Next

Figure 39 - Activity Values of "Travel"

4.3.2 Value Stream Map in ArchiMate

Recently, the Open Group published the ArchiMate 3.1 specification (2019) with as main addition the introduction of a value stream element as a behavioral strategic element. The value stream "represents a sequence of activities that create an overall result for a customer, stakeholder or end user" (The Open Group, 2019, p.53). This is in line with the value stream as represented in the VMP where it defines the set of activities (and their values) that contribute to a value proposition(VDMbee, 2016b). In both the VMP and the ArchiMate language, it is stated that the recipient, and hence the stakeholder triggering the value stream, could be an external customer (i.e. customer of the enterprise) as well as an internal customer (i.e. actor within the enterprise such as a department)(Poels et al., 2020). Figure 40 represents the

value stream as introduced in the ArchiMate specification. According to this representation, activities are represented by the value stream element, competencies by the competency element, resources by the resource element and values by the motivational value element.

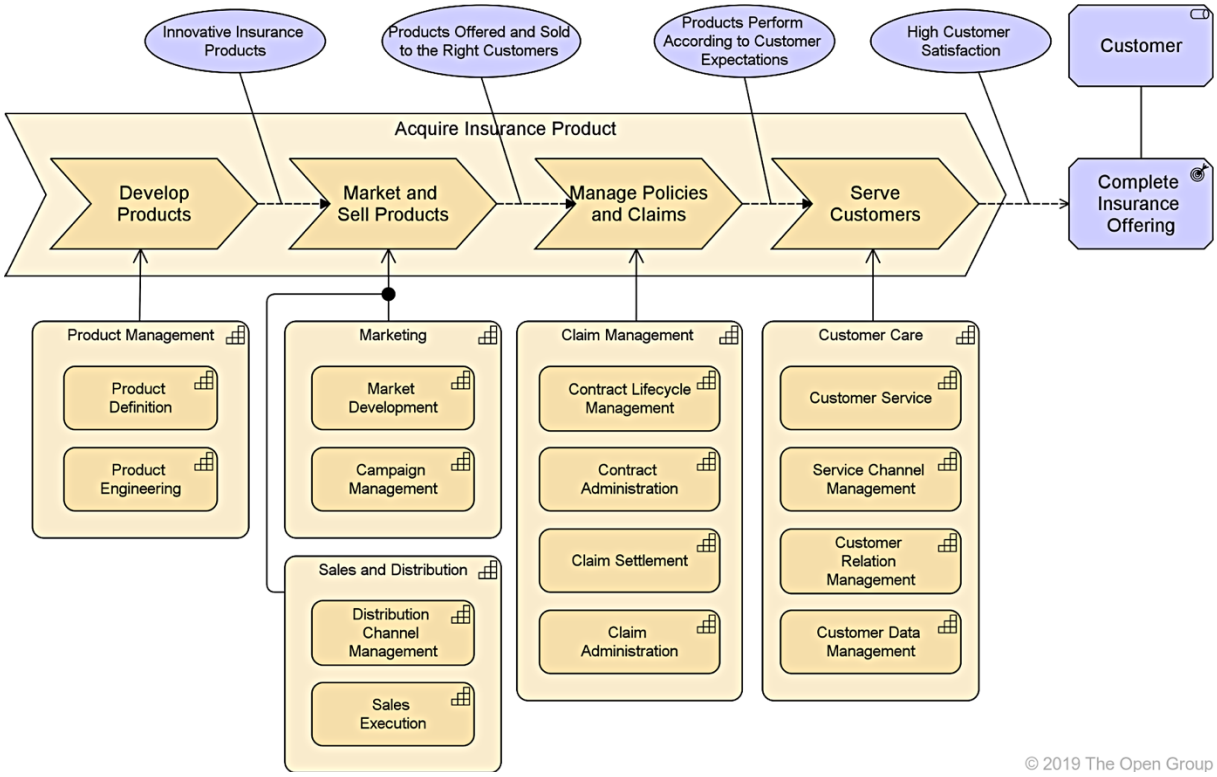


Figure 40 - Value Stream with Capability Cross- Mapping (reference: Open Group Standard)

4.3.2.1 Activities

Activities in the Value Stream represents the "work performed by a participant in a role in a participant network" (VDMbee, 2016b, p.10). Thereby a value stream focuses on the value that this activity provides in the form of a ValueAdd contributing to the value proposition values delivered to a stakeholder. The value stream element defined by the ArchiMate provides a good representation of the value stream activity since it emphasized the value creating behavior rather than the sequence of behaviors that is more related to the operating model of the business. According to the ArchiMate specification value stream elements are realized by core behavior element such as business processes. These elements therefore provide a lower level of abstraction focusing on the 'how' rather than the 'what'.

Note that every ArchiMate construct can be defined at different levels of granularity, therefore a value stream element can represent an overall end-to-end value stream as well as a particular value stage or value adding activity within this value stream.

In line with the value stream representation in figure 40, the different value stream stages are connected with flow relationships indicating the value flows from one stage to another. Moreover, the different values produced by the activities within a value stream influence, either directly or through aggregation, the value included within the value

proposition. For example, high customer satisfaction is provided to the customer by developing innovative insurance products that are offered to the right customers and perform according to the expectations that customers have.

Notice that at the end of the value stream a flow relationship is defined connecting the last value stream stage to the outcome 'Complete Insurance Offering' associated with a Stakeholder 'Customer'. This represents that in the end a value stream produced some kind of outcome, associated with values of interest to some stakeholder (e.g. customer). However, as stated by Poels et al. (2020) the final flow from a value stream concept to an outcome is not supported by the ArchiMate metamodel. Therefore, they suggest using a realization relationship between the value stream and the outcome as shown in figure 41.

4.3.2.2 Competencies

The VMP competencies representing resources and capabilities are represented by ArchiMate resource – and capability elements. These elements are connected to the value stream stages using serving and assignment relationships indicating that capabilities serve the value stream stage and resource are assigned to it.

Resources within the VMP are described as things that can be used by an activity in order to produce an outcome. Similar, ArchiMate defines a resource as "an asset owned or controlled by an individual or organization"(The Open Group, 2019, p.51). Accordingly, a resource element can represent tangible assets (e.g. financial and physical assets), intangible assets (e.g. technology assets) as well as human assets (e.g. skills, motivation) "(The Open Group, 2019). Notice that within the VMP, according to the VDML, resources where represented as Stores (or Pools) that delivered BusinessItems over a DeliverableFLow from this Store (or Pool) to the Activity (Object Management Group, 2011). By assigning an ArchiMate resource element to a Value Stream element the same relationship could be derived representing the allocation of resources to the activity.

Capabilities in ArchiMate "represent an ability that an active structure element, such as an organization, person or system possesses". This element was already used to represent CapabilityCategories and CapabilityDefinitions within the Capabablity Map. However, it can also be used within a value stream to indicate which capabilities are required by the value stream activity. This will be represented by using a serve relationship that indicates that the capability will provides its functionality to the activity (The Open Group, 2019). Notice that this means that the capability element can be used to represent CapabilityDefinitions as wel as CapabilityMethods and therefore doesn't clearly indicates the difference between types (i.e. definitions) and instances (i.e. the use of these elements by a specific organization unit). As mentioned capabilities in the VMP delegate to CapabilitMethods that define activities for these activities that again can be delegated to other CapabilityMethod in a specific DelegationContext. However, this delegation is not supported by ArchiMate where a main focus on the representation as presented in figure 41 will be maintained.

4.3.2.3 Value Stream Viewpoint

The ArchiMate specification also defines a Value Stream Viewpoint that "allows the Business Architect to create a structure overview of a value stream, the capabilities supporting the stages in that value stream, the value created, and the stakeholders involved" (Object Management Group, 2011, p.168). According to the description of this viewpoint, included in table 10, the only elements selected from the ArchiMate metamodel are; value stream, capability, outcome and stakeholder. Hence, this viewpoint doesn't include the motivational value element and the Strategic resource element. Therefore, it could be suggested to extend the viewpoint thereby incorporating these elements to provide additional insights into the value creation of the different activities and their contribution to the outcome values as well as on the necessary resources that are assigned to the capabilities.

Value Stream Viewpoint	
Stakeholders	Business managers, enterprise and business architects
Concerns	Architecture strategy and tactics, motivation
Purpose	Designing, deciding
Scope	Strategy
Elements	Value Stream, Capability, Outcome, Stakeholder

Table 10 - Value Stream Viewpoint Description

The value stream of the value proposition "Maintenance & Repair" visualized in the ArchiMate language is represented on Figure 41. The different value stream stages are connected via flow relationships as was the case in the previous example. However, in this example the entire value stream is connected to the outcome 'Maintenance and Repair' via a realization relationship. Hence, the value stream is critical for the realization of a particular outcome. Both the participant delivering the values resulting from the value stream (i.e. Maintenance Service Provider) as well the value recipient (i.e. Operator) can be indicated in the value stream map by associating them respectively with the value stream itself or with the outcome that is realized by it. Additionally, it could also be possible to relate providing participants with the different activities since they could be performed by the business itself or by a partner in the ecosystem (Poels et al., 2020). For the Maintenance Service case all activities are performed by the Maintenance Service Provider.

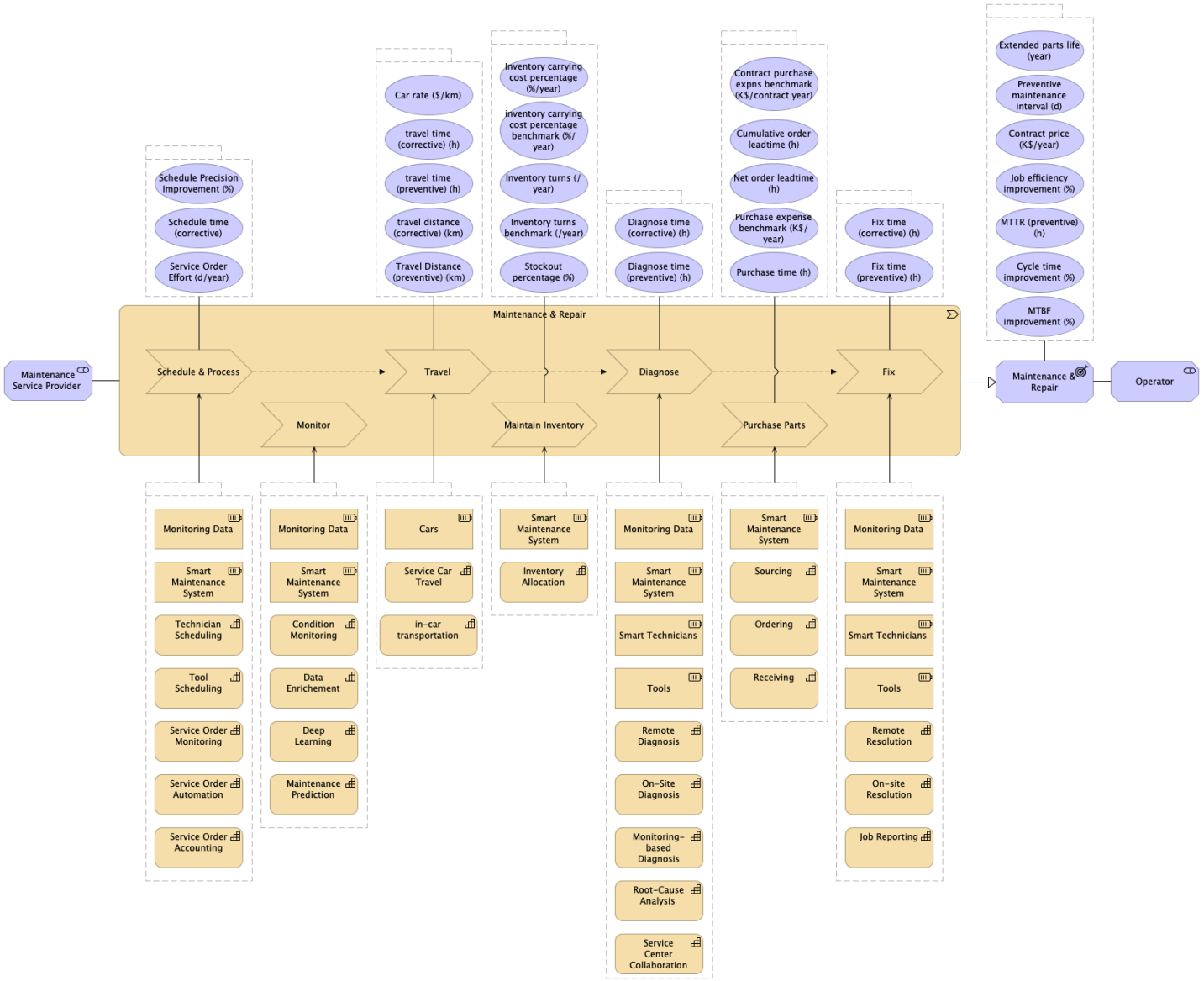


Figure 41 - Value Stream for 'Maintenance & Repair' value proposition

4.4 Strategy Map

4.4.1 Strategy Map in the VMP

A value stream map will describe which participants you use and apply to your value stream in order to create value for yourself as well as for your customers given the intended innovation (VDMbee, 2019). Therefore, all the shapes represented in a strategy map represent the most important values (i.e. activity values, business values, plan values, value proposition values, competency related values), competencies and activities within the context of the transformation or innovation for a particular BM owning participant. Each strategy map defined in the VMP describes the value creation story from the perspective of one business model owning participant.

For the Maintenance Service case there are two BM owning participants. The Equipment Care Company, in its role of Maintenance Service Provider, has a business model "Maintenance" and the Operator Company, in its role of Operator, has a business model "Heavy Duty". The strategy map representing the value creation story through the "Maintenance" business model is shown in figure 42. The Strategy Map of the Operator Company is included in Appendix 3.1.2. As can be seen, there are four perspectives in which shapes can be placed; the business value perspective, the customer value perspective, the value stream perspective and the competency perspective. The first two perspectives define the most important values that are created for yourself (business value) as well as for your customers (customer value) by participating in the business ecosystem. Note that values that you create for participants are not represented in the Strategy Map. The two other perspectives mainly describe the most important factors contributing to these customer and business values.

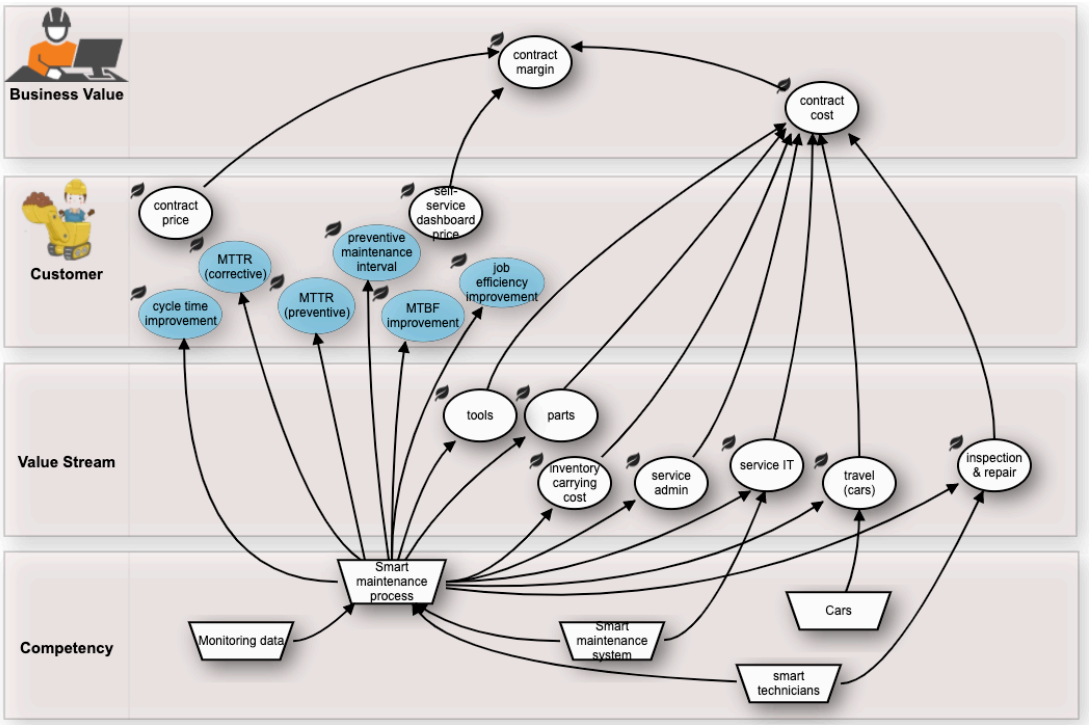


Figure 42 - Strategy Map Maintenance

The value creation story from the perspective of the MSP shows that 'Monitoring Data' and 'Smart Maintenance System' competencies provided by participants together with 'Smart Technicians' aggregate up to the 'Smart Maintenance Process' competency that the MSP uses to improve important customer values such as cycle time, MTTR and job efficiency. The Smart Maintenance Process competency also comes with cost for tools, parts, inventory that together aggregate up to the contract cost value which is an important business value for the MSP itself since it will determine the contract margin. Hence, the 'Smart Maintenance Process' also provides lower cost values and thereby increases the contract margin. Within the VMP it is also possible to indicate important values for the value creation story that are not specific enough to become structured measurable values (e.g. workforce flexibility). As is the case for the Smart Maintenance transformation the value creation process is driven by the competencies that become available by closing a partnership with International Big Machines (i.e. providing monitoring data) and MaintainIT (i.e. providing the maintenance system). These competencies are used by the activities in the value streams in order to deliver value to the customer and the business itself.

Note that value shapes, competency shapes and activity shapes can be included in the Strategy Map. However, for the maintenance service case no activities are explicitly included within the value stream perspective. The main purpose is to create a clear value creation story that can be understood by all stakeholders involved. Therefore, it is also possible to represent an activity together with an activity value or a competency with a competency value if this creates a clearer picture of the value creation story.

4.4.2 Strategy Map in ArchiMate

In the previous sections the created models already contained some value objects associated with value propositions (i.e. Ecosystem Map) and with activities (i.e. Value Stream Map). For this the motivational value element was used. In addition, VDML competencies and activities were also presented by similar ArchiMate constructs (i.e. strategy resource and capability elements, value stream element). The strategy map also indicates plan values and my proposition values. Plan values are defined as "a basis for management and measurement of success of plan outcomes"(VDMbee, 2016b, p.7). My proposition values express the value that the business itself captures from creating and exchanging value with other participants in the business ecosystem (VDMbee, 2016b, p.11).

4.4.2.1 Plan values and Business values

Since my proposition values as well as plan values have not yet been mapped to a corresponding ArchiMate elements it is needed to see how they should be represented within an ArchiMate Model. It was already mentioned that every ArchiMate element could represent different levels of aggregation, therefore the motivational value element can represent a low-level activity value as well as a high-level plan value. Also, values attached to value propositions captured by the business itself can be presented by plan values. Aldea, Iacob, & Quartel (2018) suggest that when constructing a Strategy Map with ArchiMate concepts, the Motivational Goal and Outcome elements should be used. This suggested was based on the Strategy Map as represented by Kaplan and Norton. Here the different perspectives defined objectives connected to each other by cause-and-effect relationships. However, in the VMP the strategy map is linked to the use of value delivery modeling hence the different perspectives define the values that are created

representing their high-level aggregation relationships to indicate how values created by competencies and activities influence the ones deliver to customers and captured by the business itself. Therefore, it is recommended to use the motivational value element to represent these measurable values, at higher level they can be associated with goals and assessments made in the SWOT analysis.

4.4.2.2 Strategy Map Viewpoint

A description of the Strategy Map Viewpoint is provided in table 11. The viewpoint mainly serves to inform the business managers – of the business owning the business model – about the most important values, competencies and activities in relation to the value creation for customer and captured by the business itself. Therefore, the viewpoint includes elements from the strategy and the motivation layers. The view corresponding to this viewpoint is provided in figure 43.

Strategy Map Viewpoint	
Stakeholders	Business managers
Concerns	Overview of most important value aggregation relationships
Purpose	Informing
Scope	Motivation, Business
Elements	Value, Capability, Resources, value stream stages

Table 11 - Strategy Map Viewpoint description

As indicated in figure 43, influence relationships are used to connect the different value shapes. This relationship can be used to express how one value influences the achievement of another value(The Open Group, 2019). Moreover, plus and minus signs can indicate how the source element influences the target element. ArchiMate only supports influence relationships from ArchiMate elements to Motivational Elements therefore this relationship can't be used to connect a competency with another competency or an activity with another activity. The relationship between a competencies and activities should therefore be indicated with other types of relationship. In the example on figure 43 the assignment relationship is used to connect a resource with a capability since resources support capabilities that are required by activities to create value. Also notice that the ArchiMate grouping element is used to represent the different perspectives since they group elements according to their origin (e.g. business values, customer values, value stream values and competency values).

Notice that the ArchiMate view in figure 43 indicates relationships between different ArchiMate elements. In the VMP these relationships correspond to specific aggregation relationships. For example, contract margin is influenced by contract cost, self-service dashboard price and contract price. Within the ArchiMate language signs could indicate if this influencing relationship is positive or negative. In the VMP this relationship corresponds to a specific value formula: contract margin = contract price + dashboard price – contract cost. By this formula it is possible to calculate the precise contribution of each of these elements.

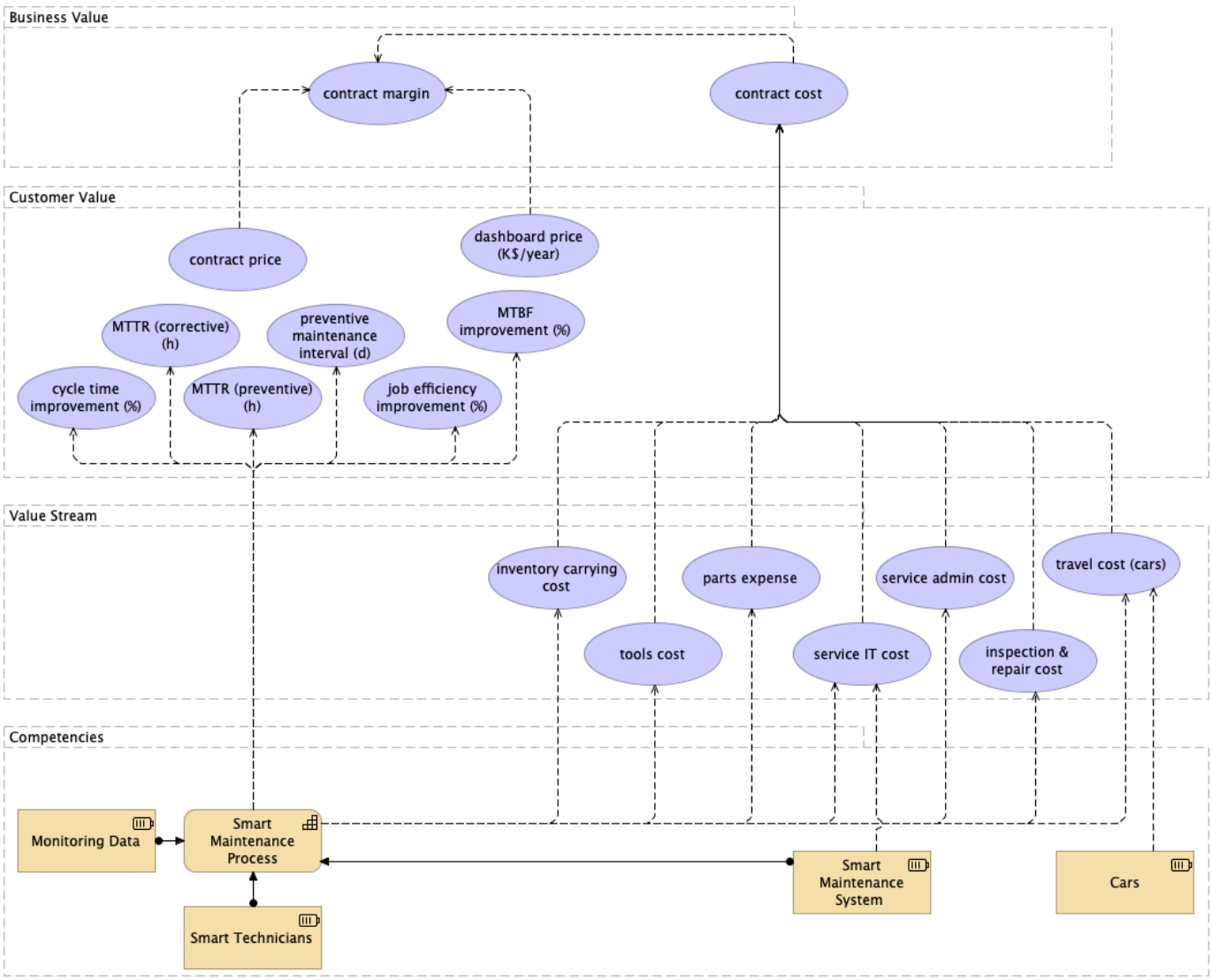


Figure 43 - Strategy Map Viewpoint (MSP)

4.5 Business Model Canvas

4.5.1 Business Model Canvas in the VMP

The Business Model representation of concern in the scope of this research paper is the Business Model Canvas of Osterwalder and Pigneur(2013) that is typically used in to capture ideas or other information for an innovation or transformation. “Maintenance” Business Model Canvas of the Equipment Care Company is shown in figure 44, the BMC of the Operator Company is included in Appendix 3.1.1.

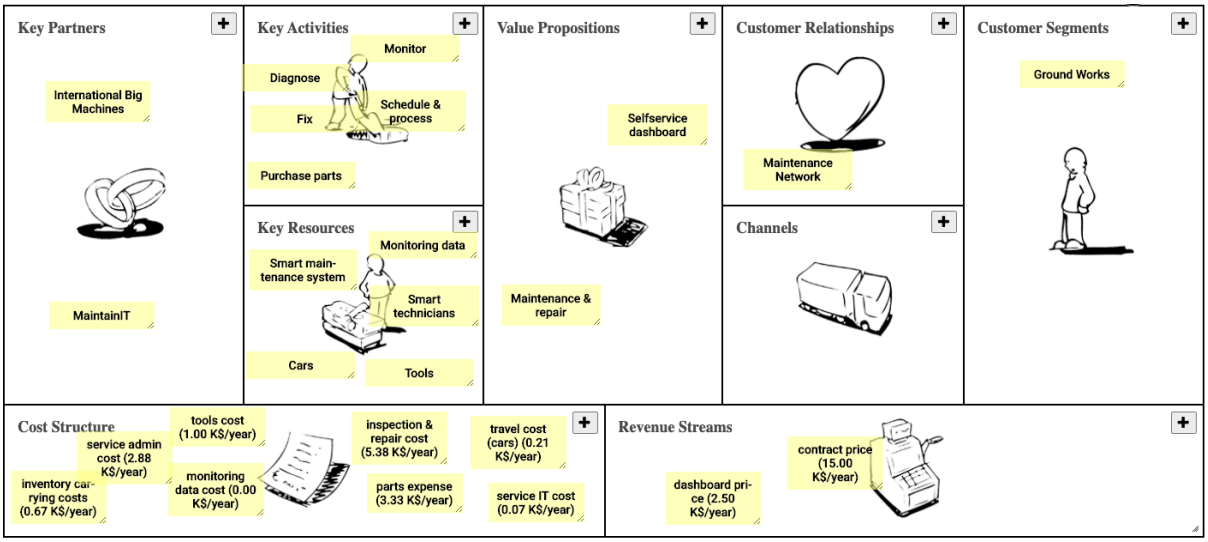


Figure 44 - Business Model Canvas "Maintenance"

4.5.2 BMC in ArchiMate

In order to provide a mapping for the Busines Model canvas references will be made to previous research on this topic. Here the different building blocks will be described one by one focusing on the representation of this building block within ArchiMate. However, note that these building blocks are all connected to each other although this is not explicitly shown in the Business Model Canvas.

4.5.2.1 Customer Segments

Customer Segments define the different groups of people or organizations an enterprise aims to reach and serve (Osterwalder & Pigneur, 2013, p.20). This building block corresponds to the VMP participant shapes representing enterprises, market segments and individuals that are customer to the Business Model. It is suggested to represent this building block by the ArchiMate Business Actor, Business Role or Stakeholder elements (Iacob et al., 2014; Lankhorst, 2016; Meertens et al., 2012) to. As mentioned, it is recommended to use a stakeholder element whenever prototypical actors are defined thereby not focusing on the specific behavior they have.

4.5.2.2 Customer Relationships

Customer relationships describe the types of relationships a company establishes with specific customer segments (e.g. personal assistance, self-service, automated services)(Osterwalder & Pigneur, 2013, p.28). In the VDML this corresponds

to collaborations that engage customers in the exchange of value propositions (Object Management Group, 2011). Before it was proposed to represent a participant network (e.g. maintenance network) by the ArchiMate business collaboration element as suggested by Lankhorst (2016). Additionally, Iacob et al. (2014) suggest the use of the ArchiMate Business Interaction element defined as "a unit of collective business behavior performed by (a collaboration of) two or more business actors, business roles, or business collaborations" (The Open Group, 2019, p.65). Hence, a business collaboration represents an active structure element that performs behavior while a business interaction represents the behavior performed (The Open Group, 2019). Here it is suggested that within the context of the Business Model Canvas both elements can be used. A business collaboration focuses on the structural customer relationship emphasizing collective behavior (e.g. a customer community sharing knowledge about the received product/service). A business interaction emphasized the specific behavior, hence the specific activities that are needed in order to form and maintain the customer relationships. For example, personal assistance provided by the company to the customer during the development, purchase and after-sales service.

4.5.2.3 Channels

Channels describe how a company communicates with and reaches its customer segments to deliver a value proposition (Osterwalder & Pigneur, 2013, p.26). A distinction can be made between channels owned by your company thereby reaching customers directly (e.g. sales force, web sales) or indirectly (i.e. own stores) and partner channels (i.e. partner stores, wholesaler). In the VMP there is no clear indication to indicate channels and map them to structured data objects. However, the ecosystem map provides a clear overview of which value proposition exchanges take place in the business ecosystem indicating how customer are reached (i.e. direct through you own company or indirectly through a partner company). In the case of the Maintenance Business Model there is no important channel integrated but it can be seen from the ecosystem and the value stream map it can be assumed that customers are reached through own channels (i.e. smart technicians traveling to the construction site to do some diagnosis) and that a partner channel is used in order to provide Monitoring Infrastructure to the Ground Works Company.

According to the Business Model Ontology a Channel is used to deliver a Value Proposition to a Customer Segment. In VDML Channels are defined as the mechanism to execute a deliverable flow, such as e-mail, face-to-face conversation, SOAP, REST, physical transportation, postal service, telephone, fax, FTP, etc(Object Management Group, 2011, p.98). Channels as interpreted in the Business Model Canvas is therefore more related to customers while the VDML channel concept is applicable to deliverable flows to and from multiple participants. Iacob et al. (2014) suggest to use the ArchiMate Business Interface element defined as "a point of access where a business service is made available to the environment" (Iacob et al., 2014, p.1069). The ArchiMate 3.1 specification thereby states that "it is often referred to as a channel (telephone, Internet, local office, etc.)" (The Open Group, 2019, p.61), hence using this ArchiMate element is a good representation of the Channel component in the Business Model Canvas.

4.5.2.4 Value Proposition

A value proposition in the Business Model Canvas describes the bundle of products and service that create value for a specific customer segment (Osterwalder & Pigneur, 2013, p.22). The Value Proposition element as included in the VMP

is an expression of the values offered to a recipient, based on a product or service or a bundle of product(s) and/or service(s). Hence, in the Business Model Canvas "limits" itself to those value propositions that are offered to the market while the VMP includes all value propositions between roles in a business ecosystem.

In the ecosystem Value Propositions where represented by the Motivational Outcome element together with associated values as perceived by the recipient. Outcomes are high-level, business-oriented results produced by capabilities of an organization, and by inference by the core elements of its architecture that realize these capabilities (The Open Group, 2019, p.44). This representation will also be used to represent value propositions in the Business Model Canvas. Note that the price values associated with the two value propositions (i.e. contract price, dashboard price) in the Maintenance Business model Canvas are included in the revenue stream building block. Hence, providing these value propositions makes it possible to generate revenue.

4.5.2.5 Key Activities

The key activities describe the most important things a company must do to make its business model work (Osterwalder & Pigneur, 2013, p.36). Hence, they include a subset of all the activities the organization in the scope of the plan will do. For the Maintenance Business Models the key activities it needs to perform in order to make its business model work in the Smart Maintenance initiative scope are; diagnose, fix, monitor, purchase parts, schedule and process. Hence, these are all value stream sub-stages that where defined in the Value Stream Map. Here the Value Stream element was used since the Value Stream Map was mainly about the creation of value here a value Stream element could be used to represent value stream stages at different levels of aggregation. Additionally, Iacob et al. (2014) propose to use the Behavioral Business Process, Business Function and Business Interaction elements while Lankhorst (2016) proposes to use the capability Element. Note that the value stream element was only introduced in 2019 and could therefore not be used within these proposals.

Looking at the Business Model Ontology we can see that Key Activities are similar to the Value Configuration and Activity concepts, where a value configuration is a set of one or more activities that are executed by actors. Moreover, a value configuration relies on capabilities allowing an organization to provide its value proposition. Hence, using the Value Stream element where the focus is on the value creation could represent the key activities that contribute to the value proposition delivered to the customer. Capabilities also represent the most important things that a company must to in order to provide value to the customer but they support the activities as indicated in the Business Model Ontology rather than indicate the activities itself. The last option to consider is using Behavioral Business Elements that can be used at different level of aggregation. In accordance with the ArchiMate Metamodel business functions realize capabilities and business process realize value streams. Hence, to represent the economic value-oriented perspective on a strategic level the Value Stream Element is more appropriate.

4.5.2.6 Key Resources

Key Resources as defined in the Business Model Canvas describe the most important assets required to make a business model work and can be physical, financial, intellectual, or human depending on the type of business model (Osterwalder & Pigneur, 2013, p.34). A resource in the ArchiMate language is described as assets owned or controlled by an individual

or the organization that can be classified in different ways (e.g. tangible assets, intangible assets, and human assets). Hence both definitions and concepts can be mapped directly to each other. In the Maintenance Business Model Canvas the most important resources are; the Smart Maintenance System and Monitoring Data provided by partners of the business model, Tools, Smart Technicians and Cars owned by the Equipment Care Company itself.

4.5.2.7 Key Partnerships

Key partnerships describe the network of suppliers and partners that make the business model work (Osterwalder & Pigneur, 2013, p.38). For the Maintenance Business Model, there was a key partnership with the aim of acquiring the necessary competencies for delivering Smart Maintenance Services to its customers. This was done through participating with MaintainIT in the IT participant network and with International Big Machines through the Parts Network. In line with this observation, Iacob et al. (2014) suggest using Business Actor, Business Role, Stakeholder, Business Collaboration and Contract ArchiMate Elements to describe the participants involved in the partnership as well as the relations between them. In the context of the VMP the participants can be identified as Business Actors participating in a Business Collaboration where they have a particular Business Role. Therefore, it is recommended to use the business collaboration element to express the relationships between these participants (i.e. business actors) instead of the contract element. Note that also the stakeholder element can be used similar as defined within the customer segment dimension.

4.5.2.8 Cost Structure and Revenue Stream

The last two blocks represent the cash a company generates from each customer segments and all cost incurred to operate the business model (Osterwalder & Pigneur, 2013, p.30-40). Within the VMP revenue streams are often defined within the business perspective of the strategy map since these are important drivers for the business itself. For example, the Equipment Care company captures the values 'contract price' and 'dashboard price' as revenues generated through the Maintenance Business Model. At the other hand, the Equipment Care also has some cost in order to provide a value proposition in return for these captured price values. These are cost values that are represented in the value stream perspective since they represent the KPI's cost values. For the Equipment Care Company these cost values include for example the cost for tools, cost for parts, cost for the monitoring data, travel cost, etc. Hence, all cost- and revenue elements can be represented as Motivational value elements.

The representation of the Business Model Canvas using general ArchiMate elements is represents on figure 45, while the "Maintenance "Business Model Canvas in ArchiMate is represented on figure 46. In figure 46 the maintenance network is represented by the business collaboration element. The inclusion of this network within the customer relationship block represents the creation of a B2B network (e.g. contracts, agreements).

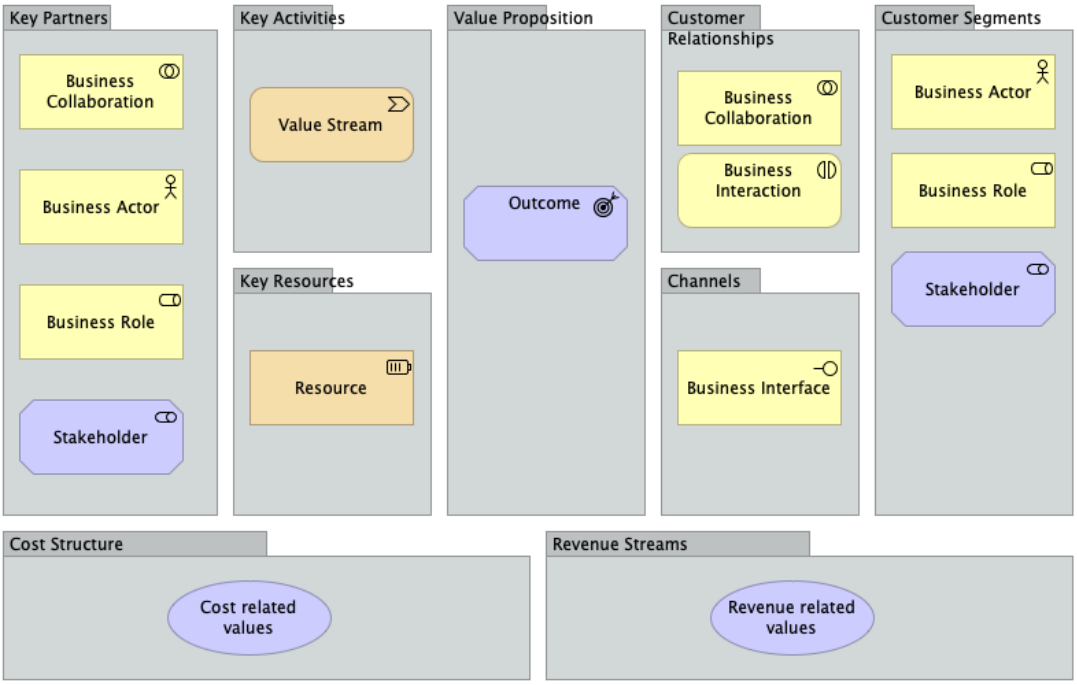


Figure 45 - Business Model Canvas Representation in ArchiMate

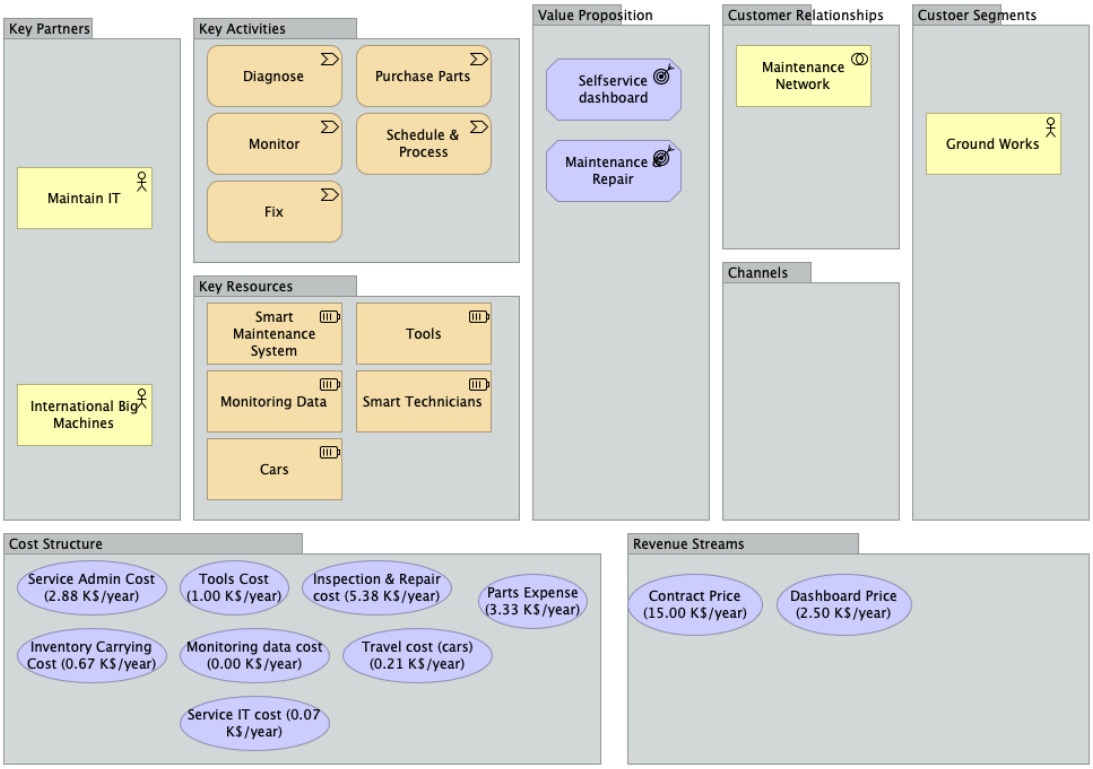


Figure 46 - Business Model Canvas "Maintenance"

4.6 Business Model Cube

The final part of the mapping will involve a representation of the Business Model Cube Framework represented in the prototype stage. The Maintenance Service Case contains two interacting business models represented by a business model cube (i.e. “Maintenance”, “Heavy Duty”). The business model cube contains 6 panes that respectively contain the value propositions provided and received (incl. my propositions), the network partners involved to create these value propositions, the competencies used to perform activities, the activities to create and deliver the values contained in the Value Propositions, the customers that are served by the business and the values delivered by value propositions and created by activities. These panes are all connected to each other through the wiring within the cube, VDMbee represents this wiring by six tabs in which a story telling technique is applied; participants, value propositions, my proposition, activities, values and competencies. Moreover, at the business model cube level business values are defined representing the most important values for the business to steer on. Next to the business model values also plan values, used to steer the plan at the ecosystem level, are defined. For this case, the ecosystem represents a value network and plan values are an aggregation from individual business values (i.e. contract cost, contract margin, production cost, TCO/h). However, plan values could also be defined as a cumulative value (e.g. cumulative profit) or to measure the impact of the business ecosystem on the outside (e.g. sustainability). Note that the Business Model Cube of the VMP integrates the different models constructed in the discover stage. The ecosystem is connected to the participants and value proposition tabs, the value stream to the activities and competency tabs. And the values tabs represent all the values that are defined within the business model including the refinements that have been made during the prototype stage. In order to represent the business model cube in an understandable way multiple viewpoint will be defined related to the business model cube, these viewpoints will either focus on a detailed description on some of the concepts while others focus on an aggregated overview. Notice that all the viewpoints described here will always be constructed from the perspective of the business model unless mentioned otherwise.

4.6.1 Participant Network

Corresponding to the first tab, represented in figure x, a participant network viewpoint could be defined. This viewpoint will be restricted to the business layer and will show, from the perspective of a business model, in which participant networks the business is involved. Multiple participants interact with the business model based on participant networks. These participant networks define each of the participants from a generic role – customer, owner or partner - in relation to the business model cube and a specific role in relation to the responsibilities these participants have within the participant network. The customer role indicates that the business model delivers value to this participant, the partner role assumes that the participants will deliver value propositions to the business model and the owner role will assume that the participant will be responsible of doing activities in the business model order to provide value to other participants thereby using the received values. The second role is a specialization from the first one and indicates the specific behavior of the participant within the participant network. For example, which values does a supplier role provide based on his specific role within the participant network. The participant viewpoint for the Maintenance business model is provided in figure 47. As can be seen the business model owner is the Equipment Care Company that is assigned to two specific roles. Through these roles the Equipment Care Company participates in three different

participant networks (i.e. IT, Maintenance and Parts). Note that participant Networks are expressed as Business Collaboration since the viewpoint is a structural representation of the participant network. A specific description of this viewpoint is provided in table 12.

Participant Network	My Business (Role)	Customers (Role)	Partners (Role)	Other Participants (Role)	Attached
Maintenance Network	Ground Works (Operator)		Equipment Care (MSP) , International Big Machines (Enabler)	Fuel companies (Fuel supplier)	✔
Operations Network	Ground Works (Operator)		Tire vendors (Supplier) , Fuel companies (Fuel supplier)		✔

Figure 47 - Participants Tab from Business Model Cube Maintenance

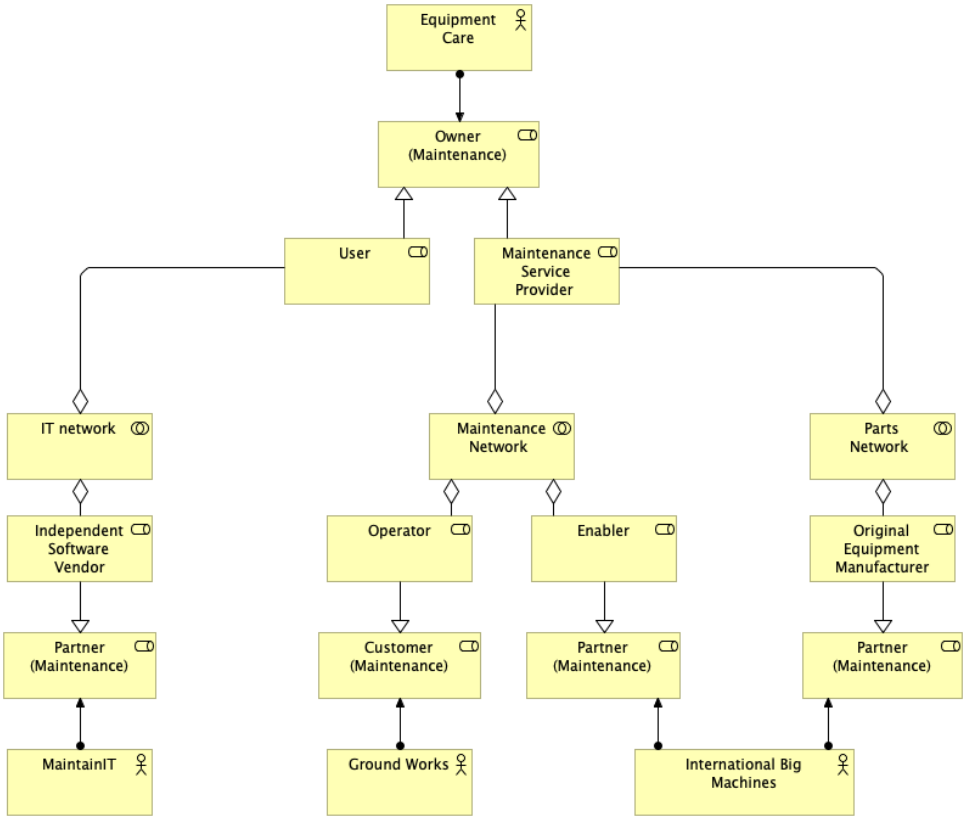


Figure 48 - Participant Network Viewpoint ArchiMate

Participant Network Viewpoint	
Stakeholders	Business managers, enterprise and business architects
Concerns	Structural overview of the participant network in which the business is involved
Purpose	informing
Scope	Business
Elements	Business Actor, Busines Collaboration, Business Role

Table 12 - Participant Network Viewpoint description

4.6.2 Value Propositions

The next viewpoint corresponds to the value proposition tab where the received value propositions (customers and partners), the outgoing value propositions (to customers) and my propositions (the result of the BM for the owner) are described. As can be seen in figure 49, for each of the value proposition the provider (incl. role) and the recipient (incl. role) are defined together with the values that are offered through the value propositions. Hence, this viewpoint is a further refinement of the previous one and actually provides a partial overview of the business ecosystem map (i.e. viewpoint) based on the perspective of the business model. Therefore, it is not necessary to define an additional viewpoint since the viewpoint for the business ecosystem map already defines the necessary constructs. However, the generated view will only select those concepts that are relevant to the business model representing the values that a business receives and delivers through the business model. Figure 50 represents a view corresponding to the value proposition tab for the Maintenance Business Model.

Value Proposition	From (Role)	To (Role)	Values	Attached
Maintenance & repair	Equipment Care (MSP *(Business)* *[Maintenance Network]*)	Ground Works (Operator *(Customer)*)	contract price 15.00 K$/year cycle time improvement 25.00 % extended parts life 7.50 year job efficiency improvement 7.14 % MTBF improvement 66.70 % MTTR (corrective) 11.13 h MTTR (preventive) 2.00 h parts life extension 50.00 % preventive maintenance interval 200.00 d	✔
Maintenance & repair business	Ground Works (Operator *(Customer)*)	Equipment Care (MSP *(Business)* *[Maintenance Network]*)	call frequency 7.30 /year installed base 1000.00 contracts	✔
Maintenance system	MaintainIT (ISV *(Partner)*)	Equipment Care (User *(Business)*)	user license 2500.00 $/year	✔
Monitoring data	International Big Machines (Enabler *(Partner)*)	Equipment Care (MSP *(Business)* *[Maintenance Network]*)	data subscription price 0.00 K$/year	✔
Parts	International Big Machines (OEM *(Partner)*)	Equipment Care (MSP *(Business)* *[Parts Network]*)	delivery time 10.00 h parts life 5.00 year	✔
Selfservice dashboard	Equipment Care (MSP *(Business)* *[Maintenance Network]*)	Ground Works (Operator *(Customer)*)	dashboard price 2.50 K$/year	✔

Figure 49 - Value proposition tab of the Maintenance Business Model

The value propositions with their corresponding values were already represented in the business ecosystem map. Hence, the information contained within this tab "who (participant in participant role) offers what (value proposition) to who (participant in participant role) delivering what values (value proposition values)" was already represented in the ecosystem map. However, from the perspective of the business model 'customer' and 'business' roles can also be indicated since each participant can be a customer in one business model while being a participant in another business model. A representation of the value proposition exchanged between multiple participants is presented in figure 5. The Equipment Care Company, who is the business (i.e. owner) in the business model, in the role of MSP offers 'maintenance and repair' to the Ground Works Company, who is the customer in the business model, in the role of Operator. The values that are hereby delivered are associated with the offer. Again, the offer is represented by the outcome to indicate that offering these values is the end result of a business.

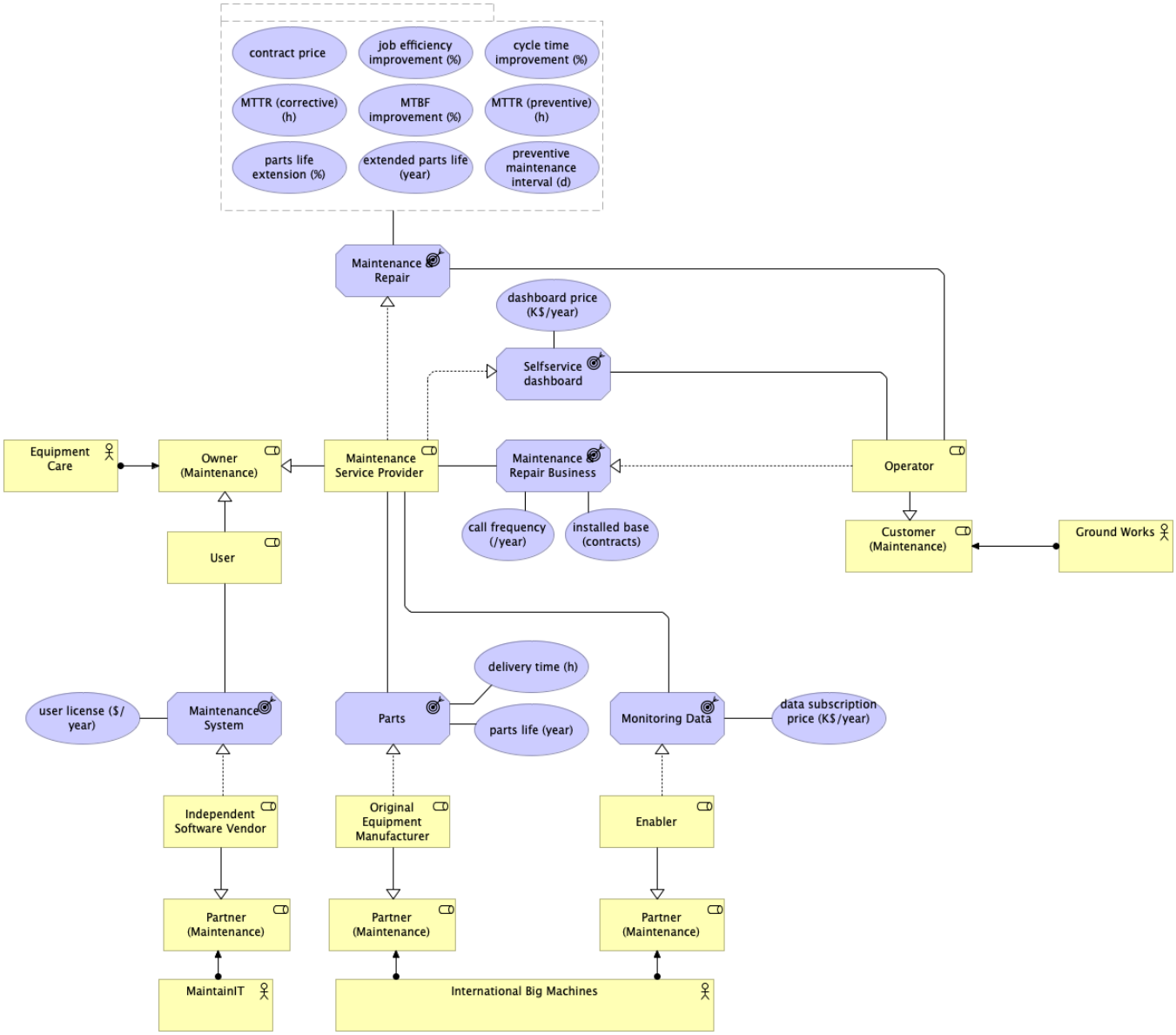


Figure 50 - Value Propositions received and provided from the perspective of the Maintenance Business Model

Note that within a Business Model Cube, also Outcome II type of values are defined representing the most important values captured by the business. Hence, a value proposition can be defined in relation to the my propositions that are offered by the business to the business (i.e. from the business model to the business model). These value proposition express how the business benefits from participating in the business ecosystem. The My propositions tab of the Maintenance business model is represented in Figure 51. From this figure it is clear that the business model receives three propositions corresponding to the participant networks that where defined before. Note that this is not always the case. From participating in the IT network a value proposition “IT cost” is captured by the business model, similarly “Maintenance cost” and “Parts cost” are value propositions captured by the business model from participating in the maintenance- and parts network.

My Proposition	From (Role)	Values
IT cost	User	service IT cost 0.07 K$/year service IT use 6.00 d/year
Maintenance cost	MSP *[Maintenance Network]*	inspection & repair cost 5.38 K$/year monitoring data cost 0.00 K$/year service admin cost 2.88 K$/year service admin effort 6.00 d/year service admin wage cost 60.00 $/h technician corrective cost 4.75 K$/year technician corrective time 6.50 h technician preventive cost 0.64 K$/year technician preventive time 3.50 h technician wage cost 100.00 $/h tools cost 1.00 K$/year travel corrective cost (cars) 0.18 K$/year travel cost (cars) 0.21 K$/year travel preventive cost (cars) 0.02 K$/year
Parts cost	MSP *[Parts Network]*	average contract inventory 3.56 K$ inventory carrying costs 0.67 K$/year parts expense 3.33 K$/year

Figure 51 - My Proposition tab of the Maintenance Business Model

When representing 'My Propositions' value proposition in ArchiMate the business actor element can be used similarly as within the ecosystem. However, now value propositions (i.e. outcomes) are provided by the same participant (i.e. the business model owner) but through different roles. As is clear from figure 51, the Equipment Care Company has three roles, through the role of user it received the IT cost value proposition thereby capturing service IT cost and service IT use. And through the role of MSP (in the Maintenance Network) it receives the Maintenance cost value proposition capturing the corresponding values. In ArchiMate this can be represented as shown in figure 52. As can be seen, the equipment care 'business actor' and 'business role' elements are duplicated to provide a better overview. This representation clearly indicates what value propositions are delivered by the business for the business and the corresponding values that are incapsulated within these value propositions. The outcome element will be used since it represents a value proposition and can be understood as follows. A business participates through its customers model in a participant network in order to achieve a certain end state related to (1) serving customers with the right value propositions and (2) doing this in a profitable way. The latter one is what is represented by the my proposition value proposition.

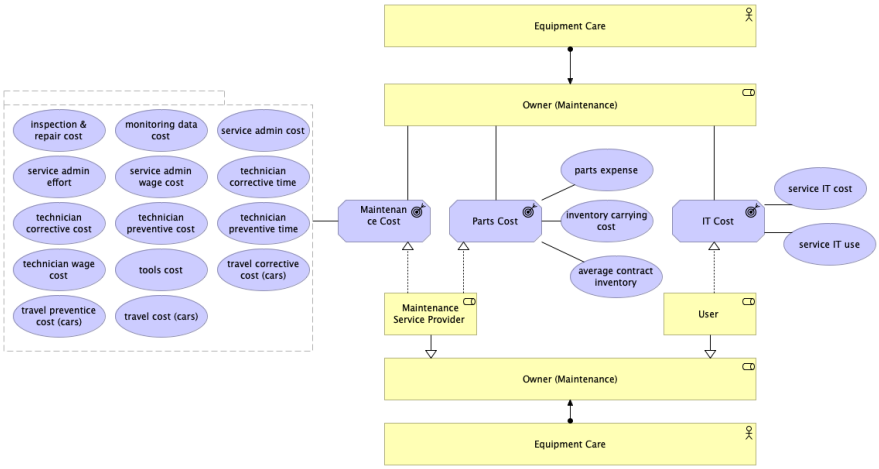


Figure 52 - My proposition Viewpoint

Another way to represent this is to only represent one role and thereby assuming that if the business provides a value proposition through a particular role it also receives this value proposition through the same role. This representation is presented on figure 53.

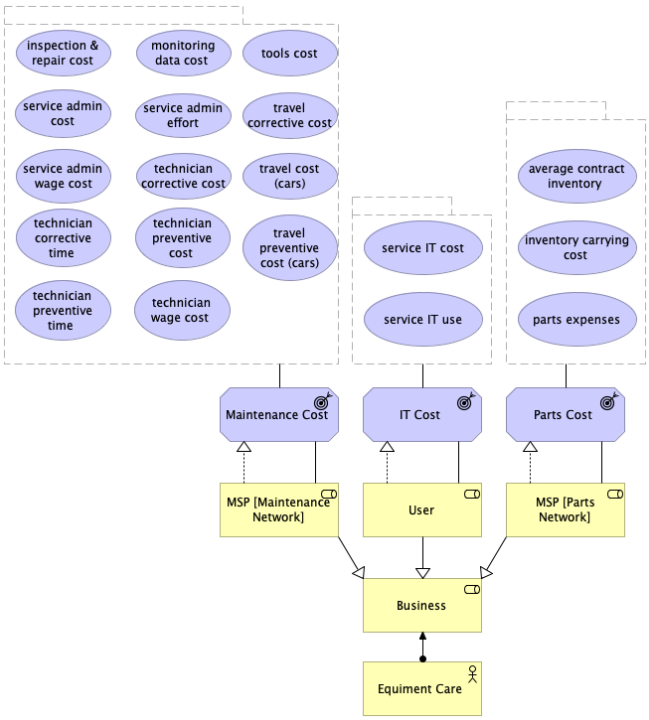


Figure 53 - My Proposition Viewpoint under assumption

When relating this to a viewpoint description it might be useful to integrate it with the previous one thereby also indicating the main influencing relationships from incoming values to outgoing or captured values. This is represented on figure 54 and the corresponding viewpoint is defined in table 13. This viewpoint provides a more in detail view of how specific incoming values are generating outgoing values that are either provided to the customer or captured by the business itself. Hence, the purpose of this viewpoint is to link the ecosystem with the value aggregations that are within the business model defined between incoming and outgoing values in one picture. Note that when a lot of these relations exists the figure might become overloaded with influencing relationships.

Value Proposition Viewpoint	
Stakeholders	Business managers, other stakeholders
Concerns	Overview of the different value propositions received and provided including those that are captured by the enterprise thereby indicating how incoming values influence the outgoing once.
Purpose	informing
Scope	Business and motivation
Elements	Business Actor, Busines Role, Value Element, Outcome Element

Table 13 - Value Proposition Viewpoint description

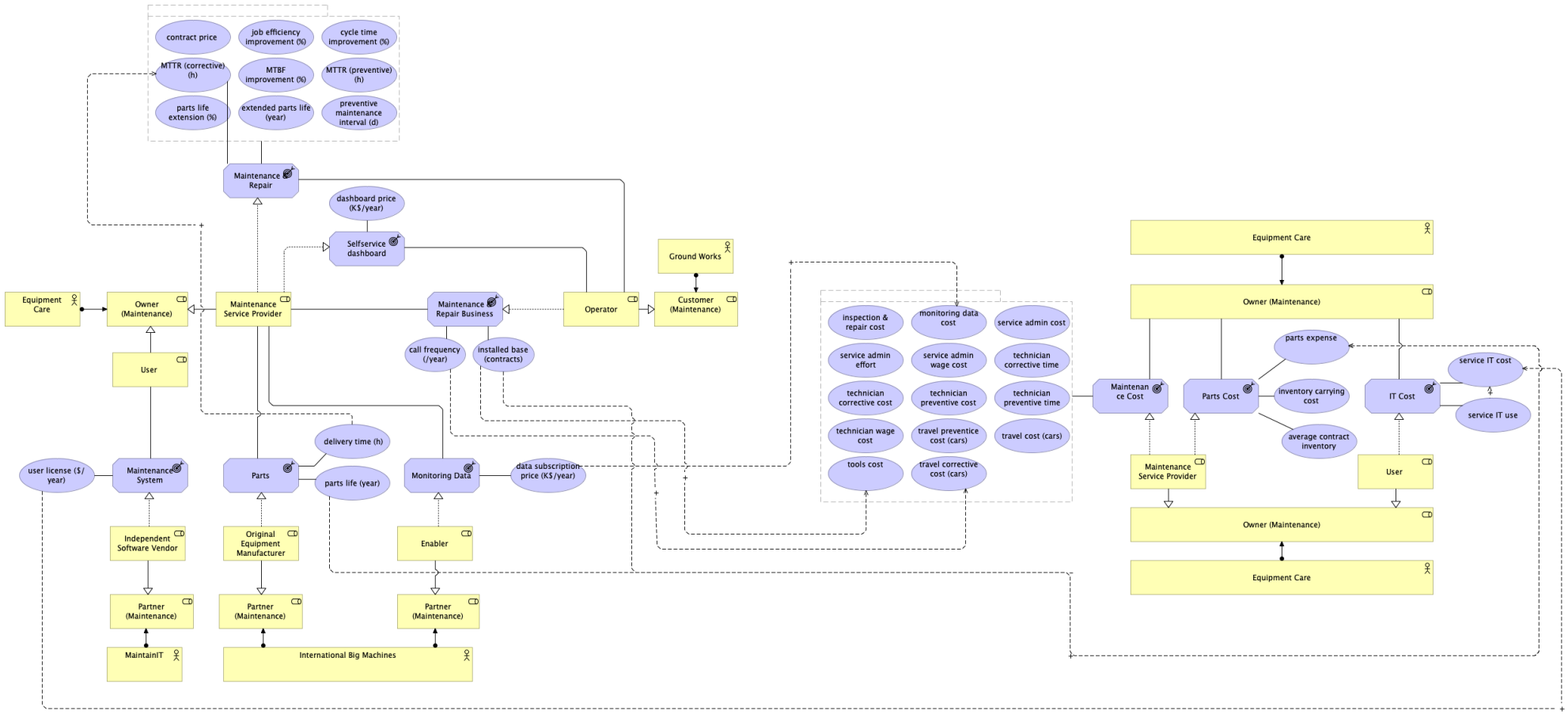


Figure 54 - Value Proposition View corresponding to Maintenance Business Model

4.6.3 Activities

The activity tab of the Business Model Cube framework as implemented within the VMP represents the different activities that are performed by the business in order to pursue the different value propositions (i.e. included within the value stream of the value proposition). The activity tab of the Maintenance Business Model Cube is partially represented in figure 55. For each value proposition, including 'my propositions', the different activities are included thereby indicating which participant in which role is responsible for these activities. Moreover, values are created and when looking at the story on figure 56 also the values to which they contribute are included within this pane. Hence, the activity tab actually looks at the value proposition pursued by the business model and indicates for each of these values who performs which activities, what values are created by these activities (I.e. valueAdd) and to what values they contribute. When activities are performed by partners of the business model two lines will be created similar to the Maintenance & Repair value proposition. This indicates that the Equipment Care Company is responsible for some of the activities through the role of MSP in the parts networks and for other through the role of MSP in the maintenance network.

Pursued	Participant (Role)	Activities	Values
IT cost	Equipment Care (MSP *(Business)* *[Maintenance Network]*)	Manage contract , Schedule & process	contract effort 1.00 d/year (Manage contract) service order effort 5.00 d/year (Schedule & process)
Maintenance & repair	Equipment Care (MSP *(Business)* *[Maintenance Network]*)	Diagnose , Fix , Monitor , Schedule & process , Travel	diagnose time (corrective) 1.50 h (Diagnose) diagnose time (preventive) 1.00 h (Diagnose) fix time (corrective) 2.00 h (Fix) fix time (preventive) 1.00 h (Fix) schedule time (corrective) 2.00 h (Schedule & process) travel time (corrective) 3.00 h (Travel) travel time (preventive) 1.50 h (Travel)
Maintenance & repair	Equipment Care (MSP *(Business)* *[Parts Network]*)	Maintain inventory , Purchase parts	cumulative order leadtime 10.50 h (Purchase parts) net order leadtime 2.63 h (Purchase parts) purchase time 0.50 h (Purchase parts) stockout percentage 25.00 % (Maintain inventory)

Figure 55 - Activity tab of the Maintenance Business Model

In order to Pursue...*	IT cost
Who (Participant) ?*	Equipment Care
Who (Participant Role) ?*	MSP (Business) [Maintenance Network]
Does What ?*	Add Another Manage contract Schedule & process
Creating what Values ?	Add Another contract effort 1.00 d/year (Manage contract) service order effort 5.00 d/year (Schedule & process)
Contributing to what Values ?	Add Another service IT use 6.00 d/year

Figure 56 - Details of the Pursued Value Proposition

The purpose of the corresponding viewpoint in ArchiMate is to give insight into the activities performed by a business and its partners in order to create values that ultimately contribute to the business values captured by the business itself or to values delivered to customers. Hence, it is similar to the value stream only here more detail will be given to the specific roles of the providers and recipient, as more detail will be provided to the specific values these activities generate and how these values are related to values provided to customers and captured by the business. A description of this viewpoint is provided in table 14 and the view for the maintenance business model – IT cost and Maintenance & Repair value proposition - is shown in figure 57. Note that compared to the value stream map the viewpoint provides the same structure only here the competencies and resources are not included and the focus is on who performs what and what values are created and aggregated (still high-level).

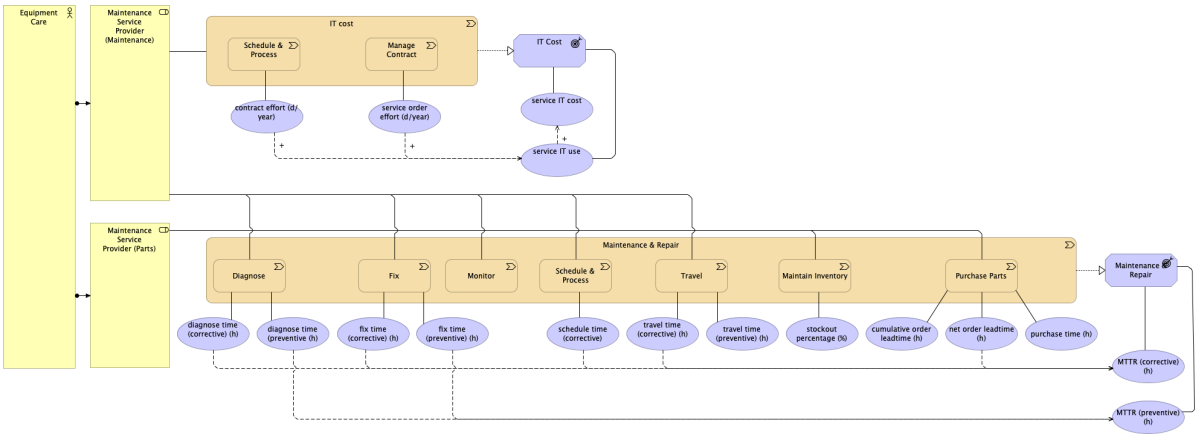


Figure 57 - Activity View Maintenance for IT cost

Activity Viewpoint	
Stakeholders	Business managers
Concerns	More refined overview of the responsibilities of participants in their roles for the activities a business needs to provide its value propositions (incl. my proposition).
Purpose	Informing, deciding
Scope	Business, Strategy, Motivation
Elements	Value element, Value Stream element, Business Actor, Business Role

Table 14 - Activity Viewpoint description

4.6.4 Competencies

The competency tab for the Maintenance business model is provided in figure 58. Here the different competencies owned by the company are included. The value stream in comparison defined all the necessary competencies that were needed by a value stream stage. However, from the perspective of a business model only competencies that are owned by the business can be included. An initial representation is represented on figure 59. Note that this doesn't provide any additional information to the value stream defined earlier, therefore an additional viewpoint won't be defined.

Activity	My Business (Role)	Competencies
Diagnose	Equipment Care (MSP *(Business) [Maintenance Network]*)	Monitoring data , Smart maintenance system , Smart technicians , Tools
Fix	Equipment Care (MSP *(Business) [Maintenance Network]*)	Monitoring data , Smart maintenance system , Smart technicians , Tools
Maintain inventory	Equipment Care (MSP *(Business) [Parts Network]*)	Smart maintenance system
Monitor	Equipment Care (MSP *(Business) [Maintenance Network]*)	Monitoring data , Smart maintenance system
Purchase parts	Equipment Care (MSP *(Business) [Parts Network]*)	Smart maintenance system
Schedule & process	Equipment Care (MSP *(Business) [Maintenance Network]*)	Monitoring data , Smart maintenance system
Travel	Equipment Care (MSP *(Business) [Maintenance Network]*)	Cars

Figure 58 - Competency tab of the Maintenance Business Model

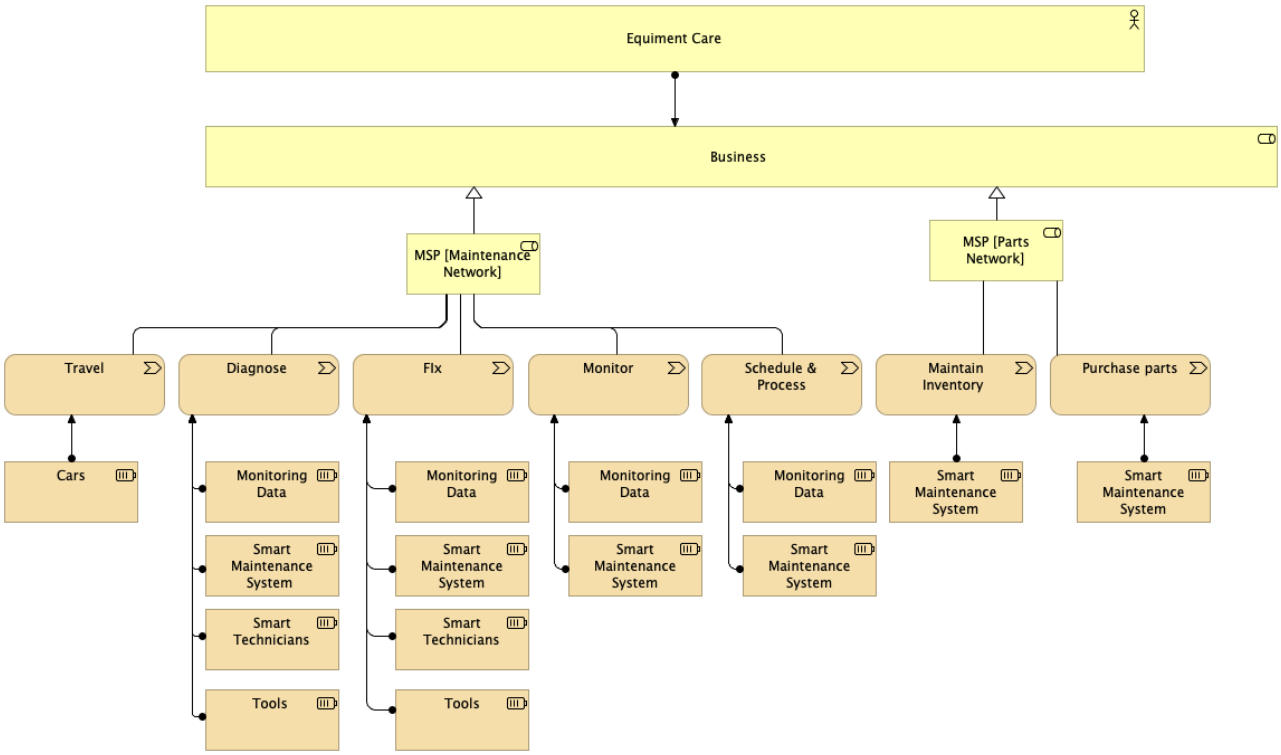


Figure 59 - Competency Viewpoint

4.6.5 Value Aggregation

Finally, it might be interesting to define a value aggregation viewpoint. Note that in the VMP different values are represented (e.g. value proposition values, activity value, etc.) that in the end all aggregate up to either an Outcome I or an Outcome II type of values. This relationship might also be represented in ArchiMate by a value aggregation viewpoint, this viewpoint serves the purpose of tracing down a value and see how this value is related to other values. For example, an activity value might aggregate up to a value in the value proposition offered to the customer therefore it might be useful to indicate within an ArchiMate model that if this value is influenced that it also has an impact on this value proposition value. A description of this viewpoint is included within table 15 and a view is shown on figure 60. Note that this view only represents the value aggregation for the inventory carrying cost, that could be used for example to see how 'parts life' influences other values that might be of importance. The green shapes represent those values that are input values, hence not calculated based on value aggregations.

Figure 60 - Value Aggregation Viewpoint

Value Aggregation Viewpoint	
Stakeholders	Business managers
Concerns	Value aggregations to important output values such as customer- and business values
Purpose	Informing
Scope	Motivation layer
Elements	Value element

Table 15 - Value Aggregation viewpoint description

5 Findings and Future Research

When comparing the different ArchiMate views defined by viewpoints with the VMP it can be noted that the general shapes implemented within the VMP can be mapped to corresponding ArchiMate shapes. However, the specific under the hood implementation of these shapes to VDML metamodel instances in order to perform value delivery analysis is not as straightforward in ArchiMate. First it must be noted that VDML makes a difference between types and instances, within VDML concepts at one hand refer to libraryDefinitions (i.e. types) that can be linked to implementations within a specific enterprise (i.e. instances). This difference is not supported, intentionally, in ArchiMate. Secondly, VDML provides a more detailed analysis when it comes to the models represented in the VMP (which supports a partial implementation of the VDML). For example, a value stream represented in the VMP defines activities that can delegate their work to CompetencyMethods that defined lower-level activities related to the different capability shapes included within the competency container. Hence, the activities are associated with these capabilities. This delegation context is not supported in ArchiMate. Moreover, the delegation of these activities to specific CapabilityMethods is related to a DelegationContext enabling the VDML to assign different measurements to activities that delegate to the same CapabilityMethod. Again, this is not supported within the ArchiMate language. Finally, the VMP supports scenario analysis moving from one stage into the other defining for example plan values that refer to plan values from the previous stage.

However, when comparing the two languages it is logical that they differ from each other in the way described above. ArchiMate is focused on the description of an enterprise in order to provide alignment between the different parts while VDML emphasizes value delivery analysis. Hence, from this research it might be clear that there is some overlap between the two however they are not interchangeable with each other. Therefore, it is suggested that based on this research a value model can be represented in ArchiMate as indicated with the different viewpoints defined earlier but focuses on the relationships between multiple elements. Use of the ArchiMate language to support the VMP can be found in several ways. One can construct a method to integrate existing modeling languages within the VMP in order to pre-define already some constructs in the different graphical diagram based on the existing enterprise architecture. Note that within ArchiMate multiple relationships exist while VDML provides a stricter implementation of relationships between multiple elements. Moreover, when the VMP is used in order to analyze some alternatives within a stage and one might wish to implement this alternative the ArchiMate language can provide additional insights into the discovered capabilities and activities (e.g. value stream map) and connect these with lower layer in the enterprise such as applications that might be needed to support this change. Hence, both languages can be used in a complementary way in order to strengthen the implementation of a change initiative in real life businesses.

Note that this research is mainly focused on one use case (i.e. The Maintenance Service case) and might therefor be adapted in order to provide some general mapping between VDML and ArchiMate. Moreover, the focus was not on designing a method for the mapping but on comparing the concepts defined in the two languages to see if there are some similarities between them.

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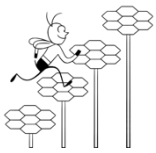
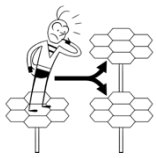
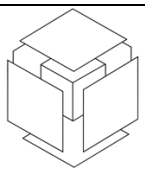
Appendix

Appendix 1 The Value Management Platform

Appendix 1.1 General Concepts

icon	concept	Definition (VDMbee, 2016b)
	Plan	A plan is a phased proceeding to achieve a strategic or tactical goal. It is the vehicle to define and execute strategies.
	Phase	Phases are the steps that are defined towards achieving the goal and are time-bound. Value objectives can be managed and defined per Phase.
	Alternative	Per phase, one or more alternatives can be defined. They represent possible scenarios (VDML) that are explored with respect to their achievement of value objectives of a phase. Multiple Alternatives are defined for a Phase when one wants to store and compare what-if Scenarios and make explicit decision to adopt one.
	Business Model	A Business Model defines how a Business, in particular product-market combination, creates and delivers value for the stakeholders involved. A product-market combination is typically defined as the combination of a Value Proposition provided to a Customer.
	The business	The business is a participant that own the Business Model. A business typically owns and operates multiple business models.

Appendix 1.2 The Continuous Business Model Planning Method

Stage 1: Discover

The method starts with the discover stage where a workshop leader will organize multiple workshops involving the different stakeholders of the change initiative (VDMbee, 2018). Within these workshop sessions ideas, problems and other inputs are used in order to construct a business ecosystem map, define key participants, construct business models and define the values to steer the business on. Hence, multiple models will be created based on the value creation process observed by the different stakeholders (VDMbee, 2018). The creation of these models is not random but follows a predefined structured as shown in figure x.

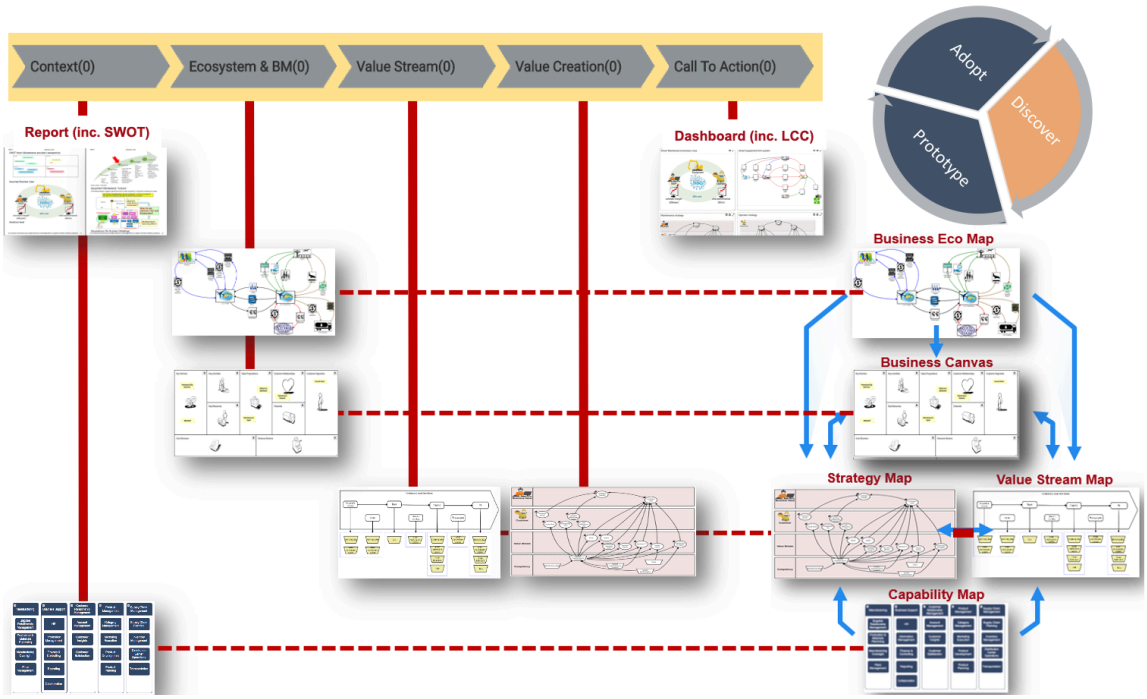


Figure 9 - Sub-stages of the Discover Stage (VDMbee, 2018)

The first sub-stage, context, serves the purpose of exploring the problem at hand and discovering the story of the business before constructing the different models. Within the VMP this is supported by the creation of a free-format report where you can include answers to the following questions:

- What is the problem/opportunity of the organization?
- Have there already been defined any strategies that can be explored within the platform? What do you want to achieve in the long term and how do you want to achieve this?
- What are the main success criteria for your organization to measure whether you are going into the right direction (i.e. KPI)?
- What are the factors that influence these success criteria?
- What do participants in the ecosystem gain from the initiative?
- Who are your participants in the ecosystem? What are their competencies?

As can be seen in figure x the context stage also supports the inclusion of a SWOT analysis. A SWOT Analysis is a well-known tool used to analyze the internal Strengths and Weaknesses of a business together with external Opportunities and Threats in the market the business is active in. Hence, whenever a business has no clue about the strategic direction it wants to pursue or what opportunities there exist the VMP a SWOT analysis can be used to provide useful insights. The specific details of the SWOT analysis are not essential for the scope of this dissertation.

In the context stage a Capability Map or Library can be used to provide a more complete picture on the capabilities used by the business and its business partners. Industry reference models, such as the provided by the Business Architecture Guild, can be imported within the VMP to enable the comparison of capability definitions with capabilities used within the initiative (VDMbee, 2018). A capability Library can also be used to support the discovery of capabilities, and even entire value streams, in later stages. The specifics of a Capability Library and map will be discussed in the next section.

The next sub-stages contain the construction of a Business Ecosystem Map, a Business Model Canvas, a Value Stream Map and a Strategy Map. These models will all be discussed in the next sections describing their purpose, their origin, concepts and relations. In general, a Business Ecosystem Map will provide a high-level overview of the interconnection between multiple participants and the exchanged value propositions between them. For the strategic initiative at hand, it might be useful to implement the perspective of one or more participants. These participants are key participants and their business models within the ecosystem will be included in the analysis. Moreover, their value streams will be defined to indicate what they need to do (i.e., competencies, activities) in order to provide the defined value proposition in the ecosystem. And finally, in order to understand how and what value is created from the perspective of the defined business models a strategy map will be constructed. A strategy map will show a high-level value overview of the value creation story indicating how values created by activities and competencies contribute to business- and customers values. This sequence, from ecosystem to strategy map, is not prescribed by the VMP (VDMbee, 2018). However, it is recommended to follow it since every model serves a certain purpose and some of the concepts can be re-used in later models increasing overall efficiency.

The final sub-stage of the discover stage is the call-to-action sub-stage. This stage will summarize everything from the previous constructed models (VDMbee, 2018). The main purpose of this stage is to take a decision, namely the decision of proceeding with the initiative at hand and continue to the prototype stage where more refined value aggregations will be defined. Or the decision to stop, now that a clearer picture has been created of the impact and value creation on the business models involved (VDMbee, 2018). To support this decision, two tools are implemented within the VMP. First a Lean Change Canvas can be constructed describing the initiative in terms of different building blocks (e.g. urgency, target state, vision, communication). Hence, this canvas visually represents a summary of the knowledge gathered in the four previous sub-stages. The second tool that can be used is an interactive dashboard that will also summarize the previous sub-stage but through the interface of a

dashboard that could also include the Lean Change Canvas (VDMbee, 2018). The specific constructs of these two tools are outside the scope of this paper and will therefore not be discussed any further.

Finally, the analyst, responsible for the prototype stage, will already be present during the workshop sessions in order to gradually convert the different graphical models into conceptual ones. This will be done by mapping the different shapes (e.g., value proposition, participant, competency) represented in the models to structured VDML concepts thereby creating structured business models. Moreover, this in-between mapping also provides the benefit of re-using concepts from one map in another, increasing overall efficiency. For example, value propositions discovered in the ecosystem can be mapped to structured value proposition objects that can in turn be re-used for creating value streams in value stream maps. The relationship between the VMP concepts and the VDML concepts will be discussed in more detail in the next section, for now the focus is on the CBMP method.

Stage 2: Prototype

The prototype stage also contains two sub-stages that are performed in a particular sequence as indicated in figure x. The first sub-stage - business model - contains the creation of a structured busines model based on the discovery that has been done in the previous stage. Remember that a business is not an island on its own but interacts with multiple other participants in a business ecosystem (VDMbee, 2018). Therefore, it is important to include the impact of a new initiative on the business model of the business itself, but also on the business models of its most important participants (i.e. key participants). This is where the structured business model can be used since it is able to represent a business model as embedded within an ecosystem of business models. More specifically, the elements included within a structured business model are related to each other both inter-business model (i.e. within one business model) and intra-business model (i.e. across different business models). For example, suppose there are two participants within an ecosystem where one participant offers a value proposition to another one. The structured business model of the recipient will be able to represent the received value proposition, included in the business model of the provider, as an element within its own business model. Thereby it is able to provide a blueprint of the business that can be used for impact analysis. Since the users of the VMP are mostly businesspeople the structured business model will be represented by use of the business model cube framework proposed by Peter Lindgren and Ole Horn Rasmussen.

As mentioned, an analyst will be present during the discover stage to make the discover of other graphical models more efficient and, most importantly, to build a structured business model that can be used for prototyping. Accordingly, several elements will already be defined when starting the prototype stage; value propositions, value proposition values, value streams, activities, activity values, plan values, business values, etc. However, all the models from the discover stage made an abstraction for the purpose of the model itself. For example, a strategy map focused on the value creation story thereby abstracting from all possible values and their aggregation relationships to only the most important ones. Within the prototype stage will further refine the structured business model by specifying value aggregation relationships in more detail and extend them with value measurements. These measurements include objective measurements based on value formulas (i.e.

perspective of the provider) as well as subjective measurements (i.e. perspective of the recipient) based on recipient opinion, satisfaction and the weight (i.e. relative importance) (VDMbee, 2018).

The second stage includes the creation of process- and case models. Hence, this sub-stage provides a further disaggregation to support business process management. As indicated in figure x, these models are generated from the value stream map. As will be explained in the next section, value streams indicate the activities that need to be performed for delivering a particular value proposition. Moreover, a value stream includes the resources and capabilities that are needed to successfully perform this activity. A process model at the other hand focuses on the control flow between activities including sequences, triggers and conditions (VDMbee, 2018). Hence, the transformation from a value stream to a process model will include a disaggregation from value creation and value delivery to implementation on the operational level. The specific description of this mapping process is not part of this master dissertation and will therefore not be discussed any further.

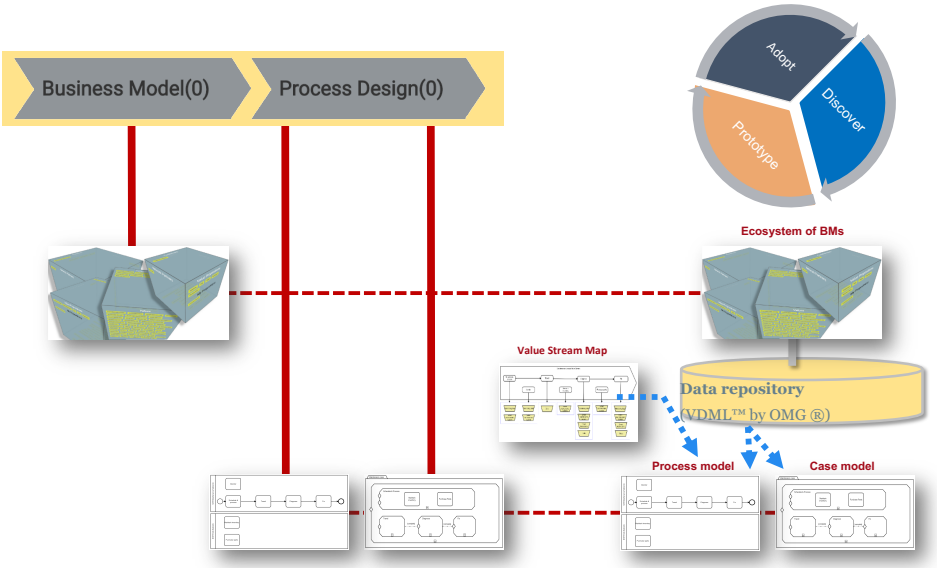


Figure 1 - Sub-stages of the Prototype Stage in the VMP (VDMbee, 2018)

Stage 3: Adopt

The last stage is the adopt stage, here a change agent will be responsible for creating visualizations and reports of the data within the structured business models. This will be done by creating a dashboard that will summarize the different results in order to enable comparing plan values for each alternative. In addition, it will be able to support scenario- and what-if analysis to gain a better understanding of how sensitive results are to changes in the input values. Finally, the dashboard will also support monitoring where plan values can be compared with actual values (i.e. real-life performance data) and deviations can be detected. Whenever large deviations occur the VMP can be used for introducing a new cycle to bring the values back on track (VDMbee, 2018). However, the implementation of the change itself is not supported by the VMP (Poels et al., 2019).

Appendix 1.3 Building Blocks of the Business Model Canvas

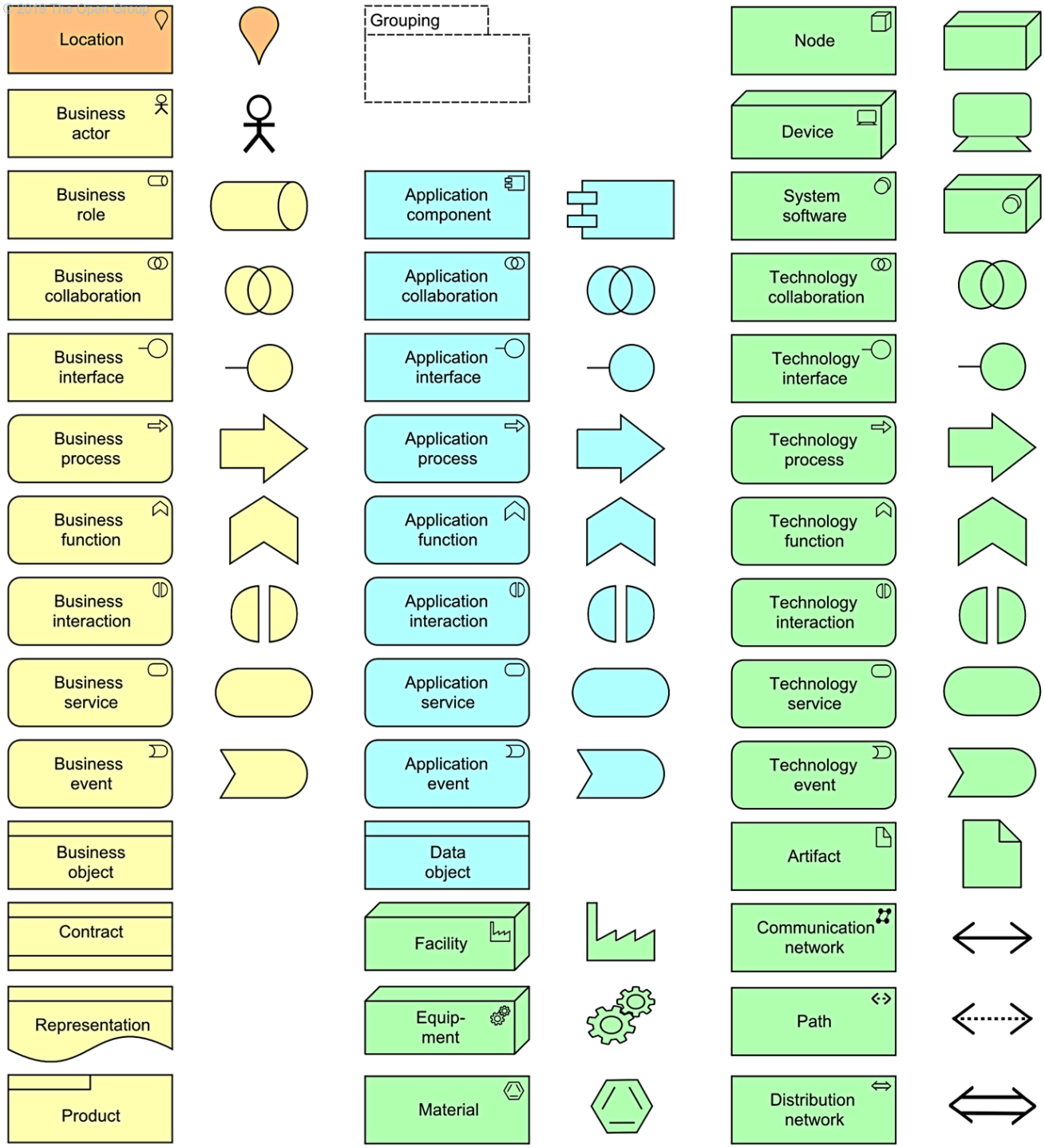
Note: whenever the term 'enterprise' is used, it describes the business for which the Business Model Canvas is defined. Hence, all customers and participants are determined from their perspectives.

Building Block	Definition *(Osterwalder & Pigneur, 2013)*
Customer Segment	This block defines the different groups of people/organizations an enterprise aims to reach and serve. A business model defines one or several customer segments (e.g., mass market, niche market, diversified) based on common needs, behaviors or other attributes.
Value Proposition	This block describes the bundle of products/services that create value for a specific Customer Segment. Each value proposition consists of a selected bundle of products and/or services that caters to the requirements of a specific Customer Segment. Hence, this section describes how an organization will offer a superior value to its customers compared to its competitors.
Channels	This block describes how a company communicates with and reaches its customer segments to deliver a value proposition. Channels could include communication, distribution and sales channels that form customer touch points (e.g. physical stores, online service support).
Customer Relationships	This block defines the relationships a company wants to establish with specific customer segments (e.g. personal assistance, self-service, co-creation)
Key Resources	Here you describe the most important assets a business needs in order to make a business model work (e.g. create/offer value, reach markets). Resources can be divided into three subgroups: physical resources (i.e. tangible), intellectual resources (i.e. intangible) or human resources. These resources can be leased by the company, owned or acquired from key partners.
Key Activities	What are the most important things a company must do to make its business model work (e.g. production, problem solving, platform/network). Hence, how are the key resources transformed into the corresponding value proposition.
Key Partners	Here the network of suppliers and partners is included that make the business model work (e.g. strategic alliances, coopetition, joint ventures)
Cost Structure	Here the most important costs are described that are incurred while performing your business. This block is defined last as the previous ones give a picture of the most important costs in the business model (e.g. cost driven, fixed costs, variable costs).
Revenue Streams	This block defines how and trough which pricing mechanisms your business is capturing value (e.g. subscription fees, licensing, usage fee, advertising).

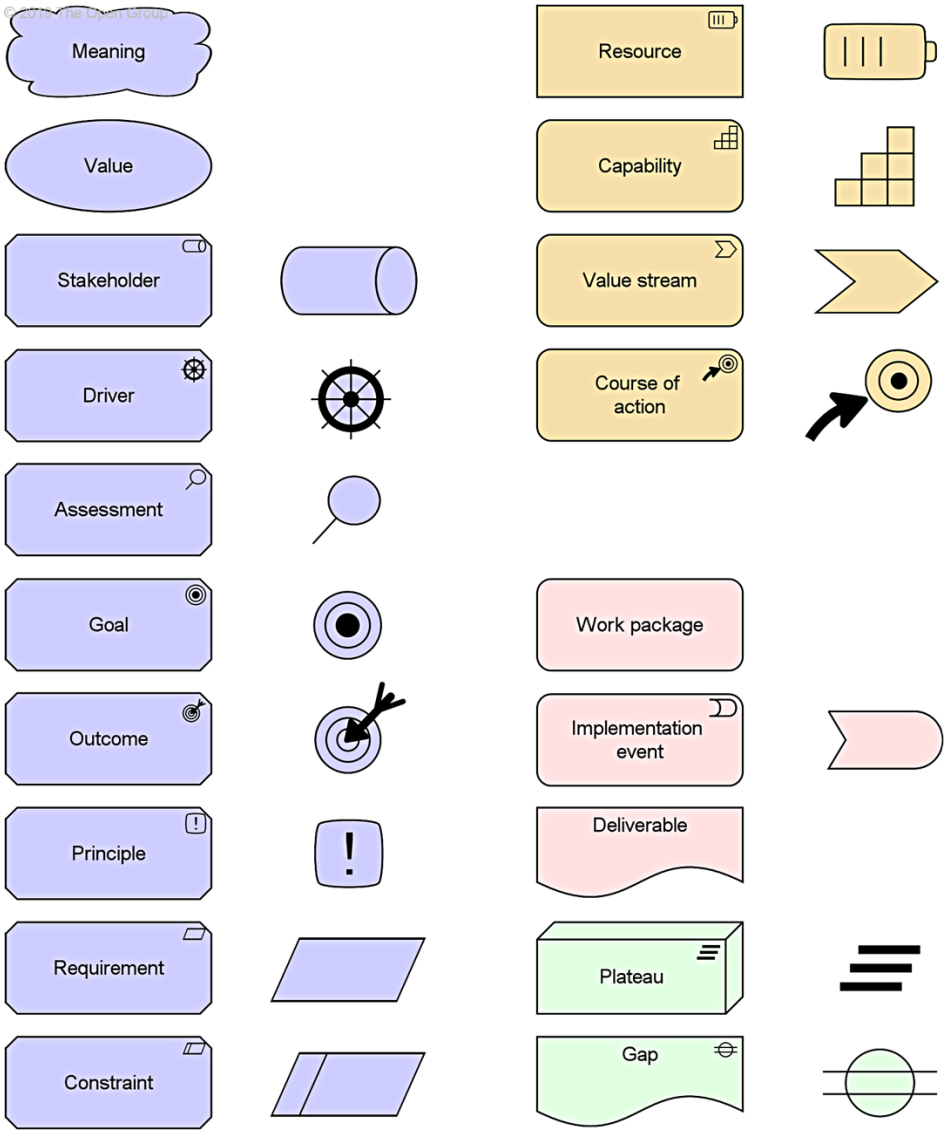
Appendix 2 ArchiMate 3.1

Appendix 2.1 Notation Overview

Appendix 2.1.1 Core Elements



Appendix 2.1.2 Motivation, Strategy, Implementation and Migration Elements



Appendix 2.1.3 Relationships

Relationship	**Notation**	**Definition** (The Open Group, 2019, p.37-38)	
Structural Relationships	Composition	Represents that an element consists of one or more other concepts.	→ composed of ← composed in
	Aggregation	Represents that an element combines one or more other concepts.	→ aggregates ← aggregated in
	Assignment	Represents the allocation of responsibility, performance of behavior, storage, or execution.	→ assigned to ← has assigned
	Realization	Represents that an entity plays a critical role in the creation, achievement, sustenance, or operation of a more abstract entity.	→ realizes ← realized by
Dependency Relationships	Serving	Represents that an element provides its functionality to another element.	→ serves ← served by

	Access	Represents the ability of behavior and active structure elements to observe or act upon passive.	→ accesses ← accessed by
	+/- Influence	Represents that an element affects the implementation or achievement of some motivation element.	→ influences ← influenced by
	Association	Represents an unspecified relationship, or one that is not represented by another ArchiMate relationship.	associated with → associated to ← associated from
Dynamic Relationships	Triggering	Represents a temporal or causal relationship between elements.	→ triggers ← triggered by
	Flow	Represents transfer from one element to another.	→ flows to ← flows from
Other Relationships	Specialization	Represents that an element is a particular kind of another element.	→ specializes ← specialized by
Relationship Connectors	(And) Junction	Used to connect relationships of the same type.	
	Or Junction		

Appendix 2.2 Concept Definitions

Appendix 2.2.1 Motivation Aspects

Concept	Description (The Open Group, 2019, p.49)
Stakeholder	A stakeholder represents the role of an individual, team, or organization (or classes thereof) that represents their interests in the effects of the architecture. They change, set and emphasize goals.
Driver	An external or internal condition that motivates an organization to define its goals and implement the changes necessary to achieve them.
Assessment	The result of an analysis of the state of affairs of the enterprise with respect to some driver.
Goal	A high-level statement of intent, direction, or desired end state for an organization and its stakeholders.
Outcome	An end result that has been achieved.
Principle	A statement of intent defining a general property that applies to any system in a certain context in the architecture.
Requirement	A statement of need defining a property that applies to a specific system as described by the architecture.
Constraint	A factor that limits the realization of goals.
Value	The relative worth, utility, or importance of a concept.

Meaning	The knowledge or expertise present in, or the interpretation given to, a concept in a particular context.

Appendix 2.2.2 Strategy Layer Elements

Concept	Description (The Open Group, 2019, p.56)
Resource	An asset owned or controlled by an individual organization.
Capability	An ability that an active structure element such as an organization, person, or system, possesses.
Value Stream	A sequence of activities that create an overall result for a customer, stakeholder, or end user.
Course of Action	An approach or plan for configuring some capabilities and resources of the enterprise, undertaken to achieve a goal.

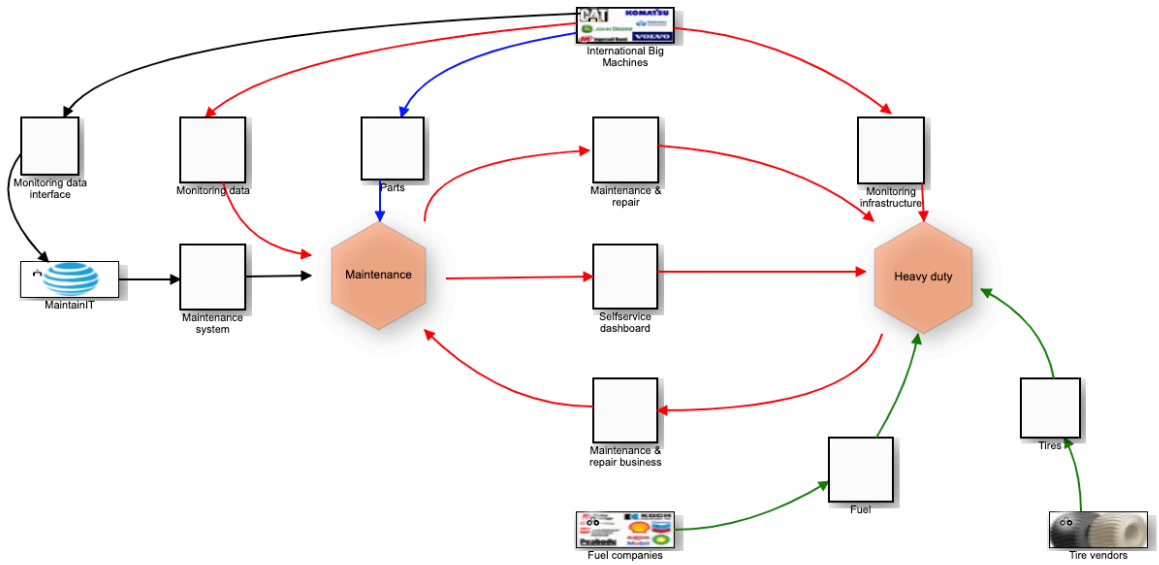
Appendix 2.2.3 Business Layer Elements

Concept	Description (The Open Group, 2019, p.71-72)
Business actor	Represents a business entity that is capable of performing behavior.
Business role	Represents the responsibility for performing specific behavior, to which an actor can be assigned, or the part an actor plays in a particular action or event.
Business Collaboration	Represents an aggregate of two or more business internal active structure elements that work together to perform collective behavior.
Business interface	Represents a point of access where a business service is made available to the environment.
Business process	Represents a sequence of business behaviors that achieves a specific result such as a defined set of products or business services.
Business function	Represents 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 interaction	Represents a unit of collective business behavior performed by (a collaboration of) two or more business actors, business roles, or business collaborations.
Business event	Represents an organizational state change.
Business service	Represents explicitly defined behavior that a business role, business actor, or business collaboration exposes to its environment.
Business object	Represents a concept used within a particular business domain.
Contract	Represents a formal or informal specification of an agreement between a provider and a consumer that specifies the rights and obligations associated with a product and establishes functional and non- functional parameters for interaction.
Representation	Represents a perceptible form of the information carried by a business object.

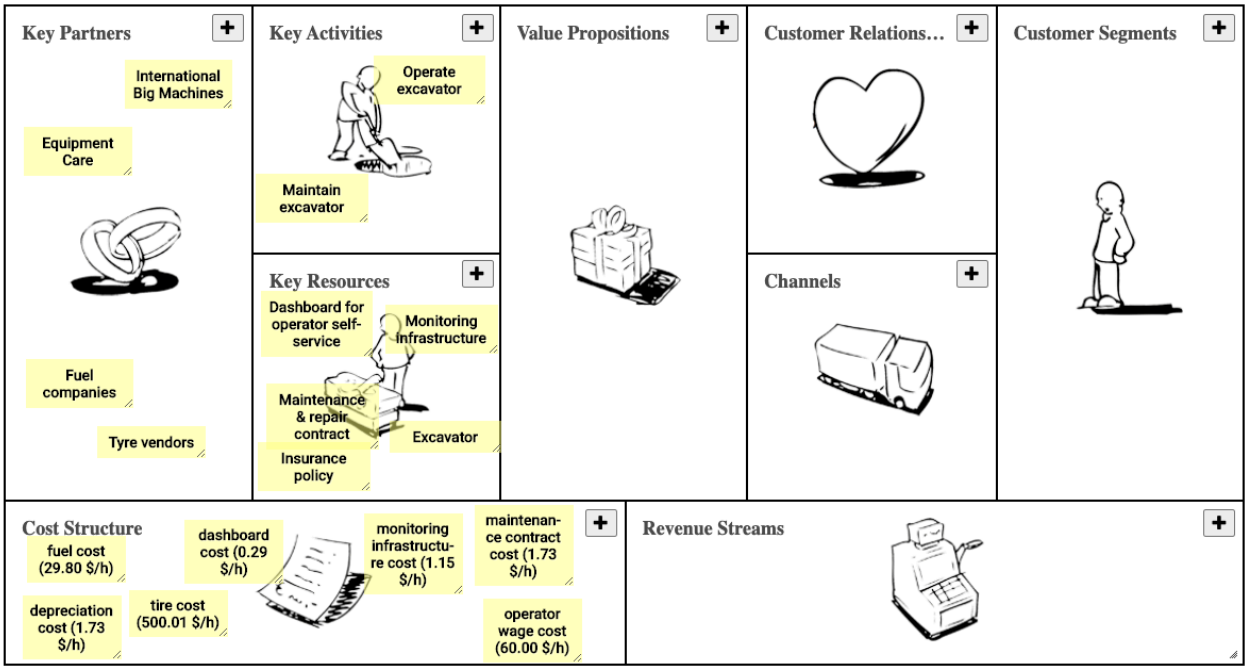
Product	Represents a coherent collection of services and/or passive structure elements, accompanied by a contract/set of agreements, which is offered as a whole to (internal or external) customers.

Appendix 3 Business Case: additional figures

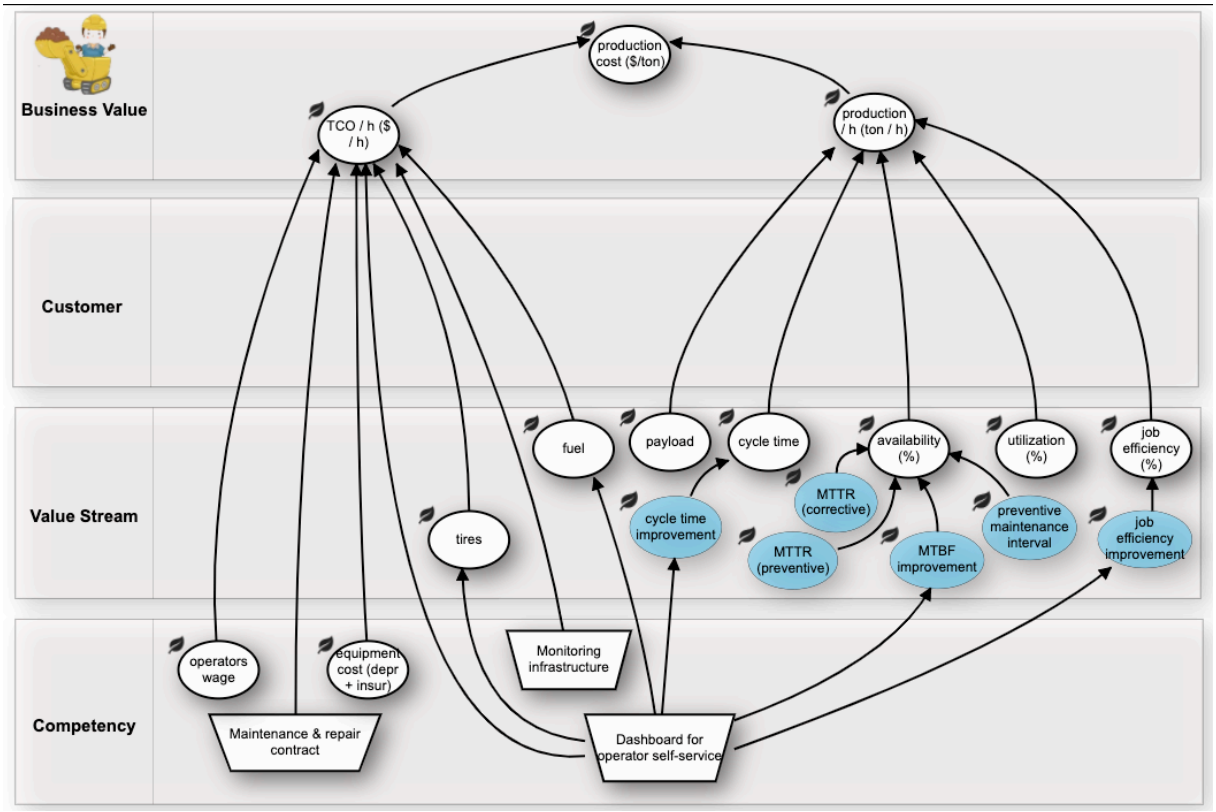
Appendix 3.1 Ecosystem map using the business model shape



Appendix 3.1.1 Business Model Heavy Duty



Appendix 3.1.2 Strategy Map Operator



Appendix 4 Additional ArchiMate Models

Appendix 4.1 Business Ecosystem Viewpoint using color coding