## Integrating Business Value in Enterprise Architecture Modeling and Analysis



Prince Mayurank Singh

Assigned by:

## UNIVERSITY OF TWENTE.

# BiZZdesign

## Integrating Business Value in Enterprise Architecture Modeling and Analysis

Prince Mayurank Singh

MSc. Business Information Technology August 2013

Graduation committee:

Dr. M.E. Iacob, University of Twente

Dr. Marten J. van Sinderen, University of Twente

Dr. Henk Jonkers, Research Consultant, BiZZdesign.

# Man is made by his belief. As he believes, so he is. – *Bhagavad Gita*

### **Management Summary**

The aim of this research is to better understand the primary activity of a firm and the source of its survival – value creation, how a firm creates value for the consumer. The approach adopted in this research is to analyze value creation from a process level viewpoint.

There is big difference between specifying a *value offering to the customer* in a board room and implementing it in practice. A common problem which managers face is translating the value creation logic of a firm from strategy to implementation. Process and IT managers in a firm use different modeling techniques to model and understand value creation in the firm.

The enterprise architecture (EA) of a firm is an enterprise wide model showing the Business and IT architecture of the firm. EA's are a unique way of modeling the processes and infrastructure of a firm because they lie at the interface of strategy and process level of abstraction. This research is an attempt to show value creation using EA models. The EA modeling language which has been used for this research is **ArchiMate**. ArchiMate language consists of different *elements* which model the business and IT processes of a firm and also the supporting infrastructure.

The main research question of the thesis is how value creation can be shown in terms of ArchiMate. This main question has been further divided into three research sub questions. An extensive literature survey is done for building a sound background for answering the research questions. This literature survey is used to formulate a *value creation framework* at the process level. Then, a mapping is attempted between the framework developed and ArchiMate.

The output of this research is a 6 step methodology which will aid managers to model value creation using ArchiMate elements. As a part of the methodology an algorithm is developed which relates a *value proposition* offered by the firm (to its customers) to processes and infrastructure of the firm which realize it. This algorithm when applied to a given ArchiMate model results in a smaller model which is called the *value model* for the particular value proposition. This algorithm is implemented in the EA modeling tool, *BiZZdesign Architect* <sup>®</sup>. The deliverables of the methodology are a *value creation model* and *value table*. The value creation model can be used for cost benefit, analysis, sensitivity analysis and traceability analysis. These possible uses of the value creation model are discussed in detail. *Value tables* formed as a part of the methodology, show how the resources and the services acquired from the network can be incorporated in the value model.

To explain and demonstrate the methodology a case study is presented. Another example case is used to demonstrate the uses of the *value creation model*. The merit and applicability of the methodology is evaluated by combination of a survey and personal interview with experienced researchers and practitioners in the field EA modeling.

## **Management Samenvatting**

Het doel van dit onderzoek is om de primaire activiteiten, het bestaansrecht, de waarde creatie en de totstandkoming van de waarde creatie voor consumenten beter te begrijpen. De gehanteerde benadering in dit onderzoek is het analyseren van de waarde creatie vanuit het procesperspectief.

Er is een groot verschil tussen het specificeren van het *aanbod van de waarde aan de klant* in een bestuurskamer en de implementatie hiervan in de praktijk. Een gemeenschappelijk probleem waar managers tegenaan lopen is het maken van de vertaalslag vanuit de strategie van de waarde creatie naar de implementatie. Proces en IT managers gebruiken binnen organisaties verschillende modelleertechnieken om te modelleren en begrijpen hoe de waarde creatie van een organisatie tot stand komt.

De Enterprise architectuur (EA) van een organisatie is een op organisatieniveau overkoepelend model en laat de bedrijfs- en IT architectuur van de organisatie zien. Enterprisearchitecturen geven unieke mogelijkheden om processen en infrastructuren van organisaties te modelleren, omdat deze tussen strategie en processen staan qua abstractie. Dit onderzoek geeft inzicht in de waarde creatie wanneer er gebruik wordt gemaakt van Enterprisearchitectuurmodellen. De tijdens dit onderzoek gebruikte (EA) modelleertaal is **ArchiMate**. De Archimate taal bestaat uit verschillende elementen die zowel ondersteuning bieden voor modellering van de bedrijfs- en IT processen als de infrastructuur.

De hoofdvraag van dit onderzoek is: Hoe kan de creatie van waarde worden weergeven in de termen van Archimate? De hoofdvraag is verder opgedeeld in drie deelvragen. Er is een uitgebreide literatuurstudie uitgevoerd om te zorgen voor een solide basis, zodat de hoofdvraag en de daarbij horende deelvragen kunnen worden beantwoord. De literatuurstudie is gebruikt om op procesniveau een *raamwerk voor waarde creatie* te formuleren. Na het formuleren van het raamwerk is er een koppeling gemaakt tussen het ontwikkelde raamwerk en Archimate.

Het resultaat van dit onderzoek is een uit 6 stappen bestaande methodologie die managers zullen ondersteunen bij het modelleren van waarde creatie waarbij gebruik wordt gemaakt van Archimate elementen. Als onderdeel van de methodologie is een algoritme ontwikkelt die een door de organisatie aan de klant aangeboden *waarde propositie* relateert aan de processen en infrastructuur die dit mogelijk maken. Wanneer dit algoritme op een Archimate model wordt toegepast resulteert dit in een kleiner model, dit noemen we het waarde creatie model voor een specifieke waarde propositie. Dit algoritme is geïmplementeerd in de EA modelleertool **BiZZdesign Architect**. De deliverables van de methodologie zijn een model en een waarde tabel. Het waarde creatie model kan worden gebruik voor kostenbesparingen en analyses op het gebied van traceerbaarheid en gevoeligheid. Deze mogelijkheden aangaande het gebruik van het waarde creatie model worden tot in detail bediscussieerd. Waarde tabellen die als onderdeel van de methodologie zijn gevormd laten zien hoe de vanuit het netwerk verworven bronnen en services kunnen worden opgenomen in het waarde model.

Om deze methodologie te verduidelijken en demonstreren is een case studie gepresenteerd. Een andere voorbeeldcase is gebruikt om het gebruik van het *waarde creatie model* te demonstreren. De baten en de toepasbaarheid van de methodologie zijn geëvalueerd door gebruik te maken van studies en persoonlijke interviews met ervaren onderzoekers en beroepsbeoefenaars die zich bevinden in het domein EA modellering.

## Acknowledgements

This report is the outcome of my efforts for the past 8 months on my Master Thesis research. It is also the finishing point for my MSc. degree in Business Information Technology, at the University of Twente. Looking back, for the past 8 months, this research has been my top priority and I have dedicated myself fully to it. It was difficult, to work intensively and keep the motivation level up for the whole time period. But, I am glad with the outcome of my research and also with the effort I have put into it. During the course of my thesis, there were many times when I felt that I am stuck, having no clue about how to move forward, still, I motivated myself to keep moving ahead and continue working with dedication.

There are many people whom I would like to thank, because I think, without their support and belief in me it would have been very difficult to do this research.

First of all, I want to thank my parents. I owe every bit of my achievement to them. I am grateful to my wife, for her undaunted support and the belief she has in me and my abilities. She was often the only one to be sure that this research will be a good academic work. I have had many insightful discussions with her during the literature survey for this research.

I am indebted to Henk Jonkers, BiZZdesign, for always being there to listen to my ideas and thoughts. His help was detrimental in implementing the artifact of this research. His supervision has played a vital role in the successful completion of this research.

I consider myself lucky to have Maria lacob, as my first supervisor. She constantly motivated me to do better and strive for improvement. Many times, during the course of my research when my ideas were quite vague and unclear, she showed me the way ahead and guided me.

I am also grateful to Marten van Sinderen, my second supervisor, for giving useful suggestions, helping me in formulating the evaluation questionnaire and pointing out necessary changes in the text.

I am thankful to Henry Franken, CEO, BiZZdesign for giving me the opportunity do my thesis project at BiZZdesign. I would also like to thanks my BiZZdesign colleagues, Jan Jaap, Tim Vehof, Lianne Bodenstaff and Rob Kroese for their invaluable suggestions and evaluation of my research. I am grateful to Lucas Meertens, for taking the time out to help me with the evaluations.

Last but not the least, a big thanks to all my fellow interns at BiZZdesign. It was fun to work together with you all. Those little pep talks and small breaks between office hours were great stress busters and helped in rejuvenating me, so that I could go back to work. I am going to miss you all.

Prince Mayurank Singh

August 2013

## **Table of Contents**

1. Introduction	1
1.1 Project Context: BiZZdesign and Value Modeling	2
1.2 Problem Definition	3
1.2.1 Problem Statement	3
1.2.2 Research Objectives	4
1.2.3 Research Questions	4
1.2.4 Research Scope	5
1.3 Research Approach	5
1.4 Significance of the Project	7
1.5 Thesis Outline	8
2. Background and Literature Survey	9
2.1 The Concept of Value.	9
2.1.1 Features of value	10
2.1.2 Kinds of value	10
2.1.3 Definition of Value	11
2.2 Value creation process	12
2.2.1 Value creation and value capture	12
2.2.2 Resources, Activities, Knowledge or Human Input? Most valua	ble for Value creation18
2.3 Combining resources and activities.	20
2.3.1 The value chain, the value shop and the value network	20
2.3.2 Value creation in a network	22
2.3.3 Summary	25
2.4 What ArchiMate element represents value?	25
2.4.1 ArchiMate – Introduction	25
2.4.2 ArchiMate 2.0	27
2.5 Value Networks and ArchiMate	34
2.5.1 Network concepts and ArchiMate	34
2.5.2 e-3 value and ArchiMate	34
3. Developing a methodology to model value creation	
3.1 Value creation at process level	
3.1.1 The value creation triangle	
3.2 Objectives of the artifact.	41

3.2.1 Identifying value elements in a ArchiMate EA model	42
3.2.2 Relating value elements of an ArchiMate EA to a value proposition	44
3.2.3 ArchiMate models and value inflow from the network?	71
3.3 Methodology for showing value creation by ArchiMate	77
3.4 Uses of the Value Model	79
3.4.1 A smaller model	83
3.4.2 A networked enterprise architecture	84
3.4.3 Traceability	85
3.4.4 Cost Benefit Analysis	86
3.4.5 Sensitivity Analysis	86
3.4.6. For providing new services, off the shelf solutions	90
3.4.7 Bringing e-3 value model and ArchiMate closer	90
4. Implementation	92
5. Demonstration of the Methodology	94
6. Evaluation	102
6.1 Surveys	102
6.2 Method	103
6.2.1 Profile of the respondents	103
6.2.2 Choice of Survey	103
6.3 Formulating the questionnaire	104
6.4 Some important points from Personal Interviews	106
6.5 Data Analysis and Results	107
7. Conclusion and Future Work	111
7.1 Summary	111
7.2 Contributions	111
7.2.1 Theoretical contributions	112
7.2.2 Practical Contributions	112
7.3 Limitations	113
7.4 Future Research	113
References	115
Appendix A - Some question on the algorithm	119
Appendix B– Object Oriented Pseudo code of the Algorithm	122
Appendix C – Personal Interview Responses	125
Interviewee 1	125

Intervie	ewee 2	126
Intervi	ewee 3	127
Intervi	owee 4	128
Intervi	2wee 5	120
Annondiu		120
Appendix	D – Survey Response	130

## List of Figures

Figure 1 : Research Approach	6
Figure 2: The Relationship between Need and Fulfillment	12
Figure 3: Use Value and Exchange Value in Value Creation Process	13
Figure 4: Kinds of Use Values (Bowman and Ambrosini, 2003)	14
Figure 5: ICT value creation model (Cavusoglu, 2011)	17
Figure 6: Data, Information and Knowledge	19
Figure 7: The Value Chain	21
Figure 8: A Value Network	23
Figure 9: The different abstraction levels	24
Figure 10: A simple e3 value model	25
Figure 11: A Generic Metamodel of ArchiMate	26
Figure 12: Architectural Framework of ArchiMate	26
Figure 13: Metamodel of Motivation Extension	28
Figure 14: Metamodel of Implementation and Migration Extension	29
Figure 15: Resource and Capability in ArchiMate	31
Figure 16: Mapping between Business Model Canvas and ArchiMate by Iacob et. al. (2013)	32
Figure 17: Correspondence between BMO and ArchiMate by Fritscher & Pigneur (2011)	33
Figure 18: Mapping e3 value to ArchiMate using DEMO (Kinderen et. al. 2012)	35
Figure 19: Process and Value	37
Figure 20: The value creation framework	38
Figure 21: Value flow in a firm	38
Figure 22: Question to be answered by Value Creation Framework at process level	39
Figure 23: The resources acquired by a firm from the network	41
Figure 24: The realization relationship in ArchiMate	45
Figure 25: The bi-directional nature of the realization relationship	45
Figure 26: The attribute fields of a node	47
Figure 27: Example Values in the attribute fields	47
Figure 28: The most generic representation of an ArchiMate model	48
Figure 29: A general representation of an ArchiMate model	48
Figure 30: Value transfer between two firms	71
Figure 31: Modeling value acquired as a service	72
Figure 32: e3 model of the example	73
Figure 33: Business Collaboration showing the combination of two roles from two different roles .	74
Figure 34: Business Interaction showing the activity performed by the Business Collaboration	74
Figure 35: Application Collaboration showing the combination of two roles from two different	
applications	75
Figure 36: Application Interaction showing the activity performed by the Application Collaboration	۱.75
Figure 37: The e3 value model of the example case, adapted from Schuster & Motal (2009)	80
Figure 38: The EA model of the Newspaper Publisher	81
Figure 39: The EA model of the Vendor	82
Figure 40: The EA model of the Call Center	82
Figure 41: The Value Model	84
Figure 42: Traceability between two EA models	85
Figure 43: Example EA model: Archinsurance	95
Figure 44: The e3 value model for Archinsurance	96

Figure 45: The value model for Customer Information Service	
Figure 46: The Value Creation Model for Customer Information Service	

## Table of Tables

Table 1: Comparison between Resources (Osterwalder, 2004) and Inputs (Bowman and Ambros	sini,
2003)	16
Table 2: Previous works on Value Modeling and ArchiMate	30
Table 3: Conceptual Mapping between e3, DEMO and ArchiMate	35
Table 4 : Classification of Processes	37
Table 5: Mapping between the value framework at the process level and business models	39
Table 6: Objectives of the Artifact	42
Table 7: Classification of ArchiMate elements	43
Table 8: Classification of Resources	44
Table 9: The nodes for the algorithm	45
Table 10: ArchiMate relationships and their weights	46
Table 11: An Internal Value table	77
Table 12: An External Value table	78
Table 13: Table showing the In-Degree and Out- Degree for all elements in the Value Mode	87
Table 14: The Importance of elements	89
Table 15: The Sensitivity of elements	90
Table 16: Screenshot showing Generate value model option added in the tool, Architect	92
Table 17: Internal Value Table for Customer Notification	99
Table 18: Internal Value Table for Decision on Claims	99
Table 19: Questions for the personal interview	104
Table 20: Questionnaire for the internet survey	106

## **Table of Charts**

Chart 1: Applicability of the Methodology	
Chart 2: Correctness of the Methodology	
Chart 3: Completeness of the Methodology	
Chart 4: Network aspect of value creation is covered in the methodology	
Chart 5: Practicality of the methodology - is an input for improving Business IT alignment	110
Chart 6: Responses for Question 1	130
Chart 7: Responses for Question 2	130
Chart 8: Responses for Question 3	131
Chart 9: Responses for Question 4	131
Chart 10: Responses for Question 5	132
Chart 11: Responses for Question 6	132
Chart 12: Responses for Question 7	133
Chart 13: Responses for Question 8	133
Chart 14: Responses for Question 9	134
Chart 15: Responses for Question 10	134

Chart 16: Responses for Question 11	135
Chart 17: Responses for Question 12	
Chart 18: Responses for Question 13	136
Chart 19: Responses for Question 14	136
Chart 20: Responses for Question 15	
Chart 21: Responses for Question 16	137

## 1. Introduction

The primary pursuit of business is creating and maintaining value (O'Cass & Ngo, 2011) (Sirmon, Hitt, & Ireland, 2007). As long as an organization offers value to its customers, it stays in business. The moment it stops offering *value*, in the eyes of the consumer, its existence is threatened.

With the advent of IT, globalization, service oriented economy and ever demanding customers, the market has become very dynamic, forcing firms to be more agile and alert of potential opportunities. The need of the customers keep on changing and thus the worth, which they attach to a particular value offering by a firm. Understanding the processes by which a firm creates this value, is essential for managers, especially when these processes are both in market place and market space. (Rayport & Sviokla, 1995). This understanding will not only be helpful in managing the current value offering but also for new value creation. But, unfortunately, there is minimal theory explaining "how" managers/firms transform resources to create value. (Priem & Butler, Jan 2001)

Based on their study of *Value Creation for E-Businesses* Amit & Zott (2001) proposed that the business model should be used as a unit of analysis for value creation. They defined a business model as follows.

A business model depicts the content, structure and governance of transactions designed so as to create value through the exploitation of business value. A more widely accepted definition of a business model is that *"it is a conceptual model of how an organization creates, delivers and captures value"*. (Osterwalder, 2004). The business model of an organization is the highest level model of an organization's value logic.

A firm's assets (owned or acquired), its activities and its position in the environment in which it operates, together decide, how the firm creates *value* for its customers. *Enterprise Architecture* is the "organizing logic for business processes and IT infrastructure reflecting the integration and standardization requirement of the company's operating model." (MIT, 2013). EA gives an overview of the architecture of the whole organization, but in less detail than the *domain architectures*<sup>1</sup>. It focuses on the relationships and integration between the different domains, (like business, process and IT) which in practice have their own language, models, tools and techniques (Lankhorst & van Drunen, 2007). In short, Enterprise Architecture model shows how a firm realizes the services it offers to its customers. (Janssen, Buuren, & Gordijn, 2005).

The mapping of concepts between the domains of business modeling and enterprise architecture is very promising and has been attempted by previous researchers. (Kinderen, et. al., 2012) (Kinderen, et. al., 2011) (Janssen, et. al., 2005). Linking business models and enterprise architecture "results in a powerful modeling tool that couples the value exchanges between businesses and the costs that are required to realize these service" (Janssen, et. al., 2005). As Janssen et al (2005) observed, business models don't stand on themselves, "but relate to many other perspectives, such as inter organizational business processes and supporting ICT".

There are different modeling techniques, both for business models and for enterprise architecture as well. Previous attempts for understanding this relationship between the two are varied and dependent on modeling techniques. In most of the previous attempts, concepts of business models are matched to ArchiMate concepts. For this research, ArchiMate is chosen as the representative EA which is justified by the "wide acceptance" of ArchiMate in the "academic and practitioner" community of EA

<sup>&</sup>lt;sup>1</sup> A firm can have different detailed architectures for each domain, like process architecture, IT architecture, business architecture and organization architecture.

(Iacob, et al., 2012a). Another reasons of choosing ArchiMate is that it is an open and independent standard, also adopted by The Open Group <sup>®</sup>. By using ArchiMate it is possible to not only model processes in the business and IT domain but also the IT infrastructure which supports these processes. Thus, it is suitable for representing aspects used in this research. ArchiMate bears a close resemblance to UML, which has facilitated its fast adoption by practitioners, since they find it easy to learn and use.

This research does not attempt to map a business modeling approach upon ArchiMate, instead, an analysis is done on ArchiMate to ascertain, how well, it can represent value creation and value flows in a firm. By doing this, it contributes to existing literature on the exploration of the relationship between business models and ArchiMate, but from the ArchiMate perspective. Not choosing a definite business modeling approach allows us to dive deep in understanding value creation by firms since **a**) we are then not bound by concepts as specified by in a certain business modeling technique and **b**) different business modeling techniques can have different focus of particular aspects of value creation.

The aim of this thesis is to first provide a framework of *value creation* by a firm at the processes level. Then this framework is used to model the *value creation process* of the firm using ArchiMate. The framework of value creation by firms is developed from a very basic level, starting from what is valuable to a firm, to value creation inside a firm, and finally value creation by a firm in a network.<sup>2</sup>

As stated above the importance of this research is twofold. On the one hand, it will help managers and architects to model value flow in terms of ArchiMate elements, while on the other hand, it will contribute to the existing literature of Business IT alignment.

#### 1.1 Project Context: BiZZdesign and Value Modeling

BiZZdesign started as a spinoff company of the Telematica Instituut, Enschede and is now a major player in Business Process Management, Enterprise Architecture tools and consultancy market. BiZZdesign was a member of the tool vendor forum of the project which resulted in the development of the ArchiMate enterprise architecture modeling language which was also adopted as a standard by the Open Group. It is also the creator of popular EA modeling tool, BiZZdesign Architect. BiZZdesign, helps organizations to analyze, improve and re-invent their business for maximizing profitability and agility. It achieves this by various tools, like BiZZdesign Architect, BiZZdesigner (a tool for BPM) and Decision Modeler (a tool for better decision making in firms).

In its continuous efforts to bridge the gap between Business and IT, BiZZdesign has been very prompt in facilitating EA as a steering instrument for business strategy and decision making. This is evident from the various white papers and the academic articles, written by BiZZdesign on the alignment of business models/business strategy and EA. Also the motivation extension module added in ArchiMate 2.0 is aimed as depicting the rationale behind an EA and its contribution in fulfilling business goals.

This research is another attempt in the pursuit of aligning EA with business strategy using ArchiMate models to represent the value creating process of a firm. Since, an EA in ArchiMate represents the complete snapshot of the business and IT infrastructure (processes, functions, applications) in a firm, it can help to answer, perhaps the most difficult question a manger has to answer, *how is value created in the firm*?

<sup>&</sup>lt;sup>2</sup> The terms *firm* and *organization* have been used interchangeably throughout the text.

The motive is to bring ArchiMate closer to business strategy and decision making. Also, by depicting value creation in terms of ArchiMate elements, this research tries to bring closer the disciplines of Business Models and EA.

#### **1.2 Problem Definition**

This section is dedicated to specifying the problem for this research in detail. The main research question is formulated and divided into sub questions. The research objective clarifies what this research wants to achieve. Also, the scope of the thesis is defined.

#### 1.2.1 Problem Statement

The *value* which a firm offers to its customers is made possible by processes which require many human, technological, financial and intellectual resources. For analyzing and improving the *value creation process*, it is necessary for the firm to first identify every asset which is used in this process. Only then, can it improve the way value is acquired, represented and used in the process.

An enterprise architecture, which shows the infrastructure and the processes of a firm, should be able to provide a representation of this value creation process in terms of processes and the IT infrastructure which supports these processes. This representation or model should ideally show which, EA elements are (value creating) resources, capture resources, change resources and enhance resources to finally realize a value proposition. Such a model should consist of all the EA elements which are involved in a certain value creation.

Although, previous research efforts have tried to relate "*value*" to all components of ArchiMate (lacob,et. al., 2012b) (Kinderen, et. al., 2011) there is no previous work which relates the value offered to customers to the internal components of ArchiMate.

Not all the resources used in value creation are always owned by the firm; instead they are frequently traded from other actors in the business network. This business network, in which a firm operates and trades *valuable resources and products,* is called the *value network*. Any representation or model showing value creation by a firm, must be able is able to show these assets/resources are acquired from partners in the value network.

Although the relationship between ArchiMate with the value network has been investigated before (Kinderen, et. al., 2012) (Janssen, et. al., 2005) there is still uncertainty as to how the resources and assets (acquired from the network) can be represented in ArchiMate. Moreover, in these previous research the mapping between *e-3 value*<sup>3</sup> and ArchiMate is confined to the business layers of ArchiMate. How the acquired assets/resources are being used in the application and technology layer is not investigated. Any representation of how a firm uses internal and acquired assets for value creation, in terms of ArchiMate, should span all the layers of ArchiMate and not just the business layers. This is important because business processes are tightly integrated into the IT systems and every business process in the *marketplace* (tangible world) is replicated in *market space* (IT world) (HBR 1995). The notion that ArchiMate elements in all the layers are important for the value creation analysis and thus valuable to a firm was put forward by lacob et. al (2012a) where they state that "value should not only be considered in relation with a firm's environment (i.e., its customers), but also internally".

To conclude, there is a need to show value creation process at the process level of abstraction for better understanding of how a firm create, captures and delivers value to its customer. Also the

<sup>&</sup>lt;sup>3</sup> e-3 value is a value modeling technique to model value creation by firms in a network. It is explained briefly in Section. 2.3.2.3. For more on e3 value refer to (Gordijn & Akkermans, 2003)

*capacity of ArchiMate to represent value creation in firms has not been investigated before.* These are the motivations for this thesis and the research questions are formulated to provide an answer to the above concepts.

#### **1.2.2 Research Objectives**

On one hand, there are business executives who formulate a blue print of products a firm has to create (by the use of business models) and on the other hand we have process managers who have to realize the value creation by the available infrastructure, human skills, processes and applications. The business side executives represent the **WHAT** side while process and IT managers represent the **HOW** side of value creation.

Both have to speak the same language and the discussion of value creation would be incomplete if the mechanism of its creation is not considered at the same time. It is important for the managers and IT staff to understand how value is being created by using the firm infrastructure, because in the case of changes or opportunities of new value creation, existing capabilities, processes and tested approaches may have to be reused.

By showing the value creation of a firm by means of ArchiMate elements, the thesis tries to bridge the gap between strategy formulation and strategy implementation.

The research objective is: to develop a methodology for ArchiMate to relate a value proposition (offered by a firm) with all the owned and acquired resources being used by the firm for its creation.

#### **1.2.3 Research Questions**

In order to achieve the research objective as stated above the following main research question has been formulated as:

#### How can an ArchiMate be used to model the value creation process of a firm in a value network?

This main research question is further divided into 3 sub questions as shown below:

#### RQ1: How can ArchiMate elements be used to model value?

An extensive literature survey is done to find out what is valuable to a firm in the value creation process. A value creation framework is presented. Then, the ability of ArchiMate to represent these values is then evaluated to find which ArchiMate elements represent value for the firm.

#### RQ2: How can ArchiMate elements be used elements to model value creation by a firm?

After identifying ArchiMate elements which represent *value*, an algorithm is presented to relate a value proposition of a firm to these ArchiMate elements, thereby showing a value flow.

#### RQ3: How can an ArchiMate model be used to show the value inflow from the network?

Firm rarely produce everything on their own these days (Cavusoglu, et. al., 2011). Instead, value is cocreated by firms. How can ArchiMate be used to model the capture assets obtained from the network and their use in the value creation processes.

#### 1.2.4 Research Scope

This thesis is aimed towards the representation of value creation using ArchiMate. There are many approaches and techniques to show value creation at the strategy level of an organization. This layer is the highest level of analysis of how a firm works and gives an overview of the value creation process of a firm. Different modeling techniques at the strategy level include *e-3 value model* and *business model canvas*. Lepak, Smith, & Taylor (2007) have discussed the source of value creation at 3 levels, individual, organisation and society. This research will only look at value creation from the process level viewpoint of the firm.

There are different process modeling (BPM) techniques to model the processes in a firm. These modeling techniques although efficiently model processes of the firm but they fall short in showing the necessary infrastructures required for performing these processes. A major reason for choosing ArchiMate for this research is because it allows modeling not only the business processes of the firm but also the IT processes and functions which support these business processes.

This research is done in the context of BiZZdesign, the design and development of the methodology is geared towards the organizational context of BiZZdesign.

A full implementation of the methodology is beyond the scope of this thesis. A prototype of the algorithm (developed as a part of the methodology) is made to show the working of the method, but a full integration with the existing ArchiMate tool, Architect, is beyond the scope of this research.

#### **1.3 Research Approach**

Design science emphasizes the connection between knowledge and practice by showing that we can produce scientific knowledge by designing useful things. Design science can be defined as the "design and validation of solutions to practical problems" (Wieringa, 2009). It enables understanding of a problem domain and realization of its solutions by building applications artifacts like algorithms, formal logics and even informal language descriptions.

As stated above in section 1.2.2 the aim of this research is to develop a methodology which uses ArchiMate to show value creation by a firm. The research methodology followed for this thesis is Design Science Research Methodology (DSRM) proposed by Peffers, Tuunanen, Rothenberger, & Chatterjee (2008). The motive of design science is to motivate the need for a solution, design it and show its usefulness by application to a test case or an example. This solution is referred to as an *artifact*. Peffers et. al., (2008) define an artifact as "constructs, models, methods or instantiations (each defined broadly) or "new properties of technical social and /or informational resource".

Peffers et. al., (2008) proposed a DSRM which provides researchers pursuing design science research "a mental model or template for a structure for research outputs".

The different stages of the DSRM as proposed are as follows:

- 1. *Identify Problem and Motivate* This is the first step of DSR and it involves clearly stating the problem and how the researcher views it. The problem as it exists and the importance of its solutions are the necessary knowledge for this step.
- 2. *Define Objectives of a solution* What will the solution achieve, is stated in this step. In what way the new solution will be better than the earlier ones (if any) is also specified in this step.
- 3. *Design and Development* This forms the core of the research, which involves developing an artifact for solving the problems stated in Activity 1 having the objectives as stated in 2. The

resources required for this step include knowledge of theory that can be brought to bear in a solution.

- 4. *Demonstration* This step is the demonstration, showing the application of the artifact to a problem and solving it. Based on this demonstration other researchers can replicate the steps and use the artifact to solve other instances of the problem.
- 5. *Evaluation* This step of design science compares the result of demonstration with the objectives of the solutions as specified in activity 2. The evaluation will tell us how well does the designed artifact solves the problem. Conceptually, evaluation could include any appropriate empirical evidence or logical proof. There can be qualitative or quantitative methods to measure the performance of the artifact.
- 6. *Communication* This step is concerned with spreading the work done by the researcher to the scientific and practitioner community via different medium like journal, reports and scholarly articles.



#### Figure 1 : Research Approach

According to Peffer et. al., (2008), any of the steps between 1 and 4 can be starting point of design science research depending on the source of the problem. For e.g. a research which is concerned with observing a practical solution which was successful in solving a problem earlier can start with activity 4, Demonstration. This thesis follows the nominally sequential order of DSRM starting form step 1, Problem Identification. Activities 1 and 2 have been covered in chapter 1.

The figure above shows the research approach followed to answer the research questions. The number 2 in the figure above indicates the literature survey and its themes. This literature survey is done to form the necessary background knowledge of value creation and also to study previous work done on the topic. Chapter 3, corresponds to the design and development activity of DSRM and a Value Creation Framework at the process level is derived from the literature survey of Chapter 2. Further in the Chapter 3, a mapping between ArchiMate and the framework is done to answer each of the three research questions.

#### **1.4 Significance of the Project**

Many useful contributions are expected from this research. These contributions are both practical and theoretical. The significance of this project is enumerated below, classified by the stakeholders.

**1. Higher level managers and Strategists:** Understanding of how *value* for customer is being created, and which infrastructures elements are used in the process is important for managers. Armed with this understanding they can evaluate and re-engineer the processes for better profits and services (Lankhorst & van Drunen, 2007). The result of this thesis will be a methodology which can be applied to an ArchiMate EA model to show how a definite value proposition is realized, and thus will help managers in understanding value creation. With the help of this method managers can scrutinize the current processes and the infrastructure employed in creating value for the customer.

This thesis will also add to the previous literature which justifies the utility of EA's as a steering instrument for strategy formulation. By showing the infrastructure elements involved in value creation, this method will help in decision making, thereby justifying the usefulness of EA.

The value creation model, which is the output of the methodology, will provide a base for quantitative analysis to gauge how much it costs to realize a value proposition. It can also be used to determine the critical and non-critical resources of a firm.

**2. CIO's:** It is essential for the CIO and the IT staff to be able to pin point the software and the hardware which are being used in facilitating a business process. The way in which IT is supporting the business processes by the required data and automation, is an integral part of value creation. The methodology to be developed in the thesis will not only allows CIO's to dissect the value creation process in terms of applications and technology components used, it will also be able to justify or analyze their usage.

Different applications, systems and data come together to form a *capability*. Different application and technological resources can be grouped together in an organization to form a capability. For example, Accounting function and Billing function can be grouped together and be referred as Financial Services, which can be a capability. The method developed in the thesis will help in pointing out the capabilities (grouped EA components) which are detrimental for realizing certain value. This capability can be then also be used, as a package, for another endeavor.

**3. BiZZdesign:** This thesis adds to an existing body of literature based on ArchiMate and value modeling. The methods show how ArchiMate can be used as an important tool, aiding strategy formulation for a new value proposition or for the analysis of a current value proposition of a firm. The method can also be implemented as addition viewpoint in ArchiMate showing, all the process, applications and technology used for a particular value proposition.

**4. Research Contribution:** Apart from the practical contribution mentioned above, this thesis also contributes to research, in the fields of Enterprise Architecture, ArchiMate, Value creation by firm and the Business Value of Enterprise Architecture.

A lot of work has been done on the integration of value modeling and ArchiMate<sup>4</sup>, this research will also shed light on how value is represented in ArchiMate.

The theoretical contribution of this research have been discussed in detail in Section 7.2.1

<sup>&</sup>lt;sup>4</sup> For more on previous research on value modeling and ArchiMate refer to Section. 2.4.2.1 and Section 2.5.2

#### **1.5 Thesis Outline**

The structure of the report is according to the activities of the Design Science Research Methodology. (Peffers, et. al., 2008)

The problem statement and the motivation behind the research have been covered in Chapter 1. Also the main research questions and the sub questions have been stated. Different stakeholders for this research are identified and the expected benefit from this research to each of them is stated.

In chapter 2 an extensive literature survey is done. This literature survey helps in formulating a sound theoretical foundation which is used to answer research questions, primarily RQ 1. Gaps in the present literature and practice are identified. How will the artifact of this research i.e. the methodology will fill these gaps has been stated as the objective of the artifact.

Having built the necessary theoretical knowledge, a methodology for showing value creation using ArchiMate is developed in Chapter 3. This chapter corresponds to the third activity of DSRM i.e. Design and Development. The different steps of the methodology are explained in detail.

The 4<sup>th</sup> activity in DSRM is the demonstration of the artifact. The methodology developed in Chapter 3, is demonstrated with the help of an example case in Chapter 5. A demonstration of the algorithm, developed as a part of the methodology is shown with the help example in Section 3.2.2.5. The potential uses of the methodology and its application to provide insights in value creation, has been discussed in detail in Section 3.4.

The 5<sup>th</sup> activity of DSRM is Evaluation, in which the results of application of the artifact to the problems are evaluated against the objectives. Evaluation of the artifact can be either quantitative or qualitative and could include any appropriate empirical evidence or logical proof (Peffers, et. al., 2008). The evaluation for this research consisted of personal interviews and an internet survey. The findings from the personal interview and the survey have been summarized in Section 6.4 and Section 6.5 respectively.

The communication of the results to "relevant audiences" forms an important activity of the DSRM. (Peffers, et. al., 2008). This is important for cumulative research and for the progress of science in general. This research will be made public through the website of University of Twente. It would be submitted to relevant conferences in order to communicate the result to the academic community.

The last chapter of the report is the Conclusion chapter. Apart from proving a summary of the whole research, important contributions (practical and theoretical), limitation and future research areas are discussed in detail.

## 2. Background and Literature Survey

This chapter is about the extensive literature survey done for answering the research questions. This background knowledge is used for developing a sound theoretical base. Some important concepts are introduced in this chapter which will be used in the rest of the report.

The electronic databases selected for the literature survey are: Google Scholar, EBSCO Information Services, SCOPUS and Web of Science. The criteria based on which these particular databases are selected, is their comprehensive and wide coverage of business literature as indicated by University of Twente, library.

The themes followed for conducting the literature survey are mentioned below:

- Value, its nature and features
- Value Creation
- Value Networks
- ArchiMate and Value modeling

These themes are the criteria for searching relevant literature and also for filtering them. Why, we have chosen these themes, can be understood by the relationship each theme has to the research questions.

*Value, its nature and features*- is used for understanding the concept of value in general and is instrumental to better grasp the research theme. Section 2.1 is about the concept of *value*. Previous studies about the nature and features of *value* are presented. Distinction between two types of *values* is brought out.

**Value Creation-** forms the core of this thesis and has been studied in details. The different aspects of value creation are studied. This study of value creation is related to all the three research questions. Two business models as representatives of value creation have been summarized. Section 2.2 explores, what is value in the eyes of the firm. Different perspectives on the value creation by firms are shown. The constituents of the value creation process should represent business value at the process level. Section 2.3 presents the different value configuration techniques.

*Value Networks-* this theme is studied to answer the third research question, i.e. to model value inflow from the network using ArchiMate elements. Value networks have been studied under the heading *Value Networks and ArchiMate* in Section 2.5.

Finally, previous research on *ArchiMate and value modeling* is studied to account for the research already done in this particular research domain. The gaps in current state of research are identified. Section 2.4 introduces the EA modeling language ArchiMate and Section 2.5 is about the previous attempts of representing business value using ArchiMate.

#### 2.1 The Concept of Value.

Owing to its wide usage in day to day life the word *value* can be used for specifying many different concepts. Its intended meaning can easily be misunderstood if the context or its usage is not specified. Value can be used for a number of varied concepts like brand value, investment value, share value, customer value etc. In whichever way it is used, it is meant to indicate the *worth* of a tangible or intangible thing.

Effort on defining value and its nature has been continuously on since a long time, and scholars have been perplexed in understanding its true nature. As Vargo, Maglio, & Akaka (2008) stated "the nature

of *value* has been discussed and debated since Aristotle. Part of its elusiveness stems from the oblique – if not orthogonal – meanings of value that have been embedded in the foundations of economics and the study of market exchange". Efforts to understand the nature of value is still being pursued by researchers. In the words of O'Cass & Ngo, (2011) *"understanding what value is and how it is created has attracted significant attention over the past decade"*.

There is a lot of literature on the nature of value including the works of Marx<sup>5</sup>. An extensive study about the nature of *value* requires diving deep into philosophy, and is beyond the scope of this research. Still, based on the literature which was consulted for this research, following points have can be deduced.

- Value is a manifestation of need.
- Need is the sufficient and necessary condition for value to exist.
- Value is a theoretical concept. (Carr, et. al., 2003)

#### 2.1.1 Features of value

As mentioned above, for understanding *value*, first the context in which it is used to should be understood. Generally, to make the context of a particular value more explicit and clear, a modifier is added in front of the term *value*, like market value, brand value, liquidation value, stock value, taxable value, current market value, face value etc.

Moreover, value can be understood as a manifestation of *need*. Since need can vary from person to person (Vargo, et. al., 2008) and from situation to situation, therefore value of a thing can is dependent on the person and the situation/context (Allee, 2008) .This makes the concept of value a very subjective and theoretical concept. Value has a different meaning for different stakeholders". (Pombinho, et. al., 2012) (Lepak, et. al., 2007) (Bowman & Ambrosini, What does value mean and how it is created, maintained and destroyed ?, 2003)

To show dependence of *value* on the context, let's consider an example. A bottle of water has a certain worth to a thirsty person at home. The worth of the same bottle of water would increase dramatically if the person is stranded in a desert.

#### 2.1.2 Kinds of value

What is the true nature of value? This question has puzzled scholar from ancient times. Aristotle was the first to distinguish between the two meanings of value – *use value* and *exchange value*. Although, he was able to explain use-value, he had difficulty specifically identifying exchange value. (Vargo, et. al. 2008)

Properties of things which are attributed to them because of their very existence or because of their property of satisfying a purpose, are use values.

The division of value into "use value" and "exchange value" is not new and is found in many articles on value creation and value flows. "Use value" is the value which things have by virtue of use or utility. (Bowman & Ambrosini, What does value mean and how it is created, maintained and destroyed ?, 2003)

For example an automobile has use value for a person who can drive it.

<sup>&</sup>lt;sup>5</sup> Karl H. Marx was philosopher, economist and revolutionary socialist. His works on economics in general and labor theory in particular have a great influence over the current economic thoughts.

"Exchange value" of things is realized during a transaction. It is the value which things have by virtue of their power to barter things in a value exchange between two parties. The same automobile has exchange value for the seller when sold off to a second hand garage.

**Value and Price:** Price should not be confused with value. While value relates to the worth of the commodity, a service or an object, price is the actual money it brings when it is sold. (Carr, et. al., 2003).

#### 2.1.3 Definition of Value

The core of economics is based on "product" or goods which have exchange value. The goods or things are exchanged because the parties in the exchange see "perceived" use value in things being exchanged. Owing to its different usage and meanings, it is difficult to devise an all-encompassing definition of *value*.

As discussed above, we have seen different features of value. A definition of value is attempted below, which combines the concepts about the nature of value.

Value can be defined as the perceived quality of a tangible or intangible thing which enables it be used for satisfying a need purpose.

The above definitions uses 5 important words, *perceived*, *quality*, *tangible*, *intangible*, *need*, each of which has been defined below and their inclusion in the definition are clarified.

- 1) *Perceived:* Value of something is dependent on person analyzing it and also on his perspective.
- 2) *Quality:* The use of the word, quality, in the definition makes value an adjective, the property of a thing. Value is the property or attribute of a *need satisfying thing*.
- 3) *Tangible/Intangible:* The thing possessing value can be tangible or intangible. This can easily be understood from many daily life situations. Today, firms are increasingly providing their customers with a mix of intangible and intangible values. This is clear from a large number of literature on service firms which points out that today there are hardly any firms which provide only tangible products to their customers and no intangible services. For e.g. advice by a law firm, is a valuable service to a client and an intangible thing. Also, as stated above, *value* is a theoretical concept.
- 4) Need/Purpose: It is the source of value. One important aspect to note here is that the needy (person or firm having need) might not be aware of it. For e.g. the customer base of Apples' IPad was not aware of his need for a tablet before IPad was launched. In the more general sense the person having need is also aware of it.



Figure 2: The Relationship between Need and Fulfillment

#### **2.2 Value creation process**

Based on their study on *Value Creation for E-Businesses* Amit & Zott (2001) proposed that the business model should be used as a unit of analysis for value creation. Their definition of a business model is: A business model depicts the content, structure and governance of transactions designed so as to create value through the exploitation of business value.

A more common definition of a business model is that "it is a conceptual model of how an organization creates, delivers and captures value" (Osterwalder, 2004). The business model of an organization is the highest level model of an organization's value logic. *This value creation logic should also be mirrored in the process level viewpoint of the firm.* This section is based on literature study of value creation by firms. First we studied three value creation model i.e. Bowman and Ambrosini (2003), Business Model Canvas (Osterwalder 2004) and ICT value creation model (Cavusoglu, et, al. 2011). There is a specific reason for choosing these 3 particular models. The model by Bowman and Ambrosini (2003) is chosen because it shows value creation by firms in terms of use values and exchanges values. This model will help in classification of elements in ArchiMate. The Business Model Canvas (Osterwalder, 2004) is chosen in lieu of its popularity and wide usage in academic literature. The ICT value creation model by Cavusoglu, Al-Natour, & Cavusoglu (2011) is studied, because it gives a complete and comprehensive idea of how IT infrastructure creates value.

The words *value* and *valuable* are used so many times in the text, that it is easy to get confused. A small clarification is given here. The product or the service offered by the firm to the customer has *value (use value) to* the customer. The word *value* in the term value creation refers to this value.

For creating this products or service the firm requires goods, people, machinery etc. These things have *use value* for the firm and are thus *valuable* to the firm in the value creation process.

#### 2.2.1 Value creation and value capture

Value creation encompasses all the resources and activities of a firm which a firm uses in order to create value for the customer. It being the essence of a firm's *'survival'*, one assumes that it must be well understood, both by managers and researchers. Unfortunately, this is not the case. "There is little consensus on what value creation is or how can it be achieved." (Lepak, Smith, & Taylor, 2007)

Three points which have caused disagreement and confusion among researchers and practitioners regarding 'value creation' are mentioned below.

1. Owing to the multidisciplinary nature of the field of management, there is "significant variance in the parties or targets for which new value is created". (Lepak, Smith, & Taylor, 2007). For e.g. for researchers from HRM or organizational behavior the target of value creation employees and

organizations; for researchers of sociology or economics, the target of value creation is the society or nations; for researchers of marketing or entrepreneurship, the target of value creation is the consumers or the stakeholders.

2. The term 'value creation' can be used for specifying both the content as well as the process of new value creation. When referring to the content, value creation is used to mean, what is value, for whom it is valuable and where does it reside. When used to specify a process, it can be used to refer to "how value is generated and the role, if any, of management in this process" (Lepak, Smith, & Taylor, 2007)

3. The process of value creation is often wrongly used to refer to value capture, thus there exists a confusion between the concepts of value capture and value creation. (Lepak, Smith, & Taylor, 2007) (Bowman & Ambrosini, What does value mean and how it is created, maintained and destroyed ?, 2003). Sometimes these terms are used interchangeably. Since the concept of value creation forms the core of this research and has been mentioned many times in the thesis, it is important to define, what is meant by value creation and also bring out its difference vis-à-vis value capture.

*Value capture* is concerned with extracting the maximum exchange value (mostly, money) from the market after the product is offered to the customer and is in use. Typical activities in value capture include sales, branding and marketing and typical resources are brand image, reputation, capital stock etc.

Refer back to the definition of *value* as stated in 2.1.3. In the term, *value creation*, the word *value* is meant to refer to what Osterwalder (2004) calls *value proposition* and refers to "a bundle of product or services" that are of value to the customer. (Osterwalder, 2004).

The word *creation* is meant to specify the mechanism of creating use value. Thus, *Value creation* can be defined as the logic or the mechanism via which firms build, combines and reconfigure resources (possessed or acquired) to produce a product or service for the customer.

#### 2.2.1.1 Value Creation Model by Bowman and Ambrosini (2003)

Bowman and Ambrosini (2003) based on the concepts of use value and exchange value put forward a model of value creation. It is shown in the diagram below.



#### Figure 3: Use Value and Exchange Value in Value Creation Process

According to Bouwman and Ambrosini, the inputs for the value creation process are inert inputs and human input. Inert inputs are physical elements like data, steel, machinery. Inert inputs are further classified as follows:

1) Enduring inert inputs, like building and machinery. These inputs are not transformed in products or services themselves but aid in the value creation process.

2) Intermediate use values, like trust and brand image. These values are created once the firm is up and running.

The model shows that the firm acquires Inert Inputs, human inputs and enduring capital from different supplier. For obtaining these inputs the firm also requires exchange value (usually money) with which it can acquire resources from the suppliers.

Bowman and Ambrosini make a clear distinction between inert input and human input. Human input has the ability to create new use value. Also they specify that, the personal capability of a person (e.g. network connections, knowledge) is also an input for the value creation process. The following figure shows all the inputs in the value creation process according to Bowman and Ambrosini.



Figure 4: Kinds of Use Values (Bowman and Ambrosini, 2003)

Below we give the definition of the concepts of the figure above by provided by Bowman & Ambrosini (2003)

- Use values are properties of products and services that provide utility
- Exchange Value is a monetary amount exchanged between the firm and its customer or suppliers when use values are traded.
- Inert use values Inputs in the production process take the form of *inert* use values e.g. components such as data, steel etc.
- Human Input are capable of creating new use values that generate a revenue stream.
- Enduring Inert Inputs The fixed assets of the firm, like building and machinery.
- Capability competence and qualities of human input
- Intermediate Use value Use values created inside the firm to improve the efficiency and/or the effectiveness of the use value creation process. Examples include, reputation, trust, brands and special equipment.

The authors also mention 5 kinds of activities which a firm indulges in. These activities are described below.

1. Activities that capture Exchange Value – These activities form the core of the value creation process are 'involved in the production and sale of products and services'.

2. Activities that capture use value – these activities are aimed at capturing maximum use value from the suppliers of input, for a given amount of exchange value.

3. *Capital Stock creating activities* – Activities like marketing and R & D are capital stock creating activities. These activities are aimed at generating value streams for firms in the future.

4. *Firm maintenance activities* – Although, these activities of the firm do not contribute to the present or future profit stream, they are essential for the firm to conduct business. Examples of these activities include health and safety services, and legal services.

5. *Value destroying activities* – Such activities are the outcome of poor management and neither contribute for capturing use value nor exchange value.

#### 2.2.1.2 Business Model Canvas

Osterwalder (2004) proposed a model of value creation by a firm and identified the 9 building blocks for it. The model proposed is called the Business Model Canvas and the related ontology is called the business model ontology.

The nine building block of business model canvas are:

- Key Partners
- Key Activities
- Key Resources
- Value Proposition
- Customer Relationships
- Channels
- Customer Segments
- Revenue Streams
- Cost Structure

According to the business model ontology, value is created when a set of activities are performed on the resources which are available to the firm. The performance of activities on resources is called value configuration and is defined as the "arrangement of activities and resources that are necessary to create value for the customer".

What is referred to process of value creation in this thesis corresponds to the concept of value configuration as put forward by of the Osterwalder.

From the theory presented above, value creation is the conversion of tangible or intangible resources by activities to value proposition. This activities are performed by human capital of the firm. Analyzing the value creation process of a firm in terms of operands and operant was also forward by Constantin & Lusch (1994) in the marketing literature and then incorporated in service science. (lacob, et al., 2012a)

The concept of different types of input as shown in Figure 2 is analogous to the concept of key resources as put forward by Osterwalder (2004). Osterwalder provide a classification of key resources which are used in the value creating process as follows:

- Physical building, machines, IT
- Intellectual Copyrights, Partnerships, firm know how, brands
- Human employees, employee skills
- Financial stocks, cash and bonds.

The following table presents a mapping between the Inputs of use value (Bowman & Ambrosini, What does value mean and how it is created, maintained and destroyed ?, 2003) and key resources. (Osterwalder, 2004)

Osterwalder	Bowman and Ambrosini
Physical	Inert Inputs
Human	Human inputs
Financial	Exchange Value for acquiring inputs
Intellectual	Intermediate use value

#### Table 1: Comparison between Resources (Osterwalder, 2004) and Inputs (Bowman and Ambrosini, 2003)

The concept of *Use value for customer* can be mapped to the concept of value proposition as put forward by Osterwalder. Moreover, of the 5 value creating activities only the 1<sup>st</sup> activity (Bowman & Ambrosini, What does value mean and how it is created, maintained and destroyed ?, 2003) is concerned with using resources to produce exchange value. So activity 1 in the model of Bowman and Ambrosini is what Osterwalder refers to as *Capability*. And the entire value creation process of the firm as put forward by Bowman and Ambrosini can be mapped to the concept of Value Configuration.

Based on the two figures shown above we can conclude following things:

1) Use value is inherent in resources.

- 2) Activities convert resources to products or services.
- 3) Products and services have use value for consumers
- 4) A firms acquires resources from different firms in lieu of exchange value.

#### 2.2.1.3 ICT value creation model

Firms invest heavily in IT infrastructure, in fact ICT accounts for half of all business investments in equipment's. ICT is an integral part of value creation process of firms. Researches to evaluate the value of IT have been long associated with measuring the economic returns and then mapping them to IT investments. But IT produces intangible values also, e.g. new areas of innovation. (Cavusoglu, et. al., 2011).

Cavusoglu, et. al., (2011) created a model to show the "complete process through which ICT resources create value at the individual, firm, industry/ecosystems and the country/global context level". The figure below show an adapted version of the model.



Figure 5: ICT value creation model (Cavusoglu, 2011)

This conceptual model is relevant to our present research because, ICT resources and related processes are usually not mentioned in the strategic model and discussions of value creation, but are very relevant for any model of value creation at the process level. The above model traces the processes through which ICT resources existing at the various levels can collaborate to create value at these levels. (Cavusoglu, Al-Natour, & Cavusoglu, 2011). For this research only the first two levels of ICT value creation are relevant i.e. Individual Production System and Firm Production System.

**Individual level:** ICT resources help individuals increase their work performance and allow them to perform activities assigned to them in a better way. This directly contributes towards improved business processes and thus value creation at large. ICT resources indirectly impact the production system at higher levels of abstraction.

**Firm Level:** ICT resources create value at the firm level by improved coordination between individual workers in different departments or units. Also, they assist in the performance of decision making functions and management information. Since firms don't create value in isolation, rather in a network with suppliers and partners, therefore the improved business processes of one partner will indirectly

affect another partner. By improving the output of the individual and enabling business processes (both inside the firm and between suppliers/partners) the ICT resources contribute towards the entire value creation process of the firm. When this value is w.r.t to the customer it is inherent in the product or service. When this value is w.r.t to the firm, it is inherent in improved coordination, improved processes and efficiency.

The contribution of ICT to higher levels than the firm level is by Improved Production Input and Value added product. ICT resources enhance the output of the production system of firms, which are the input to the production process of the ecosystem as a whole. In this era of globalization the product in the ecosystem of one country have effect on those in another country. Therefore, the cascading effect of ICT which starts from an individual level is reflected till the country level.

#### 2.2.2 Resources, Activities, Knowledge or Human Input? Most valuable for Value creation.

We have seen that the value creation process of a firm can be summarized as the conversion of resources to products via activities. An important question is, what is the most important for the value creation process, the resources or the activities or human input?

#### 2.2.2.1 The Resource based perspective

The Resources Based View of firms (Wernerfelt, 1984), has been a breakthrough in strategic planning (also selected as one of the most influential papers published in the Strategic Management Journal) looks at firms in terms of their resources rather than in terms of their products. It was put forward in the times of traditional industries, when tangible goods which were converted by machines to products under one roof. It treats the resources as the key to success of the firm. In other words, it specifies that "a bundle of assets" lies at the heart of the firm's competitive position.

The Resource Bases View (RBV) describes resources as "anything which could be thought of as a strength or weakness of a given firm". This definition is general to the point of vagueness and does not help in the demarcation of what is a resources and what is not. In a later paper by Barney (1991), it is said that only those resources are RBV resources, which are *valuable*, *rare*, *in-inimitable* and *non-sustainable* (VRIN).

"We argue that value is fundamentally derived and determined in use- the integration and application of resources in a specific context – rather than in exchange- embedded in firm output and captured by price". (Vargo et. al., 2008)

Recent literature has raised a lot of doubt on the applicability of the RBV and some have even gone to the extent of calling it an "overtly popular literature".

#### 2.2.2.2 The Service Logic perspective

As more and more firms shift towards becoming service based firms, our notion of a business product is changing. Firms which only offer product (and no attached service) to clients are increasingly becoming lesser in number. The products offered by most of the firms today are a combination (bundle) of tangible product and services (Vargo et. al., 2008). For e.g. Auto retailer these days not only provided cars but also services like insurance, loans, loyalty programs etc.

The service dominant logic looks at firms from a service point of view. The key resources used by the firm in value creation are the skills, knowledge, (Johnson et al. 2005) processes and functions of the firm. It also provides a new way of understanding the value creation process by stating that "role of the firm is to propose and co-create value, provide service", it is up to the customer to accept or reject the value proposed. The service dominant view transforms "our understanding of value from one based on *units* of firm output to one based on *processes* that integrate resources". (Vargo et. al., 2008).

S-D logic also states that value exchange is necessary for value realization. Goods when involved in value exchange are seen as tools for the delivery and application of resources.

Moreover, the value chain model is more suitable for the analysis of manufacturing and production firms than service firms where the resulting value chain doesn't fully capture the essence of the value creation mechanism of the firm. (Amit & Zott, 2001)

#### 2.2.2.3 The Human Resource Perspective

The human resources of the firm, its employees, hold a unique place among the firm's assets. Their unique position is attributed to their capacity to *create new use value*. Owing to this unique quality of human resources, Bowman and Ambrosini (2003) make a clear distinction between *Human input* and *Inert input*. Human Input creates new use values that generate a revenue stream. The employees of any firm possess knowledge, know – how and expertise, which in itself is a critical resource for value creation and has been explained in the sub section below.

The conversion of resources to useful product is achieved through activities which are performed by the people of the firm.

#### 2.2.2.4 The Knowledge based view of the firm

The discussion on critical resources for *value creation* would be incomplete without the mention of Knowledge Based View of firms which builds upon R.B.V of firms and considers 'knowledge' as the most strategically important resources of the firm'. The knowledge based perspective of the firm postulates "that the services rendered by tangible resources depends on how they are combined and applied, which is in turn a function of the firm's know how (i.e. knowledge)." (Alavi & Leidner, 2001). The knowledge which a firm possess, defines its capacity to efficiently convert its inputs into valuable outputs. (Nickerson & Zenger, 2004)

A definition of knowledge which explains its usage in every context and is also agreed upon by academics is difficult to achieve. The answer to the question, *What is knowledge?*, "has intrigued some of the world's greatest thinkers from Plato to Popper without the emergence of a clear consensus …" (Grant, 1996). Many authors have tried to define knowledge by bringing out the difference between *knowledge, information* and *data*. There exist two different views on the hierarchy of knowledge, information and data, the first view being that the hierarchy is bottom up (from data to knowledge) while the other view is that it is top down (from knowledge to data): where data is raw numbers and facts, information is processed data, and knowledge is authenticated information. (Alavi & Leidner, 2001)



Figure 6: Data, Information and Knowledge

Alavi & Leidner (2001) have defined knowledge as *"knowledge is information possessed in the mind of individuals: it is personalized information (which may or may not be new, unique, useful or accurate) related to facts, procedures, concepts, interpretations, ideas, observations and judgment"*.

Although knowledge is possessed in the mind of the employee it is reflected via different concepts and activities like organizational culture and identity, routines policies, systems and documents.

Since these entities are usually difficult to replicate or copy and become unique to the firm they become sources of competitive advantage there by making it difficult for new entrants to enter the market. Also, these entities give the firm an edge over its competitors. *We must keep in mind that the mere presence of knowledge is not the source of competitive advantage; rather, it is the application of this knowledge to organizational activities.* 

The knowledge capital of the firm can be used to organizational capability into three basic ways. (Grant, 1996). These ways are directives, organizational routines and self-contained task teams. *Directives* are the rules, standard procedures, best practices and instructions which are used for conveying the tacit knowledge held by specialist to non-specialist. *Organizational routines* are task performed by individuals "without the need to articulate and communicate what they know to others" (Alavi & Leidner, 2001). Examples include, protocol for communication and development of task performance. *Self-contained task teams* are composed of individuals who have expert knowledge and experience of solving a particular problem type. The problem is complex and such that directives and organizational routines can't t be applied to solve it. Such teams are usually self-contained and may employ diverse innovative techniques for problem solving.

Continuous addition to the knowledge capital of the firm is essential for it to remain ahead of its competitors. For continued knowledge generation, a manager can use three distinct governance choices. These governance strategies are called as *markets, authority bases hierarchies* and *consensus based hierarchies*. <sup>6</sup>

#### 2.3 Combining resources and activities.

In the above section we have identified that value is created by the firms when activities are performed on resources. Now we look at the different ways how this can happen.

#### 2.3.1 The value chain, the value shop and the value network

The value chain concept was put forward by (Porter, 1985). The value chain has existed as a concept and a tool from a long time and has framed our thinking about value and value creation. (Peppard & Rylander, 2006). It analyses the value creation process of the firm in terms of the activities which a firm performs. The value chain identifies the activities of the firm and then studies the economic implication of those activities. (Amit & Zott, 2001). The value in the term *value chain* is the amount the consumer is willing to pay for the product or service being offered by the firm. The activities in the value chain model can be divided into two types, primary activities and secondary activities. The activities which are directly involved in value creation are called primary activities. Secondary activities are not directly involved in value creation, but are important for the firm as they affect the performance of the primary activities.

Value is created in a value chain by the continuous improvement of the resources at every step of the value chain. At each step, the use value of the resource (in the eyes of the customers) is enhanced.

The sources of value creation in a value chain are: (Amit & Zott, 2001)

- The kinds of activities which the firm performs. How are these activities performed
- Linkages of these activities
- Timing of these activities

<sup>&</sup>lt;sup>6</sup> For more on governance choices refer to (Nickerson & Zenger, 2004)

- Location of these activities
- Sharing of the activities among the business units
- Learning
- Integration
- Scale and institutional factors.



Figure 7: The Value Chain

The value chain is a special case of the value creation logic of a firm. (Stabell & Fjeldstad, 1998). The other forms of value creation are value shop and value network. According to the value chain value is created by sequentially performing the primary activities.

Firms can select, combine and apply resources and activities (to produce value for the customer) depending on the need of the customer. A firm which produces value in this way is called a value shop. The primary activities of the value shop are

- Problem finding and acquisition
- Problem Solving
- Choice
- Execution
- Control and Evaluation

In a value network, the firm creates value by 'linking customers or clients which are or wish to be independent'. (Stabell & Fjeldstad, 1998). The primary activities of a value network are

- Network Promotion and contract management
- Service provisioning,
- Network infrastructure operations.

The above configurations focus on the value creations at the firm level and falls short in capturing the value creation process of today's business. This is so because in present markets, firms seldom create value solely on their own. *"In so volatile a competitive environment, strategy is no longer a matter of* 

*positing a fixed set of activities along a value chain"* (Normann & Ramirez, 1993). The focus of strategic analysis of successful firms is the whole value creating system consisting of actors, suppliers, business partners, allies, and customers – work together to co-produce value.

#### 2.3.1.1 The Virtual Value chain

Companies today do not just compete in the physical world but also in the information world. The physical world is called the *market place* and the information world as the *markets pace*. (Rayport & Sviokla, 1995).

The value chain concept, (Porter, 1985) does not perceive information as a source of value creation. It considers information as something which facilitates the value creation process, but is not an input for it (Rayport & Sviokla, 1995). In todays' world the dynamics of the competition has changed. Major competitive advantages of firms are solely derived by firm activities in the market space, making information a key asset. For example, a website which lets you choose the best holiday package (or a tailored holiday package) depends heavily on the information of all flights, hotels, travel agents and popular tourist destination. Its competitive advantage depends on how well it is able to manage and use this vast amount of information, much of which is stored in severs around the world.

Rayport & Sviokla (1995) put forward the concept of a *virtual value chain*. The virtual value chain can be a mirror of the physical value chain of the firm, but the process which produce market space services and products out of information are unique to market space. Creating value in any stage of the virtual value chain involves a sequence of five activities: gathering, organizing, selecting, synthesizing and distributing information. (Rayport & Sviokla, 1995).

#### 2.3.2 Value creation in a network

With the advent of IT and shift towards a service oriented economy, firms can be seen to operate in increasing dynamic environment, where their success depends how well they are to adapt and embed themselves in it.

Activities of one firm, affect those of the other firms in the environment and in term get affected themselves. Porter value chain applicability has diminished in the current economic world because firms and their value creating logic have undergone a mammoth change from what they were when the Value chain was proposed by Porter. The main change in present market is that value is co-created, there exists multiple suppliers, and final products are a combination of tangible and intangible subparts.

The concept of value chain has given way to a value network (Normann & Ramirez, 1993). In the old value creation logic, only tangible resources were shown to have value and profit depended on specialization of work, division of labor and economies of scale. But the state of economy as it exists today is very much different. Profit of firms is dependent on value co creation, relationships with firms, sharing of resources and activities, flexible organization structure and boundaries. This has caused not only a change in what is perceived as valuable by firms but a change in the entire value creating system.

#### 2.3.2.1 The Value Network

As mentioned above firm create value, with supplier, customers, other firms and even sometime competitors. Globalization, increased IT usage and informed customers have shaped the market in such a way that it impossible for a firm to own every resource or capability which is used for creating value to customers. The traditional model of an industrial economy, where firms acquire resources from suppliers and produce products for customers stands somewhat outdated in the current economic situation.
This network in which a firm operates has become an important and integral part of strategy formulation for firms. As Normann & Ramirez (1993) stated "focus of strategic analysis is not the company or even the industry but the value creating system itself, within which different economic actor-suppliers, business partners, allies, customers –work together to co-produce value".

A value network can be defined as "any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social good." (Allee, 2008)

Just as a network is outside a firm, there exist also a value network inside the firm. Different department, unit and roles work together to support each other and create value for the customer. Different departments and units have different roles assigned. For e.g. the marketing department needs the help of the finance department and the IT department aids almost all the departments in their processes.



Figure 8: A Value Network

## 2.3.2.2 How are firm in a value network connected?

The firms in a value network are connected via exchange of intangible or tangible value. The exchange of assets is what binds the actors in a network. The assets which are exchange is beneficial for both the actors. As (Bowman & Ambrosini, What does value mean and how it is created, maintained and

destroyed ?, 2003) pointed out, in an exchange, one firm get *use value* via the exchange of something which has *exchange value*.

Since *exchange* is the primary process through which value is realized, firms in a network are held together by the medium of an exchange

"The participants in a value network, either individually or collectively utilize their tangible or intangible asset base by assuming or creating roles that convert those assets into more negotiable forms of value that can be delivered to other roles through the execution of a transaction" (Allee, 2008).

Exchange is the primary mechanism through which potential value becomes realized. Furthermore, exchange serves as a primary if not the only vehicle or mechanism through which any of the value that is inherent in the allocation of resources to their highest and best use is ever realized in any economic value.

## 2.3.2.3 The e-3 Value model

E-3 value model (Gordijn & Akkermans, 2003) usually referred to as e-3 value, is a well-established modeling technique which explains value creation of a firm from a network perspective. E-3 value shows that firms create value in a network by exchanging things of economic value with other firm. This model was originally proposed to gauge the feasibility of e-commerce ideas and new ventures, but has been applied to a lot of diverse industry, like healthcare and banks (Kinderen, Gaaloul, & Proper, 2012a) and has provided accurate results. E-3 value shows the value creation logic of a firm from the *Value viewpoint*, which is at the highest level abstraction (Gordijn & Akkermans, 2003) and shows the way economic value is created, exchanged and consumed in a network. The other viewpoints are Process Viewpoint and Information systems viewpoint.



*Figure 9: The different abstraction levels* 

The concepts involved in an e-3 value model are described below:

1) Actor: an actor is defined as an independent economic or legal entity in the network which is capable of independent existence in the network.

2) Value object: the value object is anything which an actor considers valuable. It can be a good, a service or money.

*3)* Value port: Through a value port a firm request or offers the value object. The value port is used to provide an abstraction from the process level of the firm.

4) Value offering: An offering is a set of equally directed value ports. The exchange of value objects via ports in an offering is atomic; all ports exchange an object or none at all. (Gordijn & Akkermans, 2003)

5) Value interface: A value offering is composed of one or more ingoing/outgoing value offerings. The value interface has the concept of economic reciprocity and can model that an actor is willing to offer something of value to its environment but requests something in return.

*6) Value exchange:* A value exchange is used to connect two value ports with each other.

7) Market segment: A market segment is a concept that breaks a market (consisting of actors) into segments that share common properties. The market segment shows a set of actors that for one or more of their value interfaces value objects equally from an economic perspective.

8) Composite actor: A composite actor clusters value interfaces of other actors. The composite actor has its own value interfaces. This grouping of actors is used to show a *value constellation* and also represent partnerships

9) Value activity: Value activity is collection of operational activities which are performed by an actor.

The e-3 value is at highest level of abstraction of the value creating process of the firm. It is above the business process view and the information systems view of the value creation.



Figure 10: A simple e3 value model

The figure above shows a simple e3 value model. In the model the actors are Buyer, Seller and Tax Office. The value objects exchanged between the actors are, Payment, Goods, VAT and Legal Compliance.

## 2.3.3 Summary

In the above sections i.e. from Section 2.1 to Section 2.3, different perspective of the value creation process of firms is presented. Firms require resources for value creation. These resources are either owned by the firm itself or acquired by from partner, suppliers. The combination of resources and the performance of activities can be in the form of a chain, depending on the customer or in such a way as to provide a match between consumers.

Also, firms do not create value in isolation, they co create value in conjunction with different entities in the network. (Fatemi, Sinderen, & Wieringa, 2009) (Cavusoglu, Al-Natour, & Cavusoglu, 2011)

The models presented above model the value creation of firms at the business strategy level. These model should also be mirrored in the process level of the firm. The level of details at the process level of the firm will be greater than the business level.

## 2.4 What ArchiMate element represents value?

## 2.4.1 ArchiMate – Introduction

TOGAF <sup>®</sup> is a widely accepted framework for Enterprise Architecture, and is endorsed by The Open Group <sup>®</sup>. Similarly, ArchiMate <sup>®</sup> is the most widely accepted language for enterprise architecture

modeling and is also endorsed by The Open Group<sup>®</sup>. ArchiMate is a lightweight and scalable modeling language "which offers an integrated architectural approach that describes and visualizes the different architectural domains and their underlying relations and dependencies" (The Open Group, 2012)

## 2.4.1.1 Elements and Layering

The ArchiMate metamodel is shown in the figure below. It consists of three types of elements: active structure elements, passive structure elements and behavior elements. These three types of elements are related the same way as the parts of a sentence i.e. subject (active structure element), object (passive structure element) and a verb (behavior element) (The Open Group, 2012). The active element performs an action on the passive element, which is shown by the behavior element.



Figure 11: A Generic Metamodel of ArchiMate

There would be a lot of structural and behavioral element is a firm and it is necessary to divide them based on their specializations and scope. The concept of *layers* is in ArchiMate to do just that. The elements are divided across three different layers i.e. Business Layer, Application Layer and Technology Layer. The elements in the technology layer provide the necessary infrastructure to run applications, which in turn realize the service and products offered to the customers. Following figure explains this concept.

	Business	
	Application	
	Technology	
Passive structure	Behavior	Active structure

Figure 12: Architectural Framework of ArchiMate

#### 2.4.1.2 Relationships

Next to the elements, ArchiMate has a set of *relationships* to show how the elements interact with one another. Many of these relationships (composition, aggregation, association and specialization) have been motivated from UML while other (triggering) from business process modeling languages. Each relationship in ArchiMate can be read in both directions depending upon from which side of the relationship we are analyzing. This can also be seen in the ArchiMate metamodel in Figure 11.

Moreover, the relationships in ArchiMate have also been assigned *weights* which are an indication of how strong a particular relationship is as compared to another. The composition relationship is said to be the strongest and the association relationship is the weakest.

Further detail about the bi-directional nature of ArchiMate relationships and the weight attached to them is discussed in section 3.2.2

#### 2.4.2 ArchiMate 2.0

ArchiMate 2.0 specification is the latest version of ArchiMate, which was released in July 2012 and has been used to for this research. Two optional language extensions were added to the ArchiMate framework in this latest release: <sup>7</sup>

- a) Motivation Extension was included to "provide the context or reason lying behind the architecture of an enterprise" (The Open Group, 2012) . The concepts in the motivation extension are Stakeholder, Driver, Assessment, Goal, Requirement, Constraint, and Principle. Relationships can be used between two motivational concepts or one motivational concept and one core element. The relationships are, Aggregation, Realization and Influence. Motivational Elements are related to the core elements via requirement or constraint concept. Below we enumerate definitions of the concepts in the motivation as given by The Open Group.
  - Stakeholder a stakeholder is defined as the role of an individual team, or organization (or classes thereof) that represents their interests in, or concerns relative to, the outcome of the architecture.
  - 2. *Driver* a driver is defined as something that creates, motivates, and fuels change on an organization.
  - 3. *Assessment* an assessment is defined as the outcome of some analysis of some driver.
  - 4. Goal a goal is defined as an end state that a stakeholder intends to achieve.
  - 5. *Requirement* a requirement is defined as a statement of need that must be realized by a system.
  - 6. *Constraint* a constraint is defined as a restriction on the way in which a system is realized.
  - 7. *Principle* a principle is defined as a normative property of all systems in a given context or the way in which they are realized.

<sup>&</sup>lt;sup>7</sup> for more on relationship between extension and core elements refer to ArchiMate 2.0 specifications



Figure 13: Metamodel of Motivation Extension

b) Implementation and Migration Extension – was included to "support program, portfolio and project management" and "migration planning". The concepts in the Implementation and Migration Extension are Work Package, Deliverable, Plateau and Gap.

Each concept can be associated with a core element. Relationships for this extension are the same as specified in the ArchiMate core.

Below we enumerate the definitions of the concepts in the Implementation and Migration extension as given by The Open Group.

- 1. *Work Package* a work package is defined as a series of actions designed to accomplish a unique goal within a specified time.
- 2. *Deliverable* a deliverable is defined as a precisely-defined outcome of a work package.
- 3. *Plateau* a plateau is defined as a relatively stable state of the architecture that exists during a limited period of time.
- 4. *Gap* a gap is defined as an outcome of a gap analysis between two plateaus.



Figure 14: Metamodel of Implementation and Migration Extension

## 2.4.2.1 Representing Value in ArchiMate.

When determining the value to an object, one should be clear about the context because the value of a thing is dependent on the stakeholder. (Lepak, Smith, & Taylor, 2007) This follows directly from the definition of value in Sec 2.1.3 where it is defined as *"the perceived quality of a tangible or intangible things"*. The word perceived is used to emphasize the heterogeneous nature of value. Value is shown as a result of need and since the need of a person (firm or department) can be very different from another, whether something is valuable (or not) will depend on the need of the person (firm or department).

For example, a database of prospective customers is valuable to an Insurance company (more specifically to the marketing department). Based on this database the marketing department will make calls for increasing the customer base and thus increasing the profit. Nevertheless, this database is of no use to a customer who comes to the Insurance Company for a policy. What is valuable to the customer is only the Insurance policy.

The *value* element present in ArchiMate (in the business layer) captures the use value the business service/product offers to the consumer. It is an informational concept and is attached to a service. Taking the Archinsurance case (Jonkers, Band, & Quartel, 2012) as an example the value of *Insurance policy* to the consumer can be modeled in ArchiMate. There also would be application services like, *billing service* or software (database software) in the firm would make it possible for the company to deliver the service, *Insurance Policy*. In this case, the *billing service* is a value creating activity, and the software becomes a resource, and both are components of a value flow. When looked into isolation, the inherent value of these elements (use value) will be difficult to state.

lacob et al (2012) observed that, *value must be present in all architecture layers and it propagates through the architecture until, eventually, it is translated in business value at the business layer*. (lacob, Quartel, & Jonkers, 2012b). Following this, they suggested an extension of definition of value in ArchiMate metamodel such that *value* can be associated with any core concept, the goal concept and the work package concept as indicated in Figure 15 below.

Some research has already been done to incorporate the concepts of strategy, business value and business model in ArchiMate. Kinderen et. al., (2011) had shown conceptual analogies between e3 value model and ArchiMate and also brought out the differences between them. Later, Kinderen et. al. (2012), with the use of DEMO, showed model transformation from e3 value to an ArchiMate model. lacob et. al. (2012b) proposed and extension of ArchiMate "to support the modeling of business strategy concepts". Fritscher & Pigneur (2011) and lacob. et. al. (2012a) have explored the idea of

mapping *Business Model Canvas* and ArchiMate, which is explained in detail in the following subsections.

These studies are aimed to bridge the gap between business strategy which drives the organization and the E.A, which models the way strategy and organization objectives are realized. The table below shows previous researches based on this notion and the techniques used.

	Mapping of	Technique	Result
lacob. et. al. (2012b)	Value and Strategy	Investigative	Proposed extension of ArchiMate
Engelsman et. al. (2011)	Business Goals and Requirement	New language	ARMOR
Kinderen et. al. (2012)	e-3 value	Transaction Modeling	Transformation ontology
Kinderen. et. al. (2011)	e-3 value	Investigative	Mapping
lacob et. al. (2012a)	ВМС	Investigative	Transformation Ontology
(Fritscher & Pigneur, 2011)	вмс	Investigative	Additional Concepts added to ArchiMate
Janssen et. al. (2005)	e-3 value	Mapping	Analogies between e-3 and ArchiMate

#### Table 2: Previous works on Value Modeling and ArchiMate

## 2.4.2.2 Resource and Capability in ArchiMate

lacob et. al., (2012b) proposed an extension of ArchiMate with strategy and "value related concepts" which included the concepts of *resource* and *capability*. A metamodel of the proposed extension and the relationship with the core elements is presented below.



#### Figure 15: Resource and Capability in ArchiMate

The *resource* concept is defined as, "a person, (information) asset, material and/or capital owned or controlled by the organization". The resource is realized by structure elements and as such we can regard it as an abstraction of structure element. (lacob & Jonkers, 2012c). The use value of resources is realized by their contribution towards a Capability.

**Capability** is defined as the ability of a structural element to perform activities that would contribute to the achievement of its objectives, especially in relation to its overall mission. *Capability* is realized by a behavior element, which is defined as 'a unit of activity performed by one or more active structural elements'.

The above concepts of resources and capability are similar to those of operand and operant resources respectively, as used in marketing and service science literature. (Iacob & Jonkers, 2012c). The behavior elements of ArchiMate are operant resources, according to service science logic, which focuses on the action of *'operant resources'* i.e. those which upon other resources. In service science logic, "value results from the beneficial application of operant resources, which are sometimes transmitted through operant resources and goods." (Vargo, Maglio, & Akaka, 2008)

## 2.4.2.3 Business Model Canvas and ArchiMate

The Business Model Canvas (BMC) and ArchiMate are at different level of abstraction. While the BMC is at the strategic layer, ArchiMate is at the operational level / process level of the firm. A conceptual mapping of between the Business Model canvas and ArchiMate was presented by lacob et. al (2012a). The mapping between the 9 building blocks of ArchiMate are mapped to the ArchiMate elements. It is shown in the figure below.



Figure 16: Mapping between Business Model Canvas and ArchiMate by Iacob et. al. (2013)

Fritscher & Pigneur (2011) investigated the similarity between Business Model Canvas and ArchiMate in their pursuit for making EA closely aligned to Business Models. They are of the view that since Business Model Canvas describes business models therefore most of its elements can be compared to the business layer of ArchiMate. Below we mention some other important findings of the authors.

- The topmost layer of ArchiMate i.e. the business layer corresponds to *Customer Segments* and *Partners* in the case of Business Model Canvas.
- There is not distinct layer in ArchiMate to map the concepts like *costs* and *revenue*.
- Some of the key resources of ArchiMate technical layer might emerge as *key resources* in the business model canvas of a firm.
- Similarly, the application services in the application layer of ArchiMate can be some of the key activities in the business model canvas of the firm.

Overall, Fritscher & Pigneur (2011) concluded that there is weak correspondence between Business Model Canvas and ArchiMate. They also proposes a detailed classification of IT infrastructure by using



the IT services framework. The IT services framework provides a more "business oriented view of enterprise architecture" and aligns the business vision of the firm with the strategic IT considerations.

Figure 17: Correspondence between BMO and ArchiMate by Fritscher & Pigneur (2011)

## 2.4.2.4 Value modeling and ArchiMate

We have now seen that the structural elements and behavior elements in ArchiMate are operand resources and operant resources respectively. ArchiMate is focused on the representation of the operational information and IT infrastructure and it can be difficult to model every resource used in value creation, e.g. Skills, financial resources, patent, knowledge etc.

Still, it can be argued that a mapping must exist between such a resource and a behavior element in an ArchiMate EA, since the resource would be used by in value creation. That is why the resources is useful to the firm. This kind of mapping will be based on intuition, experience and expertise of a manager.

For e.g. suppose a firm allows its customer to order books online and has a warehouse where books are stored. There will be an IT infrastructure in place which will make the ordering and delivery of books possible. How are these books will be represented it the architecture? They can be present as a *Data Object* (list in a database) and stored in a server. Also there will be a business process like *Update Product List* via which they become a part of the value creation process.

By relating every structural element and behavior element which directly or indirectly realizes a service we have *a value flow* inside a firm. This value flow will show us which resources (owned or acquired) by the firm are used, are worked upon by which operant resources, undergo changes in different organizational units to finally become a value proposition.

Another concern of *value modeling* is to model the resources acquired from the network. These resources can be very diverse and might influence behavior elements in all three layers.

## 2.5 Value Networks and ArchiMate

## 2.5.1 Network concepts and ArchiMate

ArchiMate gives the opportunity of modeling network features by its elements. There are ArchiMate elements which can represent the interaction of a firm with other firm with which it is connected in a value network.

The different entities in the network can be represented as Business Actors (Janssen, Buuren, & Gordijn, 2005), which is defined as "an organizational entity that is capable of performing behavior". Any work or action which the firms accomplish together can be represented as the *Business Collaboration* element. Similarly, the collaborative action of firms the IT process level can be modelled using the *application collaboration* element.

**Business Collaboration**: An aggregate of two or more business role that work together to perform collective behavior.

**Application Collaboration**: An aggregate of two or more application components that work together to perform collective behavior.

## 2.5.2 e-3 value and ArchiMate

There has been previous research on the integration of e-3 value and ArchiMate. (Janssen, Buuren, & Gordijn, 2005) (Kinderen, Gaaloul, & Proper, 2012a) (Kinderen, Gaaloul, & Proper, 2012b).

Janssen, Buuren, & Gordijn (2005) stated that there are strong conceptual analogies between e-3 value and ArchiMate and provided a conceptual mapping between the two. The authors were of the view that the mapping between the two concepts is promising and should be explored further. It can help to provide a method for transformation of business case to process and system architecture level and provide a more concrete basis for justifying or nullifying their profitability.

Kinderen, Gaaloul, & Proper (2012b) compared the concept of e3 value and ArchiMate and made the following observations.

- The concept of an *Actor* in ArchiMate is broader than that of an actor in e3 value. While an actor in e3 value is an economically viable unit and has a profit-loss responsibility, in ArchiMate, an actor can be any unit which executes a function.
- The concept of service in e3 value is at a higher level of granularity than the concept of a service in ArchiMate. The authors were of the view that the difference in the meaning of service in e3 and ArchiMate has to be explored further and must be taken into account by any future model integration efforts.
- A business object in ArchiMate does not necessarily translate to a value object in e3 value model.
- There is difference between the concept of *value activity* in e3 value model and that of a business function in ArchiMate. An "e3 value activity maintains value as a main criterion, whereas an ArchiMate business function does not".
- Due to its operational nature, ArchiMate does not have the concept of economic reciprocity, which is central to e3 value.

• It is better to map e3 value models and ArchiMate EA model manually, so as to avoid and approximation of mapping.

Kinderen et. al. (2012) used DEMO as an *ontology alignment technique* between e-3 value and ArchiMate. *DEMO (Design and Engineering Methodology for Organization) is a method comprising of a comprehensive set of conceptual modelling techniques, in combination with a theory-based-way of thinking and associated way of working focused on modelling/analyzing/designing the essential aspects of an organization.* (Kinderen, Gaaloul, & Proper, 2012a).

The concept of e3 value were first mapped to the DEMO meta-model elements. Then, these elements were mapped to ArchiMate elements, as shown by the figure below.



Figure 18: Mapping e3 value to ArchiMate using DEMO (Kinderen et. al. 2012)

In the tables below show the mapping achieved by the above transformation technique.

e-3 value	Demo	ArchiMate
Actor/Market Segment	Subject	Business Actor
Value Object	Fact	Business Object
Value Activity	Transaction	Business Interaction
Value Interface	-	
Value port	-	
Value exchange	-	
	Actor	Business Role
	Act	Business Event, Business Behavior

#### Table 3: Conceptual Mapping between e3, DEMO and ArchiMate

From the previous work on the integration of e3 value and ArchiMate some basic points have been learned. Firstly, there is a wide conceptual difference between e3 value and ArchiMate. While e3 value models the value flows between actors in a network, ArchiMate, basically model the business processes and the IT infrastructure of a firm. Secondly, although there are some similarities between them (Janssen, Buuren, & Gordijn, 2005) yet the concepts of e3 value should not be directly mapped to ArchiMate elements.

# 3. Developing a methodology to model value creation

This chapter corresponds to activity 3 of DSRM, i.e. Design and Development, and forms the core of this research. The aim of this chapter is twofold.

- Answering the research questions
- Development of the artifact

First, in Sec 3.1 below, a framework of value creation at process level is developed based on the literature survey done in Chapter 2. Then this framework is used to answer, the research question in Section 3.2. As a part of the answering the questions an algorithm is presented which allows tracing a value proposition of a firm to the resources/assets it uses (in terms of ArchiMate).

The artifact is developed to solve the problem explored in Chapter 1, meeting the objectives stated Section 1.2.2. The artifact here is a methodology to model the value creation by a firm using ArchiMate. In Section 3.3 this methodology is developed based on the answers to the research questions.

## **3.1 Value creation at process level**

The value creation logic of a firm at strategic level is shown by business models. Using a business model a firm gets an overview of its operating logic, critical activities, network actors and resources. For example, using the e-3 value model (Gordijn & Akkermans, 2003), a firm can depict the economic values it trades with the other actors in the network and uses it to make a value proposition. Similarly, by using the business model canvas (Osterwalder, 2004) a firm gets an overview of the 9 building blocks of its business.

'Business models are economic models used for business analysis, while process models capture lowlevel business activities and their coordination' (Andersson, et al., 2006). Although, there is a conceptual gap between them, yet business models and process models describe the same situation. (Pijpers & Gordijn, 2008). They are at different levels of abstraction and thus have different perspectives of the business of a firm.

But, what is the basis for a process manager to model value creation at the process level? **No clear answer is found in literature for this question, which shows at there is a need to model the value creation logic (expressed in the strategy) at the process level.** These two domains, i.e. strategy domain and process domain, are at two different levels of abstraction (at the business level and at the process level) should reflect each other and be complementary since they describe the same system.

Two characteristics of a value creation process at the process level should be kept in mind. Firstly, it is current snapshot of the internal mechanism of the firm by which it creates *value*. Secondly, there is no time dimension in the process, as it intends to shows the logic of value creation and not the sequential steps. We propose that at the process level 3 building blocks of Osterwalder business model should be shown. They are *Key resources, Key Activities and Value Propositions.* Other building blocks are not suitable to be shown at the process level. This is consistent with the finding of Fritscher & Pigneur (2011) as shown in Section. 2.4.2.3

At the process level of analysis, a firm's processes can be divided into two kinds based on the value they create.

• **Direct Value creating processes:** processes which directly create a service or product of value. This *value* of the product is with respect to the customer. Let these processes be called VCP-D • Indirect Value Creating Processes: process, whose output is of no value to the customer for e.g. data, coordination etc. These processes also create value but this *value* is w.r.t to the firm, as the output of these processes is used by the firm in realizing customer value. Examples of these processes are sales, marketing etc. Let these processes be called VCP-I

This classification of processes is based on the value output of the process. Below another classification of process is given presented, based on the actions which the process performs. This classification of process is 'well known in both business science and business process/requirement engineering literature'. (Gordijn & Wieringa, 2003)

1. Primary process, which directly contribute to the satisfaction of consumer needs. This includes processes performed in the steady state, as well as ex-ante processes such as supplier selection and service subscription, and ex-post processes such as dispute resolution or service unsubscription.

2. Support processes, which enable execution of primary processes and provide a suitable working environment.

3. Management process, which organize, staff, direct and monitor primary and support processes.

On type of work	Value produced for	On type of value
Primary process	Value for the customer	VCP - D
Support process	Value for the customer	VCP – D or VCP - I
Management Process	Value for the firm itself	VCP –I

In the table below a mapping is presented between the types of process w.r.t value.

#### Table 4 : Classification of Processes



Figure 19: Process and Value

The above figure shows the relationship between *Value (for the customer)* and the individual processes (of the firm) which create value. Here, Process A and Process B are Primary Processes and Process C is a Support Process.

Each process is actually a composition of *activities* or tasks (Gordijn & Wieringa, 2003). The work accomplished by these activities together make up the process which fulfills a goal and thus *value* for the customer or firm. Each type of process stated above can be decomposed in terms of activities. For performing these activities a firm needs *resources*. These resources are either owned by the firms or acquired from the network. The resources provide the necessary inputs for performing the activities.



Figure 20: The value creation framework

The above figure<sup>8</sup> explains the relationship between *Value, processes, activities* and *resources.* This figure points towards a **bottom up flow of value** and helps in understanding the flow of value in a firm. This value flow can be better understood, keeping in mind the definition and the concept of value as defined in Section 2.1.



Figure 21: Value flow in a firm

<sup>&</sup>lt;sup>8</sup> The figure is motivated from the figure of process hierarchy by (Gordijn & Wieringa, 2003)

## 3.1.1 The value creation triangle

Based on the relationship presented above between resources, activities and processes, different aspects of value creation process of firms can be better understood. There exist different dimensions of value creation at the strategy level, e.g. revenue, customer relationships, actors in the network etc. A value creation model of the firm at the process level must address only those dimension which are significant at the process level. The questions which should be answered by a value model at the process level are as follows.

- 1. What is the process creating?
- 2. Which activities are performed in this process?
- 3. Which resources are required for this process?



#### Figure 22: Question to be answered by Value Creation Framework at process level

Each question above represents a certain dimension of value creation process at the process level.

In the table below a mapping is provided between the dimension stated above and the some constructs of business models.

	Osterwalder (2004)	Bowman And Ambrosini (2003)	Value chain (1985)	e-3 value model (2004)
What is the process creating?	Value Proposition	Use Value for consumer		Value offering
Which resources are required for this process?	Resources	Inputs		
Which activities are performed in this process?	Activity	Five kinds of activities	Primary Activities Support Activities	Value activity

Table 5: Mapping between the value framework at the process level and business models

## 3.1.2.1 Concepts of value creation framework

In this subsection the three dimension of the value creation framework have been explained in more detail.

**1. What is the process creating (Motive of process)** – The end product of a process is a tangible or intangible service or product having *value*. In the case of a *Primary Process*, this value is with respect to the consumers and consists of a product, service, and experience. The end product of a *Support process* can be valuable to the firm or to the customer. In the case of a management process it is valuable w.r.t to the firm.

**2. Which Resources are required for the process**– The resources have use value for the firm and they are used to create new use value for the customers. Resources which are used in the value creation process are broadly divided into two types, Owned by the firm and Acquired from the network. Examples of resource are money, machines, knowledge, expertise, goods and services.

- Owned by the firm: those resources which are possessed by the firm. An addition is made to the classification of the key resources as put forward by Osterwalder (2204). As suggested by the Virtual Value chain view (Rayport & Sviokla, 1995) information should also be a form of key resources as it can also be a source of value creation. It is important since the key resources as put forward by Osterwalder cannot be mapped to the key resource of a virtual value chain, information.
- Acquired by the firm: Firm do not create value in isolation (Cavusoglu et. al., 2011). Instead, they function in a complex environment, where objects (tangible or intangible) of economic value are traded and value is co-created. Apart from the traditional resources view (i.e. physical, human, financial, intellectual and information) capabilities can also be treated as resources (operant) when acquired from the network.

The acquired resources by a firm from the network are shown in the figure below and can consist of resources as well as activities. These resources and activities will be the leaf nodes of a Process Hierarchy.<sup>9</sup>

<sup>&</sup>lt;sup>9</sup> For more on process hierarchy refer to (Gordijn & Wieringa, 2003)



Figure 23: The resources acquired by a firm from the network

**3. Which activities are performed in the process** – A firms perform different kinds of activities as shown in section 2.2.1.1. Of these activities only those activities should be included in a value creation framework that are involved in realizing a value proposition. Different activities come together to make a processes, and different processes come together to realize *value* by fulfilling a goal or need.

In terms of value and in light of the definition of value (Section 2.1.3), resources and activities have use value for the firm. The value created by the process can have use value for the customer (in case of primary or supporting processes) or the firm (in case of management processes).

## 3.2 Objectives of the artifact.

Having built the required theory in Chapter 2 and the value creation framework for in the previous sub section i.e. 3.1, we now are set to answer the Research Questions.

The objective of the Research is to build a methodology for modeling value creation in a firm and is achieved by answering all the research question. The objective of the artifact are described in the table below.

The objectives of the methodology must be clear and explicit. It is these objective which will be used to evaluate the artifact in Chapter 6.

	Solution objective	Solution Description	
1.	The methodology should be practical and can be applied to real cases by practitioners.	The motive to the methodology is to reduce the gap between <i>strategy formulation</i> and <i>strategy</i> <i>implementation</i> and thus the methodology should be such that it can be applied by practitioners. Simplicity and lightweight are important measures of practicality.	

2.	The methodology should bring out the distinction between value in use and value proposition.	The methodology should facilitate the identification of, what is valuable to a firm for value creation and what is valuable to the customer, in terms of ArchiMate elements.
3.	It should relate resources and activities to value proposition.	By showing the processes, resources and activities related to a value proposition, the methodology should be able to show the value creation process.
4.	It should be able to model value captured from the network	It should to be able to model the resources or capabilities which a firm acquires from its partners in a value network.
5.	Must improve business value alignment	The methodology should improve business IT alignment by depicting the value creation process of the firm at the process level using EA models.

#### Table 6: Objectives of the Artifact

Let's revisit the research questions stated in Sec 1.2.3. The **first** research question is, *how can ArchiMate elements be used to model value*? This question is partially answered in Sec 3.2.1 below, where ArchiMate elements are classified into resources and activities. These resources and activities have use value as they realize a value proposition. The remaining part of the question is answered in Sec 3.2.3 where a way is shown to model the resources and activities, which are acquired from the network in which a firm exists.

The **second** research question is, *how can ArchiMate elements be used to model value creation by a firm?* In section 3.2.2 an algorithm is made which traverses an ArchiMate model and relates a value proposition to the resources and activities. The result of running this algorithm is a smaller model which gives a view of the value creation process of the firm.

The **final** research question is how can an ArchiMate model be used to show the value inflow from the network? Any model of value creation would be incomplete if external value inflow in not included. Thus in Sec 3.2.3 a way is shown to include resources and activities acquired from the network in the EA model of the firm.

## 3.2.1 Identifying value elements in a ArchiMate EA model

Based on the value creation framework presented above, resources and activities both have use value for the firm because they are satisfying the need of the firm in the value creation process. The resources satisfy the requirement of the firm as necessary objects with which activities are performed. Let us then try to classify the core elements of ArchiMate based on the value creation framework presented in 3.1.

The last column of the table shows elements which can't be classified neither as resources, activity or value (the output of any process).<sup>10</sup>

<sup>&</sup>lt;sup>10</sup> Application service is exposed to the environment, and can be offered to another firm Infrastructure service is exposed to the environment and can be offered to another firm

Resource	Activity	Value Proposition	Not Included
Business Object	Business Interaction	Business Service	Meaning
Data Object	Application Function	Application Service	Value
Application	Business Function	Infrastructure Service	Location
Component			
Artifact	Application Service	Business Product	Group
System Software	Infrastructure Service		Actor
Device	Infrastructure		Event
	Function		
Network	Application		Representation
	Interaction		
Business	Business Process		Application Interface
Collaboration			
Role	Business Service		Business Interface
Application			Contract
Collaboration			
Communication Path			
Node			

## Table 7: Classification of ArchiMate elements

Based on above classifications we can now classify the resources as Physical, Human, Financial, Intellectual or Informational.

	Physical	Intellectual	Human	Financial	Information
Business Object	Х	Х			Х
Data Object					Х
Application					Х
Component					
Artifact					Х
System					Х
Software					
Device Node	Х				Х

Network	Х		х
Role		Х	
Business Collaboration			
Application Collaboration			Х
Communication Path	X		

## Table 8: Classification of Resources<sup>11</sup>

As can be seen by the classification above, ArchiMate does not have an element to model the cost, revenue any financial resources. Fritscher & Pigneur (2011) while exploring the correspondence between ArchiMate and BMO mentioned that ArchiMate lacks elements which could model explicitly model 'financial consideration like cost and revenue'.

## **3.2.2 Relating value elements of an ArchiMate EA to a value proposition.**

A particular value proposition by the firm is realized by different resources and activities. Some of these resources can be represented by ArchiMate elements as shown in the table above. The second objective of the methodology is to relate a particular business service or product (having value to the customer) to all the ArchiMate elements which have use value and which directly or indirectly contribute toward the realization of it.

As of now, no technique is present in ArchiMate, which enables the traceability of a business service or product to all elements which realize it. For achieving this traceability, an algorithm is presented in this subsection. This algorithm traverses an ArchiMate model like a *directed graph*, with ArchiMate elements as *nodes* and the relationships as *edges*. The result of applying the algorithm to an ArchiMate model is another smaller model, the value model which models the process level view of value creation.

## 3.2.2.1 Nodes

As stated above, for relating a value proposition to resources and activities, a given ArchiMate model is treated as a graph and the nodes of graph are the set of all those ArchiMate elements which are specified in Table 7 either as a resources, activity or a value. These elements together make the set N.

Resources	Activities	Value Proposition
Business Object	Business Process	Business Service
Data Object	Business Function	Application Service
Application Component	Application Function	Infrastructure Service
Artifact	Application Service	

<sup>&</sup>lt;sup>11</sup> The resources which are pointed about above are the main resources used by an IT intensive firm. As firms are increasing using IT intensively, these resources are becoming the core resources for any firm.

System Software	Infrastructure Service	
Device	Infrastructure Function	
Network	Business Service	
Business Role	Business Interaction	
Application Collaboration	Application Interaction	
Business Collaboration		
Communication Path		
Node		

#### Table 9: The nodes for the algorithm

The set **N** = {all ArchiMate element which have value in use}.

#### 3.2.2.2 Edges

Any graph is traversed with the help of edges between its nodes. The edges in this case are the relationships between the ArchiMate elements. The edges in an ArchiMate model are unique because,

1. Relationships have different weight (Buuren, Jonkers, Jacob, & Strating, 2004) which denotes how tightly two ArchiMate elements are coupled.

2. They have a bi-directional nature. Each relationship in ArchiMate can be broken down into 2 unidirectional relationships. As shown in figure 24 below, there is a realization relationship between a Business Service and the Business Function.

This relationship can be represented as two unidirectional relationships depending on the element from whose side it is analyzed as, as shown in the Figure 25 below.



Figure 24: The realization relationship in ArchiMate



Figure 25: The bi-directional nature of the realization relationship

Analyzing from the side of the Business Service, the relationship is read as 'business service is realized by the business function'. When analyzed from the Business function side, the relationship is read as

'business function realizes the business service'. In the first case, the relationship depicts the dependency of the business service on the function. The Business service is dependent on the Business function for its working and not vice-versa. The relationships which show dependency of one element on another, are used to traverse the graph. There is one exception to this rule, **the association relationship**. The association relationship does not have a bi-directional nature, as can be seen from the ArchiMate metamodel (Figure 11). Therefore, the association relationship has not been included as an edge for traversing the EA model. The table below shows each relationship and its unidirectional nature which is included in traversing the given EA model

The relationships in ArchiMate don't have the same weights but are weighted from 0 to 7 as displayed below. The relationship with the more weight (higher number) is considered more strong that the other ones. The table below has been modified version of the table used by (Buuren et. al., 2004). The two changes which have been incorporated are **a**) the association relationship has been excluded because of the lack of a bi-directional nature and **b**) the trigger and flow relationships has been included and has been assigned weights 1 and 0 respectively.

Relationship	Excluded Part	Included Part	Weight
Composition	Composes	Is Composed of	7
Aggregation	Aggregates	Is an aggregation of	6
Assignment	Performs	Is performed by	5
Realization	Realizes	Is realized by	4
Use	Is used by	Uses	3
Access	Is accessed by	Accesses	2
Trigger	Triggers	Is triggered by	1
Flow	Outflow	Inflow	0

Table 10: ArchiMate relationships and their weights

The relationships in under the heading, *Included Part*, together make the set *E*.

## The set **E** = {all unidirectional ArchiMate relationships which show dependency}.

#### 3.2.2.3 Specifications

An ArchiMate element is treated as a node of a graph and has five attribute fields, namely Name, Type, Parent, Relationship and State as shown in figure below.



Figure 26: The attribute fields of a node

*Name:* Name of the element in the ArchiMate model. For e.g. Billing Service, HP Blade.

*Type:* the type of the element. The elements can be of any type as specified in ArchiMate 2.0. For e.g. infrastructure service, application component, location or event.

*Parent:* The parent field will contain another element belonging to the set N. A *NULL* entry in the Parent field means that the element its own parent.

**Relationship:** The relationship field will contain a relationship type belonging to the set E. A *NULL* entry in the relationship field has a relationship weight equal to 8. The parent and the relationship fields will store information, only when the entity is itself not an element of set N. In all other cases these fields will be empty.

*State:* this field is there to ensure that the algorithm doesn't keep on running in a loop. Initially, the state field of all elements is equal to "not checked".

An example of an element with some of its field filled is shown in the figure below:



Figure 27: Example Values in the attribute fields

For the traversing the algorithm a stack is also required which would save the nodes which are connected to a given node. This Stack is called S.

We define a generic metamodel of any ArchiMate model for the purpose of the algorithm. The figure below represents the most generic representation of the any ArchiMate model, where X is the set of all elements, and Y is the set of all relationships in ArchiMate 2.0 respectively. Every instance of any EA made in ArchiMate is can be expressed in the form below. The algorithm for representing value flow in ArchiMate is based on this generic metamodel.



Figure 28: The most generic representation of an ArchiMate model.

The computing logic of the algorithm is to relate a given node to those nodes in the graph, on which it depends (decided by the relationship between the nodes) and carry on doing this recursively. For example let's say that, A, is the starting node for the algorithm and it is related with 4 other nodes, X1, X2, X3 and X4 as shown below. <sup>12</sup>



Figure 29: A general representation of an ArchiMate model

The algorithm first runs on node A to create a new model showing the dependence of A on X1, X3 and X4. Then the algorithm runs recursively on X1, X3 and X4.

Before the algorithm is run, the given EA model has to be prepared. Firstly, the entries in the 5 of the 5 fields of a node are initialized. The *Name* field contains the name of the element, the *Type* field contains the type of the elements. The *Parent* and *Relationship* fields are initialized to NULL. The *State* field is initialized to "not checked".

<sup>&</sup>lt;sup>12</sup> Let's assume that the direction of the arrow head shows dependency.

#### 3.2.2.4 Algorithm Code

#### Start

```
Step 1: Push the starting element into S. Create S in the new model
```

Step 2: Till S is not empty.

**Step 3:** Pop one element from S. Call it  $E_0$ . If state of  $E_0$  is not equal to "is checked" proceed further, else go to Step 2.

Step 4: For every X attached to  $E_0$  through Y

Condition 1: IF (X: type  $\in$  N) AND (Y  $\in$  E) THEN

- a) {Create a model  $E_0$ :parent $\rightarrow X$  via Y <sub>real</sub>} where Y <sub>real</sub> is the lowest weighted relationship between Y and  $E_0$ : relationship.
- b) {Push X in S if state of X is not equal to "is checked"}
- c) {X: parent = NULL, X: relationship=NULL}

Condition 2: IF (X: type  $\notin$  N) and (Y  $\in$  E) THEN

- a) {Push X in S if state of X is not equal to "is checked"}
- b) IF {E<sub>0</sub>: parent = NULL} THEN {X: parent =  $E_0$  } ELSE {X : parent =  $E_0$  : parent }
- c) IF {E<sub>0</sub> : relationship = NULL} THEN {X: relationship = Y} ELSE
  {X : relationship = Y real } where Y real is the lowest weighted
  relationship between Y and E<sub>0</sub>: relationship}

Condition 3: IF (Y∉E) THEN

a) Do Nothing

Step 5: Mark E<sub>0</sub> "is checked". Go to step 2.

#### Stop

Two assumptions have been made regarding the '*Create model*' step in Condition 1 which are as follows:

1) While making an addition in the model i.e. E0:parent -> X via Y(real), if the element X is already in the new model, then duplicate X is not created. Instead, the new relationship is made with the X, already in the model.

2) While making an addition in the model, i.e. E0 :parent -> X via Y(real), if E0:parent is NULL, then it implies that the relationship is made between E0 -> X via Y(real).

#### 3.2.2.5 Demonstration of the algorithm

An example is used to demonstrate the working of the algorithm. The ArchiMate model which is shown on the next page is used for this example. The model has been taken from the ArchiMate Training Course on 5<sup>th</sup> Dec 2012 by BiZZdesign at Amersfoort, The Netherlands.



The business service "Invoice Service", is the value proposition being offered to the consumer. We want to know what resources and activities together realize this value. The application of the Algorithm is shown below, step wise. The starting element for this example is **Invoice service**. It should be kept in mind that all elements have five fields which are initialized before algorithm is applied. The state of the stack, the attributes of the element and the resulting model (the output of the algorithm) is shown after each step.

1. The starting element is Invoice service. It is pushed to the stack 'S'. Its parent and relationship attribute are NULL. This is the first step of the algorithm. The present state of the stack is shown below. It has one element i.e. Invoice Service.



#### Stack S

2. Since S is not empty step 3 of the algorithm is executed and one element is popped out of the 'S'. It is invoice service and for further steps of the algorithm it is called  $E_0$ . Now the stack is empty and it is shown by the figure below.



3. Since the state field of EO i.e. *Invoice Service* is not equal to "is checked", the algorithm moves further. Now for  $E_0$  the EA model is referenced. It has 2 relationships. All relationships are analyzed one by one.

a) The relationship, realized by, with the business process Create Invoice, belongs to the set E.



So here X = Create Invoice and Y = is realized by. X: type is Business Process and belongs to the set N and Y i.e. *is realized by* belongs to set E. For this relationship the first condition of Step 4 is true.  $Y_{real} = is$  realized by because it is the lowest weighted relationship between E<sub>0</sub>: relationship (NULL) and Y (realized by).

X (*Create Invoice*) is put in the stack as its state field is not equal to 'is checked'. Its attributes, parent and relationship are made equal to NULL.

Also a model is created to represent the realization of *Invoice Service by Create Invoice*. The new state of the stack and the model are shown below.



New Model

b) The relationship *is used by* with the businesses process Mutate Account. Y: is used by. X: Mutate Account.



The relationship *is used by* with the business process *Mutate Account* does not belong to the set E, although X is an element of E. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made. The state of the stack and the model remain unchanged.



Stack S

4. Since all relationships of  $E_0$  are have been accounted for, control reaches Step 5 of the Algorithm. The state of Invoice Service is made equal to "is checked" and is sent to Step 2

5. Since S is not empty step 3 of the algorithm is executed and one element is popped out of S. It is business process *Create Invoice* and for further steps of the algorithm it is called  $E_0$ . The stack is empty now and it is shown in the figure below.





6. Now for  $E_0$  the EA model is referenced. It has 5 relationships. All relationships are analyzed one by one.

a) The relationship, accesses, with the business object Invoice.



Here, X = Invoice and Y = Accesses. X: type is business object. Y is an element of E and X is an element of N. The first condition of Step 4 is true.

 $Y_{real} = accesses$  because it is the lowest weighted relationship between E<sub>0</sub>: relationship (NULL) and Y (accesses). X (*Invoice*) is put in the stack as its state field is not equal to 'is checked'. Its attributes, parent and relationship are made equal to NULL.

Also a model is created to represent access of *Invoice* by *Create Invoice*. The new state of the stack and the model are shown below.





b) The relationship, accesses (writes), with the business object Customer.



Here, X = Customer and Y = Accesses. Y is an element of E and X is an element of N. According to the algorithm the first condition of the algorithm is true.  $Y_{real} = accesses$  because it is the lowest weighted relationship between E<sub>0</sub>: relationship (NULL) and Y (accesses). X (*Customer*) is put in the stack as its state field is not equal to 'is checked'. Its attributes, parent and relationship are made equal to NULL.

Also a model is created to represent access of *Customer* by *Create Invoice*. The new state of the stack and the model are shown below.



c) The relationship, *realizes* with the business service *Invoice Service*.



Here, X = Invoice Service and Y = Realizes. Y is not an element of E although X is an element of N. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made. The state of the stack and the model remain unchanged.

d) The relationship, *uses*, with the application service *Billing Service*.



Here, X = Billing Service and Y = Uses. For this relationship the first condition is true.  $Y_{real}$  = uses, because it is the lowest weighted relationship between E<sub>0</sub>: relationship (NULL) and Y (uses). X (*Billing Service*) is put in the stack. Its attributes, parent and relationship are made equal to NULL. An addition to the new model is created to represent the use of *Billing Service* by *Create Invoice*. The new state of the stack and the model are shown below.



New Model

e) The relationship is performed by, with the business role, Supporting Business Unit.



Here X = Supporting Business Unit and Y = is performed by. For this relationship, X is an element of N and Y is an element of E.  $Y_{real}$  = is performed by, because it is the lowest weighted relationship, between  $E_0$ : relationship (NULL) and Y (is performed by). X (*Supporting Business Unit*) is put in the stack. Its attributes, parent and relationship are made equal to NULL. An addition to the new model is made to represent the performance of *Create Invoice* by *Supporting Business Unit*. The new state of the stack and the model are shown below.





7. Since all relationships of  $E_0$  have been accounted for, control reaches Step 5 of the Algorithm, the state field of *Create Invoice* is marked as "is checked" and the control is sent back to Step 2.

8. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of the stack. It is the business role, *Supporting Business Unit* and for the further steps of the algorithm it is called  $E_0$ . The current state of the stack is shown below.



9. Now for  $E_0$  (*Supporting Business Unit*) the EA model is referenced. It has 2 relationships. All relationships are analyzed one by one.

a) The relationship *performs*, with the business process, *Create Invoice*.



Here, X = Create Invoice and Y = performs. Thus, Y is not an element of E, so the last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made. The state of the stack and the model remain unchanged.

(b) The relationship *is performed by*, with the business actor Shared Service Center Finance. Here X = Shared Service Center Finance and Y = performed by. Thus, X is not an element of N but Y is an element of E. So the second condition is true. X *(Shared Service Center Finance)* is put in the stack. Its parent attribute is made equal to *Supporting Business Unit* and relationship attribute is made equal to *is performed by*. No addition is made in the model. The state of the stack and the model is shown below.



#### Stack S

10. Since all relationships of  $E_0$  have been accounted for control reaches Step 5 of the Algorithm, the state field of *Supporting Business Unit* is marked as "is checked" and the control is sent to Step 2

11. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of the S. It is the business actor *Shared Service Center Finance* and for further steps of the algorithm it is called  $E_0$ . The new state of the stack is shown below.



12. Now for  $E_0$  the EA model is referenced. It has 1 relationship.

(a) The relationship *performs* with the business role *Supporting Business Unit*. Here X = Supporting Business Unit and Y = performs. Thus, Y is not an element of E, so the last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the new model is made. The state of the stack and the model remain unchanged.



13. Since all relationships for  $E_0$  have been accounted for, control reaches Step 5 of the Algorithm, the state of *Shared Service Center Finance* is changed to "is checked" and the control is sent to Step 2

14. Since S is not empty step 3 of the algorithm is executed and one element is popped out of the S. It is application service *Billing Service* and for further steps of the algorithm it is called  $E_0$ . The state of the stack is shown below.



## Stack S

15. Now for  $E_0$  the EA model is referenced. It has 2 relationships. All relationships are analyzed one by one.

a) The relationship, *is realized by*, with the application function *Billing*.



Here, X = Billing and Y = is realized by. Y is an element of E and X is an element of N so the first condition is true.  $Y_{real} = is realized by$ , because it is the lowest weighted relationship between  $E_0$ : relationship (NULL) and Y (is realized by). X i.e. *Billing is* now put in the stack. Its attributes, parent and relationship are made equal to NULL. Also an addition to the model is created to represent the realization of *Billing Service* by *Billing*. The new state of the stack and the model are shown below.





b) The relationship is used by; with the business process Create Invoice.



Here, X = Create Invoice and Y = is used by. Y is a not an element of E, so the last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made. The state of the stack and the model is shown below.

16. Since all relationships for  $E_0$  have been accounted for, control reaches Step 5 of the Algorithm, the state field of *Billing Service* is made equal to "is checked" and the control is sent to Step 2

17. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of S. It is application function *Billing* and for further steps of the algorithm it is called  $E_0$ . The state of the stack is shown below.



Stack S
18. Now for  $E_0$  the EA model is referenced. It has 5 relationships. All relationships are analyzed one by one.

a) The relationship, *realizes*, with the application service *Billing Service*.



Here, X = Billing Service and Y = realizes. Thus, Y is not an element of E although X is an element of N so the last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made. The state of the stack and the model remain unchanged

b) The relationship *is used by,* with the application function, *Change Customer Status.* 



Here, X = Change Customer Status and Y = is used by. Thus, Y is not an element of E although X is an element of N so the last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made. The state of the stack and the model is shown below.

c) The relationship *is performed by*, with the application component *Finance Application*.



Here, X = *Financial Application* and Y = *is performed by*. Here, Y is an element of E and X is an element of N so the first condition is true.  $Y_{real}$  = is realized by, because it is the lowest weighted relationship between E<sub>0</sub>: relationship (NULL) and Y (is performed by). X (*Financial Application*) is put in the stack. Its attributes, parent and relationship are made equal to NULL. Also an addition to the new model is made to represent the performance of *Billing* by *Financial Application*. The new state of the stack and the model are shown below.



The New Model

d) The relationship *uses*, with the infrastructure service *Access Service*.



Here, X = Access Service and Y = uses. Here, Y is an element of E and X is an element of N so the first condition is true.  $Y_{real}$  = is realized by, because it is the lowest weighted relationship between E<sub>0</sub>: relationship (NULL) and Y (uses). X (Access Service) is put in the stack. Its attributes, parent and relationship are made equal to NULL. Also an addition to the new model is made to represent the use of Access Service by Billing. The new state of the stack and the model are shown below.

AS	ccess ervice
Fi	nancial
Ap	plication
Cı	stomer
lr	nvoice

Stack S

60





e) The relationship, accesses, with the data object *Billing Data*.



Here, X = *Billing* Data and Y = *accesses*. Y is an element of E and X is an element of N so the first condition is true.  $Y_{real}$  = accesses, because it is the lowest weighted relationship between E<sub>0</sub>: relationship (NULL) and Y (accesses). X (*Billing Data*) is put in the stack. Its attributes, parent and relationship are made equal to NULL. Also an addition to the new model is made to represent the access of *Billing Data* by *Billing*. The new state of the stack and the model are shown below.



Stack S



New Model

19. Since all relationships for  $E_0$  have been accounted for control reaches Step 5 of the Algorithm, the state field of *Billing* is made equal to "is checked" and control is sent back to Step 2.

20. Since S is not empty step 3 of the algorithm is executed and one element is popped out of S. It is data object, *Billing Data* and for further steps of the algorithm it is called  $E_0$ . The state of the stack is shown below.





21. Now for  $E_0$  the EA model is referenced. It has 3 relationships. All relationships are analyzed one by one.

a) The relationship, *is accessed by*, with the application function *Billing*.



Here, X = Billing and Y = is accessed by. X is an element of N, but Y is not an element of E, so the last condition is true. According to the algorithm no addition to the stack or model is made.

b) The relationship, accessed by, with the application function, Mark bill payable.



Here, X = Mark bill payable and Y = is accessed by. X is an element of N, but Y is not an element of E, so the last condition is true. According to the algorithm no addition to the stack or model is made.

c) The relationship, *realizes,* with the Business Object, *Invoice*.



Here, X = *Invoice* and Y = *realizes*. X is an element of N, but Y is not an element of E, so the last condition is true. According to the algorithm no addition to the stack or model is made.

22. Since all relationships for  $E_0$  have been accounted for, control reaches Step 5 of the Algorithm, the state field of *Billing Data* is made equal to "is checked" and the control is sent to Step 2

23. Since S is not empty step 3 of the algorithm is executed and one element is popped out of S. It is infrastructure service *Access Service* and for further steps of the algorithm it is called  $E_0$ . The state of the stack is shown below.



24. Now for  $E_0$  the EA model is referenced. It has 2 relationships. All relationships are analyzed one by one.

a) The relationship *is used by,* with the application function, *Billing*.



Here, X = Billing and Y = is used by. Thus, Y is not an element of E although X is an element of N so the last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made. The state of the stack and the model is shown below.

b) The relationship *is assigned to*, with the infrastructure interface *Database access interface*.



Here, X = *Database Access Interface* and Y = *is assigned to*. Here, Y is an element of E but X is not an element of N so the second condition is true. X (*Database Access Interface*) is put in the stack. Its parent attribute is made equal to *Access Service* and relationship attribute is made equal to *is assigned to*. No addition is made in the model. The state of the stack and the model is shown below.



Stack S

25. Control reaches Step 5 of the Algorithm, the state of *Access Service* is made equal to 'is checked' and the control is sent to Step 2

26. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of the S. It is infrastructure interface *Database Access Interface* and for further steps of the algorithm it is called  $E_0$ . The state of the stack is shown below.

Financia Applicatio	l n
Custome	er
Invoice	



27. Now for  $E_0$  the EA model is referenced. It has 3 relationships. All relationships are analyzed one by one.

(a) The relationship *is used by,* with the application component *CRM application*.



Here X = CRM application and Y = *is used by*. Here, Y is not an element of E so the third condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

(b) The relationship *composes* with the node, *Database Server*.



Here X = Database Server and Y = composes. Here, Y is not an element of E so the third condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

(c) The relationship *is used by* with the infrastructure service, Access Service.



Here, X = Access Service and Y = performs. Thus, Y is not an element of E. The third condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

28. Control reaches Step 5 of the Algorithm, the state field of *Database Access Interface* is made equal to "is checked" and the control is sent back to Step 2

29. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of the S. It is application component *Financial Application* and for further steps of the algorithm it is called  $E_0$ . The current state of the stack is shown below.





- 30. Now for  $E_0$  the EA model is referenced. It has 2 relationships.
- (a) The relationship *performs* with application function, *Mark bill payable*.



Here, X = *Mark bill: payable* and Y = *performs*. Thus, Y is not an element of E. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

(b) The relationship *performs* with application function, *Billing*.



Here, X = *Billing* and Y = *performs*. Thus, Y is not an element of E. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

31. Control reaches Step 5 of the Algorithm, the state field of *Financial Application* is made equal to 'is checked' and the control is sent to Step 2.

32. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of the S. It is business object *Customer* and for further steps of the algorithm it is called  $E_0$ . The current state of the stack is shown below.



Stack S

33. Now for  $E_0$  the EA model is referenced. It has 2 relationships. Each relationship is analyzed one by one.

a) The relationship, is accessed by, with the Business Process, Mutate Account.



Here, X = *Mutate Account* and Y = *is accessed by*. Thus, Y is not an element of E. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

b) The relationship, is accessed by, with the Business Process, Create Invoice.



Here X = *Create Invoice* and Y = *is accesses by.* Thus, Y is not an element of E. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

32. Control reaches Step 5 of the Algorithm, the state field of *Customer* is made equal to 'is checked' and the control is sent to Step 2.

33. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of the S. It is business object *Invoice* and for further steps of the algorithm it is called  $E_0$ . The current state of the stack is empty.



33. Now for  $E_0$  the EA model is referenced. It has 4 relationships. Each relationship is analyzed one by one.

a) The relationship, is accessed by, with the business process, Create Invoice.



Here, X = *Create Invoice* and Y = *is accessed by*. Thus, Y is not an element of E. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

b) The relationship, is realized by, with Billing Data.



Here, X = Billing Data and Y = is realized by. Thus, Y is an element of E and X is an element of N, so the first condition is true.  $Y_{real} =$  realized by, because it is the lowest weighted relationship between E<sub>0</sub>: relationship (NULL) and Y (is realized by). X (*Billing Data*) is **not** put in the stack, because its state field is equal to 'is checked'. Its attributes, parent and relationship are made equal to NULL. Also an addition

to the new model is made to represent the realization of *Invoice* by *Billing Data*. The state of the stack remains the same. The state of the model is shown below.



New Model

c) The relationship, realized by, with the representation, Digital Invoice.



Here, X = *Digital Invoice* and Y = *is realized by*. Y is an element of E but X is not an element of N. So, the second condition is true. X (*Digital Invoice*) is put in the stack. Its parent attribute is made equal to *Invoice* and relationship attribute is made equal to *realized by*. No addition is made in the model. The state of the stack is shown below.



d) The relationship, realized by, with representation, Paper Invoice.



Here, X = *Paper Invoice* and Y = *is realized by*. Y is an element of E but X is not an element of N. So, the second condition is true. X (*Paper Invoice*) is put in the stack. Its parent attribute is made equal to *Invoice* and relationship attribute is made equal to *realized by*. No addition is made in the model. The state of the stack is shown below.



34. Since all relationships of *Invoice* have been accounted for, control reaches Step 5 of the Algorithm, the state field of Invoice is made equal to 'is checked' and the control is sent to Step 2.

35. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of the S. It is *Paper Invoice* and for further steps of the algorithm it is called  $E_0$ . The current state of the stack is shown below.



Stack S

36. Now for  $E_0$  the EA model is referenced. It has 2 relationships. Each relationship is analyzed one by one.

a) The relationship *realizes* with the Business Object, *Invoice*.



Here, X = Invoice and Y = realizes. Thus, Y is not an element of E. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

b) The *association* relationship with the meaning, *Expected Income*.



Here, X = Expected Income and Y = associated with. Thus, Y is not an element of E and X is not an element of X. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

37. Since all relationships of *Paper Invoice* have been accounted for, control reaches Step 5 of the Algorithm, the state field of *Paper Invoice* is made equal to 'is checked' and the control is sent to Step 2.

38. Since Q is not empty step 3 of the algorithm is executed and one element is popped out of the S. It is *Digital Invoice* and for further steps of the algorithm it is called  $E_0$ . The current state of the stack is empty and is shown below.

(empty)
Stack S

39. Now for  $E_0$  the EA model is referenced. It has 2 relationships. Each relationship is analyzed one by one.

69

a) The relationship *realizes* with the Business Object, *Invoice*.



Here, X = Invoice and Y = realizes. Thus, Y is not an element of E. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

b) The association relationship with the meaning, Expected Income.



Here, X = Expected Income and Y = associated with. Thus, Y is not an element of E and X is not an element of X. The last condition is true. According to the algorithm *do nothing* is executed. No addition to the stack or the model is made.

37. Since all relationships of *Digital Invoice* have been accounted for, control reaches Step 5 of the Algorithm, the state field of *Paper Invoice* is made equal to 'is checked' and the control is sent to Step 2.

38. The Stack **S** is no empty. So the algorithm stops. The resultant model after the execution of the algorithm is shown below. We call this model the **Value Model**.



The Value Model

## 3.2.3 ArchiMate models and value inflow from the network?

The 4<sup>th</sup> objective of the solution artifact is that *the artifact should be able to model value captured from the network*. This is in accordance to the last research question i.e. "How can an ArchiMate model be used to show the value acquired from the network?" This subsection is based on answering this research question.

Andersson, et al. (2006) while trying to bring business models and process models together, stated that value exchanges between business actors can be composed of resources, rights, custody and document evidence. In our model of value creation value acquired from the network consists of resources, activities or a combination of resources and activities [refer to Figure 23].

Before we proceed towards modeling values exchanges between actors in a network, three important points have to be clarified:

- 1. To model value acquired from the network the first and foremost thing is to identify the actors in the network from which resources/activities are acquired and then to enumerate, what resources and activities are acquired. For this purpose an e3 value model is used as a starting point and as a reference model for identifying the network actors and then enumerating the value (resources or activities) acquired from them. A short intro of e3 value model has already been presented in Section. 2.3.2.3. *The value object concept in the e3 value model maps to the concept of acquired resource/activity in our framework*.
- 2. Looking from the network perspective the values which we are to model is the *use value* for one firm, as it is used for performing an activity (used in value creation) while they are *value proposition* to the other firm (which offers it). In the figure below, firm A offers the value proposition to firm B.

V.P = Value proposition

U.V = Use value



*Figure 30: Value transfer between two firms* 

3. A value object as per e3 value model is defined as anything which is of value to one or more actors. It can be services, goods, money or even experiences. (Gordijn & Akkermans, 2003). This definition of a value object is as general as the definition of a resource in the resources based theory. Since our domain of analysis is at the process level, we have to better specify the value object concept.

Since e3 value model is at a higher level of abstraction than ArchiMate it is difficult to obtain a one to one or exact mapping between the value object and an ArchiMate element. This is so, because there is a wide conceptual gap between e3 value model and ArchiMate (Kinderen, Gaaloul, & Proper, 2012b). Also, an e3 value should be first transformed to a physical value model for making deriving a process model from it, as the actual exchange of value objects between firms in a network is different from those that are represented by the e3 value model (Andersson, et al., 2006). But, this transformation of an e3 value model to a physical value model is not discussed further in the text. Also such a transformation done to any e3 value model in this thesis before modeling *value exchanges* using ArchiMate elements.

# 1) Activities from the network actors which are used by a firm in value creation can be modeled as:

The activities which a firm uses from another firm can be modeled as *services* in ArchiMate. It is through services that a firm exposes it behavior and offers a capability to the environment. Thus, *services* (business, application and infrastructure) provide a good starting point for modeling acquired *use value*.

*a)* A business service – is a service that fulfills a business need for a customer (internal or external to the organization).

Modeling the value object as a business service is one way of representing it in terms of ArchiMate element. This business service can be then *used by* the business functions, infrastructure function, application function, business processes etc.<sup>13</sup>



Let's consider an example to explain the concept further. Suppose there is Insurance Company, whose marketing department performs New Customer Acquisition by three means; Online Advertising, Print Media Advertising and Cold Calling<sup>14</sup>. The cold calling function is outsourced to a *Call Center*. Here the value offered by the *Call Center* to the Insurance Company is Customer Acquisition by calling. This service has use value for the Insurance Company, as it is used for realizing the process Customer Acquisition as shown in the diagram below.



Figure 31: Modeling value acquired as a service

b) An application service - is a service that exposes automated behavior.

<sup>&</sup>lt;sup>13</sup> Refer to (The Open Group, 2012) for the complete list

<sup>&</sup>lt;sup>14</sup> **Cold calling** is the marketing process of approaching prospective customers or clients—typically via telephone, by email or through making a connection on a social network—who were not expecting such an interaction. The word "cold" is used because the person receiving the call is not expecting a call or has not specifically asked to be contacted by a sales person. A cold call is usually the start of a sales process generally known as telemarketing. [Wikipedia, <u>http://en.wikipedia.org/wiki/Cold\_calling</u> (Accessed: 18th July 2013)

The value object can also be modeled as an application service. The application service can be then *used by* the Business Process, Business Function, Business Service, Application interaction and Application function etc.



*c) Infrastructure Service* – An externally visible unit of functionality, provided by one or more nodes, exposed through well-defined interfaces, and meaningful to the environment.

Value object can also be modeled as Infrastructures services and then *used by* the Infrastructure functions, Business Function, Application Function and Business Process etc.



#### 2) Resources from the network actors which are used by the firm in value creation

*a)* Business Collaboration – business collaboration is defined as an aggregate of two or more business roles that work together to perform collective behavior.

Human resources are modeled in ArchiMate as a business actor, which has been assigned roles. When external human resources are used for performing an activity, they can be modeled as an Actor or the Role performed by the actor.



Let's take the example, of an Insurance company. The insurance company has an alliance with an intermediary firm for increasing the sale of its insurance policies. The sales agent of the intermediary and the sales manager of the insurance company together are responsible for performing the sales of the firm. Here, the *sales agent* is the acquired resource.



Figure 32: e3 model of the example

One of the ways to model the above situation, in the EA of the Insurance Company is as follows. The participating network entities is modeled as an actor i.e. Intermediary. The acquired human resources is modeled as a role, *sales agent* and the activities performed together, *Sales*, is modeled as a Collaboration.



Figure 33: Business Collaboration showing the combination of two roles from two different roles

**b)** Business Interaction – it describes the behavior of the business collaboration. It can be used to model the activities which are performed by two or more roles, together, in the network.



In the example of the Insurance Company and the intermediary above, the activity performed by the collaboration *Sales Team* i.e. *Sales* can be modeled by the Business Interaction as shown in the example below.



Figure 34: Business Interaction showing the activity performed by the Business Collaboration

*c)* Application Collaboration – An aggregate of two or more applications components that work together to perform collective behavior. The two (or more) participant application components can be from two different firms.



Let's revisit the example above. The client data is to be accessed and processed, by both the Intermediary and also by the Insurance Company. The situation is shown in the diagram below. The individual applications of the two actors together perform the required function.



Figure 35: Application Collaboration showing the combination of two roles from two different applications

**d)** Application Interaction – is a behavior element that describes the behavior of application collaboration. It can be used to model the activities which are performed by the application components of the firm together in the network.



In the example shown above, the application collaboration *Customer Administration Application* performs the activity *Customer Administration* and is modeled as shown below.



Figure 36: Application Interaction showing the activity performed by the Application Collaboration

*e) Business Product* - Physical objects which is being used by the firm. Business Products can be used by the Business Process, Business interaction and or a function (business, application or infrastructure)



Let us reconsider the above example of the Insurance Company and the Intermediary firm. Let us also assume that the intermediary firm furnishes the contact details of the new customer (to which the policy is sold)

# 3) Resources/activities which are difficult to model using ArchiMate elements.

We now turn to those values objects which are difficult to be modeled as ArchiMate elements, indicated above. Examples of such value objects can be fees (money), security, knowledge etc. For every activity in the value model a table can be created which enumerates these external value objects (resources or activities) which are required for performing that activity. Then, these value can be mapped an ArchiMate element, which uses it, as shown below.



Above, we have shown a few ways to model value exchange between the actors in a network using ArchiMate elements. These are some possible ways and are not hard and fast rules. Different process/product managers might model the same value object differently. The motive of this subsection is to incorporate value object acquired from the network so as to provide a comprehensive view of value creation.

# 3.3 Methodology for showing value creation by ArchiMate.

In this sub section, a 6 step methodology is presented to model value creation in a firm using ArchiMate elements. This subsection is an important part of the report as the artifact of the research, i.e. the methodology, is presented in this subsection. The objectives of the methodology are as mentioned in Table 6 in section 3.2

Step 1 and Step 2 are the initial step to make a basis for the application of the algorithm to a given ArchiMate model. Step 1 is necessary for relating external services (acquired resources) to the model. Step 3 relates a value proposition to ArchiMate elements which contribute to the value creation process by the application of the algorithm as shown in the previous sections. Steps 4 to Step 6 are aimed at capturing values which are not represented in the EA.

**Step 1:** The first step of the methodology is to prepare an e3 value model of the network. The motive of making such a model is **a**) to identify the actors in the network **b**) enumerate services (or products) acquired and **c**) how are these services used by the firm. A fully detailed e3 value is not an essential criterion for this step. <sup>15</sup> The acquired resources and activities are modeled in the EA model of the firm as shown in Section 3.2.3. Those which cannot be modeled are revisited in *Step 6*.

**Step 2:** From the ArchiMate model, select the service (business, application or infrastructure) or business product for which the analysis has to be done.

*Step 3:* This is the main step of the method where the algorithm is executed with the element chosen in step 2 as the starting element of the algorithm. The resultant after the step 3 will be a smaller model (w.r.t to the input model) showing elements which contribute, directly or indirectly, for the realization of a particular value proposition. It would also contain the services/resources used from the network and included in Step 1. It will include ArchiMate elements from all the 3 layers, business, application and technology. In other words, it will be *the trace* of a service or a business product in the ArchiMate model. We call this model, the **Value Model**.

**Step 4:** In the 4<sup>th</sup> step of the methodology the main processes and activities in the value creation model have to be identified. The criteria for selecting "main" processes and activities will be depend on level of analysis, the motive of analysis and the person doing the analysis.

Extracting the core capabilities from a given EA model was also indicated by lacob & Jonkers (2012c). These capabilities can be process/activities of the value creating process as shown by the value creation framework.

**Step 5:** This step is aimed at incorporating those resources (possessed by the firm) which are not modeled by a single element in the ArchiMate model but are detrimental for the value creation process. These values can be a skill of an employee or the internal structure of the company or patent rights of the firm. These values can be associated with a certain ArchiMate element or on process. For every selected process and activity in Step 4, such resources are enumerated and mapped, using an *internal value table*, as shown below.

Process/Activity	Process/Activity Resources (Use values)		Description

Table 11: An Internal Value table

<sup>&</sup>lt;sup>15</sup> See Chapter 5 for more details and an

*Step 6:* This step is for incorporating those resources and services which are acquired by the firm from the network and have not been modeled as a service. Similar to the Step 5, a table is created, called the *external value table*.

Process/Activity	Service or Resources (Use values)	ArchiMate element	Description	

Table 12: An External Value table

# 3.4 Uses of the Value Model

This section is about the potential uses of the value (creation) model described in the previous sub section. We propose that it can be used for Traceability Analysis, Cost Benefit Analysis and Sensitivity Analysis. We explain these possible uses of the value model with the help of an example case. This case is primarily based on the case presented by Schuster and Motal (2009). A simplified version of the original case is presented here.

## Case Description:

There is a Newspaper Publisher, which wants to sustain and increase its coverage by retaining its current customers and by increasing its customer base. To accomplish this, the Newspaper Publisher has started providing a monthly gift to all its current readers and to every new reader, so that they continue their subscription the Newspaper and do not start a subscription from another newspaper.

Since the newspaper does not make (or produce) gift items (and neither does it want to start doing that), it obtains them from a Gift Vendor. The gift are sent by the vendor to the office of the Newspaper, from where they are sent to the customers. The Vendor gets paid for every Advertising Gift which is delivered to the Newspaper office.

New customer acquisition is an important function of the Newspaper, which is performed by the Marketing Department. This is done in two ways. 1) By Online Marketing on the Internet and 2) By Cold Calling. Customer Acquisition via cold calling is outsourced to a Call Center. The call center transfers the details of interested customers to the Newspaper. The call center is paid a fixed amount per month by the newspaper.

The above situation is shown by the e3 value model below. The network of the Newspaper Publisher consist of the *Call Center, Vendor, Reader* (the current customers) and *Test Reader* (new customers). We also present the partial EA models of the Newspaper Publisher, Vendor and Call Center.



Figure 37: The e3 value model of the example case, adapted from Schuster & Motal (2009)



Figure 38: The EA model of the Newspaper Publisher



Figure 39: The EA model of the Vendor



Figure 40: The EA model of the Call Center

# 3.4.1 A smaller model

The first and foremost contribution of the Value model is that it is a smaller model, as compared to the complete EA model of a firm in its entirety. With the use of the value model managers not only have a smaller view of their enterprise focusing on definite value proposition, but also a model which relates resources and activities which are *not modeled by ArchiMate*, to the value proposition.

Smaller models for the purpose of facilitating analysis and for providing different view are also provided by the various standard viewpoints in ArchiMate. Examples of such viewpoint are Product viewpoint, Application behavior viewpoint, and Infrastructure usage viewpoint etc. <sup>16</sup>. While most of these viewpoints focus on a specific layer (business, application or infrastructure) of ArchiMate, some viewpoints span all the layers, like the layered viewpoint.

The value model differs the existing standard viewpoints in ArchiMate because of the following reasons.

a) It includes elements from all the three layers of ArchiMate

b) The aim of the value model is different from the existing viewpoints.

c) Only those ArchiMate elements which have been classified as a resource or activity are included in the final model.

d) The value model can have some derived relationships which do not exist in the original model.

The value model can be an addition to the list of standard viewpoints of ArchiMate.

In the example case shown above, the value model of the Newspaper Publisher for the value proposition, Advertising Gift is shown below.

<sup>&</sup>lt;sup>16</sup> For more on standard ArchiMate viewpoints refer to (The Open Group, 2012)



Figure 41: The Value Model

# 3.4.2 A networked enterprise architecture

In our classification of ArchiMate elements in Sec 3.2.1 we have modeled *Services* (business, application or infrastructure) and *Business Product* as, value proposition by a firm. In a network, services (or products) of one firm are used as resources (or activity) by another firm. This relationship can be modeled In ArchiMate by showing a relationship between the EA's elements of the two firms. When this is done for each actor to which a firm is connected in a network, it will result in a networked EA. Also it would be a model showing the *value chain* in the network. This is explained below which the help of the case described above.

The Newspaper Publisher obtains the advertising gift from the vendor. This can be modeled, by the **use of** the business service, *Provide Advt. gift* (Vendor) **by** business process, *Store Gift* (Newspaper) as shown in the figure below. By doing this, we create a link between the EA models of the Newspaper and the Vendor and trace the value proposition beyond a single firm.



Similarly, the Newspaper requires the *Call Center* for the customer acquisition via calling potential customers. Here, customer acquisition is not a value proposition of customer, but to the firm itself. It

is modeled by the business function, *Customer Acquisition*. The figure below shows how we can model the transaction of the value, *New Reader Info*, between Newspaper and Call Center.



# 3.4.3 Traceability

The methodology can be used to trace a value proposition to the resources and activities which realize it. This trace would aid processes manager and product managers to focus on a smaller model than looking at the whole EA of a firm. Also, it would help then to analyze, whether changing some of the activities or resources would affect the value proposition.

This traceability will not only be confined to a single firm, but would span different actors in a network since enterprise architectures of firms in a network can be related as shown above. For the running example of the Newspaper Publisher and the Vendor, the value proposition of *Advertising Gift* to the customer can be traced to the resources such as *Tracking Component* of the Vendor as shown below.



Figure 42: Traceability between two EA models

#### **3.4.4 Cost Benefit Analysis**

With the help of the methodology we are able to a map the required resources for realizing a product or service, the value model can be an input for doing a cost-benefit analysis, where we can add up the cost of resources and activities for a particular value proposition.

lacob et. al. (2012b) have earlier shown a similar approach of a bottom up calculation of *costs* in ArchiMate. The benefit of using a value model, for such an analysis is that it is focused on a definite value proposition. Moreover, the value model also includes those resources which are usually difficult to be modelled by ArchiMate, so, it facilitates a more comprehensive calculation of costs incurred for realizing a service or product.

#### **3.4.5 Sensitivity Analysis**

In section 3.4.2 above, we argued that the value model can be an input for traceability analysis. We said that it would help managers decide, whether a resources or activity is utilized in realizing a value proposition. We now extend the argument further, and propose that it can also be an input to analyze, *how critical* a resources or activity is for the value proposition.

#### 3.4.5.1 Importance of an element – In degree and out degree

A table can be prepared based on the value model indicating for each element present in the value model,

a) How many elements depend on this element and

b) On how many element this element depends on.

This concept is similar to the concept of *In-degree* and *Out-degree* for a node in a graph. In this table, corresponding to every element, we can indicate, on how many different elements this element is dependent? Let us call this number the *in-degree* of the element. Similarly, for every element we can write down, how many different elements are dependent on this element? Let us call this number the *out-degree* of the element. One question which arises, is, what does the in degree and out degree of an element represent?

The in degree represents a measure of dependence of the element. A higher in degree means that the element is highly dependent on other elements. The out degree is a measure of the criticality of the element. A higher out degree means that a lot of elements (resources or activities) are dependent on this particular element. An element having a high out degree has a high chance of being a **key resources of the firm for value creation.** Elements having high in degree or out degree will be difficult to replace or remove.

Element	Element Types		Out degree
Logistics	Business Role	Business Role 0	
Provide Gift to customer	Business Service	4	1
Advertising Gift	Advertising Gift Business Product		0
Store Gift	Business Process	3	1

The following table gives the in degree and out degree of all elements for the value model of the business service, *Provide Advertising Gift* as shown in the figure in section 3.4.1

Send Gift to Customer	Business Process	1	1
Order Gift from Vendor	Business Process	1	1
Send Customer Detail to courier	Application Service	1	1
Inventory Requirement Status	Application Service	2	2
Update Inventory List	Application Service	1	1
Communication Platform	Application Component	1	1
Check Requirement	Application Function	1	1
Check Inventory	Application Function	2	1
Inventory List of Advertising Gift	Business Object	0	2
Web Service Infrastructure Service		1	1
Web Server	Node	0	1
Logistic Application	Application Component	1	2
DB Software System Software		0	1

#### Table 13: Table showing the In-Degree and Out- Degree for all elements in the Value Mode

For the given value model, the business service, itself, has the highest in degree of 4. The business process *Store Gift* has the next highest in degree of 3. The application service, *Inventory Requirement Status*, the business object *Inventory list of advertising gift* and the application component *Logistic Application* have highest out degree of 2.

A similar table is the output of the "Count Relation by object" option in the ArchiMate tool for given EA model. The output table by selecting that option, enumerates for every element the in degree of element in the **total** column and also shows the division of the in degree among the constituent relationships. This table (already present in ArchiMate tool) is not discussed further to avoid confusion and further analysis that follows below is based on the table derived from the value model.

One important thing to note here is that while creating such a table, only the immediate relationships are considered. This can be a limitation of the table, whereby, it is able to capture and show immediate dependence between elements but fall short in capturing the dependence of elements which are not directly related.

Another limitation of deciding the importance of an element based on in degree and out degree is a kind of relationships involved. For example, an element having out degree of 2, because of composition relationships can be more important than an element which has in degree, due to association

relationships. Moreover, the importance of an element will also depend on the type of element. For example, a *Business Role* (human resource) having an in degree 1 or 2 can still be a more important for value creation than an application component having in degree 4 or 5.

Thus, we see that the *out degree* is not enough for deciding whether an element is a key resource. We, think that decision upon the importance of a particular element (resources or activity) cannot be done entirely in an automated manner. A balanced approach should be adopted in which elements are assigned weights, both automatically and also manually. In automatic allotment the weight is assigned based on the type of the element, for e.g. a business process being assigned a higher weight than an application process.

Moreover, in addition to this pre assigned weight, the architect while making the EA (in consultation with the process of product managers) can assign a weight to every element. This weight would be based on the experience, perception and the expertise of the architect and the process managers.

Let us define the weight of an element in the value model as a function as follows:

$$W(E) = f(a.w,m.w)$$

where:

a.w is the automatic assigned weight of the element and,

*m.w* is the manual assigned weight of the element.

Following the discussion above, we state that the importance of an element, I (E), can be expressed as a function of it's out - degree, automatic assigned weight and manually assigned weight. <sup>17</sup>

$$I(E) = \alpha (out \ degree, W(E))$$

As an example, let us consider the following application services from the value model of *Provide Advertising Gift*, Send Customer details to courier, Update Inventory list, and Inventory Requirement status. Let us assume that since all three are elements of the same type the automatic assigned weight of all three is the same let's say 5. The table below shows the automatic and manual weights of these elements. For this example, let's also assume that the function 'f' is the addition function and the function ' $\alpha$ ' is the multiplication function.

Element	Automatic assigned weight	Manual Assigned weight	Out-Degree	W(E)	I(E)
Send Customer details to courier	5	3	1	8	8
Update Inventory List	5	5	1	10	10

<sup>&</sup>lt;sup>17</sup> Another important metric while deciding the importance of an element can be, the number of occurrence of the element in different value models. This metric has not been included here.

Inventory	5	6	2	11	22
Requirement					
Status					

#### Table 14: The Importance of elements

#### 3.4.5.2 Importance of Relationships

How much a value proposition by a firm will be affected when a certain resource or activity is changed or removed? This question can be answered by analyzing, how tightly an elements of a value model is related to the service (business, application or infrastructure) or product. We introduce a new metric to measure the impact of a certain resource or activity to a value proposition and call this metric the **'sensitivity factor'**.

The sensitivity factor is calculated between two elements from a value model, one of which is the value proposition i.e. a service or a product. The other element can be any resource or activity. We define the sensitivity factor of a service or product is a function of:

a) The importance of the element under consideration (resources or activity) and

b) The relationship between the service or product and the element.

The importance of an element is as described in the previous sub section and the weight of an element is a function of automatically assigned weight and manually assigned weight.

Consider the figure below. Let's assume that a, is a service or a product and represents a value proposition, while b is an element representing resource or activity and there exist a relationship  $r_{1}$ ,  $r_{2}$ ,  $r_{3}$ ..., $r_{n}$  between them.



Then the sensitivity, *S*(*E*) of *a* with respect to *b* is:

$$S(a) = \theta(r, I(b))$$

where I(b) is the importance of the element b and

 $r = \mu(w.r1) + \pi(w.r2) + \rho(w.r3) \dots n(w.rn)$ , where w.r1 is the weight of relationship r1, w.r2 is the weight of relationship r2 and so on<sup>18</sup>. And  $\mu$ ,  $\pi$ ,  $\rho$  ... n are constants. r is called the *absolute* relationship between a and b.

As an example, let us consider the following application services from the value model of *Provide Advertising Gift* on Page 90 i.e. Send Customer details to courier, Update Inventory list, and Inventory Requirement status.

Let us also assume that  $\mu = 1$ ,  $\pi = 1/2$ ,  $\rho = 1/3$  .... n = 1/n. The importance of each of the elements have been shown in the previous table. Let's also assume that  $\theta$  is the division function.

<sup>&</sup>lt;sup>18</sup> For weight of relationship refer to table 10 in Section 3.2.2.2

The following table shows the value of *r* and the *sensitivity factor* for each of the three application services with the business service, Provide Advt. Gift.

Element	w.r1	w.r2	r	I(E)	S(E)
Send Customer details to courier	4	3	5.5	8	8/5 = 1.45
Update Inventory List	4	3	5.5	10	10/5.5 = 1.80
Inventory Requirement Status	4	3	5.5	22	22/5.5 = 4

#### Table 15: The Sensitivity of elements

A high sensitivity factor of an element w.r.t to a service or product is an indication of the how tightly the element is connected to the service or product. It is an indication of how much the service or product will be affected if the element is changed or removed.

The sensitivity factor for all elements in the value model can be summed up and can be called as the *Total sensitivity factor*, S(Et) for the service or product. The possible use of this metric is not explored further and can be an area of future research.

$$S(Et) = \sum S(E)$$

# **3.4.6.** For providing new services, off the shelf solutions.

The value model may also aid process and product managers in design and composition of a new services. Firstly, using the *value model* they can identify the resources and activities which are used to realize an existing service and then re-use or replicate these resources and activities, to compose a similar or new service. Underutilized resources can also be highlighted by using the value models.

Secondly, once the key resources and activities have been identified, new value proposition can be configured using underutilized resources. (Fritscher & Pigneur, 2011)

# 3.4.7 Bringing e-3 value model and ArchiMate closer

The concepts of e3 value model have been used extensively in this research as a basis to model value inflow from the network. The first step of the methodology presented in Section 3.3, consist of using an e3 value model to enumerate the services used from network partners.

In this sub section we present how the *value model* helps in showing the *value activity* concept of an e3 model in terms of ArchiMate element. We continue with the running example of the *Newspaper Publisher*. The value proposition (the advertising gift) is offered to the environment (the reader and the new reader) via four different *value activities* of the newspaper, i.e. *managing advt. gift, subscriptions, customer acquisition by internet, customer acquisition via call center.* 

Below we try to model each of the value activities in terms of ArchiMate elements based on the value model for *Provide Advertising Gift* and *Customer Acquisition*<sup>19</sup>. As stated by Kinderen et. al., (2011) that the business functions are a good starting point for mapping value activities of e3 model to ArchiMate

<sup>&</sup>lt;sup>19</sup> The value activity *Subscription* has not been modeled in the EA of the Newspaper Publisher

elements. Since according to our classification of ArchiMate element activities and processes are at the same level of abstraction (and both classified as activities) we argue that value activities can be mapped to functions or processes.

1) *Managing Advt. Gift* – this value activity corresponds to the 3 business processes, *Order Gift from Vendor, Store Gift* and *Send Advt. Gift to Customer.* 



2) **Customer Acquisition by Internet** – consist of the business function, *Customer Acquisition by Internet* and also uses the business service, *Provide Advt. Gift to Customer.* 



3) *Customer Acquisition by Call Center* – this value activity consists of the business function, Customer *Acquisition by Call Center*, which uses the business service, *Call Handling* of the Call Center.

It also uses the business service, Provide Advt. Gift to Customer.



As can be deduced from the figures above, the transfer of *value object* (Advertising gift) between the value activities, is shown by the use of the business service, *Provide Advertising Gift*, by the business function, *Customer Acquisition by Internet* and *Customer Acquisition by Call Center*. Each value activity can be analyzed in isolation and cost benefit analysis can be made on each of it.

The use of the business service *Call Handling* and the product *Customer Contact Detail* by the business function, *Customer Acquisition by Call Center*, models the value inflow of *New Reader Info*, as shown in the e3 value model.

# 4. Implementation

An algorithm for tracing a service or product in a given ArchiMate is presented and demonstrated in Section 3.2.2. An object oriented pseudo code for the same is given in Appendix C. The algorithm is implemented in the EA modeling tool BiZZdesign Architect 4.2.1 on a Windows machine running MS Windows 7.

For implementation, the pseudo code is written in the scripting language for BiZZdesign Architect<sup>®</sup>. The script file is called *value.script* and has been included in the Appendix F.

The script file in placed in the configuration folder for the Architect 4.2.1. The path to put the script is ...\Program Files\BiZZdesign\Architect 4.2.1\configuration\MetaModels\ArchiMate\Scripts\Libraries\. After copying *value.script* the Architect tool is restarted. Once the tool restarts an option is added under the *Analyses* button on the tool bar which reads, *Generate Value Model*, as shown in the screenshot figure below.



Table 16: Screenshot showing Generate value model option added in the tool, Architect.

For creating a value model of a given ArchiMate model,

- 1. The model is opened with the Architect ®
- 2. The starting element is selected
- 3. Option *Generate Value Model* is chosen under the Analyses button in the tool bar.

The derived model is created which can be seen under the *Model packages* option on the left hand side of the tool, as shown in the screenshot figure below. The *value model* can be viewed by clicking the *Derived View* option. Elements of the original EA model which have been copied in the *value model* can be viewed by expanding the *Copied business/application/technology layer objects,* option.



Although, while formulating the algorithm it was stated that the starting element is a *service* or a *product, value.script* is written in such a way that any element of an EA model can be chosen as the

starting element for generating the value model. If no element is chosen, then a prompt window appears which asks the user to *Select Starting Element*.

For deleting a *Derived Model*, right click on Derived Model and select Delete.

# 5. Demonstration of the Methodology

This chapter corresponds to activity 4 of Design Science Research Methodology and is concerns the demonstration of the methodology presented in section 3.3 to example case.

For this demonstration, an instance of Archinsurance case study from (lacob & Jonkers, 2012c) has been chosen as an example case. The Archinsurance case has been used in many scholarly articles on ArchiMate, and academics and practitioners are familiar with this example.<sup>20</sup> This case has the advantage of being realistic and of manageable size without being overly simplistic. First, a case description is presented and then the methodology developed in the previous section is applied step by step.

# The Case

Archinsurance is a fictitious company that provides home, travel, and car insurances. It sells its services through a network of intermediaries. Archinsurance's primary operations are (1) maintaining customer relationships and intermediary relationships, (2) contracting, (3) claims handling, (4) financial handling, and (5) asset management.

These operations are similar for most insurance companies. To support these operations, the company has several departments, and is running a collection of applications on various hardware platforms. As for all insurance companies, Archinsurance offers "security" in the form of risk reduction to its customers. In return for a premium, customers are covered in the case of incidents. The goal of the customers is to "be insured".

Archinsurance offers essentially three services to the customer: *claim submission* for which regular mail is Used (incoming claims are first sorted by the mail room employee and then scanned and registered in the Document Management System), *customer information service* that is used to inform customers about the Status of their claims via telephone or email by a back office clerk, and *claim payment* to Compensate damages suffered by customers whose claims have been accepted. Archinsurance has no control over the sales of insurance products. They work with intermediaries, who mediate the sales and marketing activities, on Archinsurance behalf, against a commission.

The problem Archinsurance is facing, is that the Customers are not satisfied with the Customer Information Service and there have been lately many complaints. The CEO wants a report to get to the base of the problem and wants to know, how the Customer Information Service is realized. Armed with this knowledge the CEO wants to pin point the problems and improve the short comings as soon as possible.

The partial EA model of Archinsurance is shown below.

<sup>&</sup>lt;sup>20</sup> For a complete description of Archinsurance case study refer to (Jonkers, Band, & Quartel, 2012)


Figure 43: Example EA model: Archinsurance

**Step 1: Create and use a value model** – Based on the small case description above a reduced value model is created. The use of this value model is to identify the collaborating actors in the network and also the values required by Archinsurance.



Figure 44: The e3 value model for Archinsurance

The value which is acquired from the network are

• Telephone Connection (from the telephone service provider). Used by the *Back office Clerk* for notifying the Customer about the status of the claim. A possible way to model this is shown in the figure below. An alternative way could be to relate the business service, *Telephone Connection,* to the business process, *Notify Customer* via the used-by relationship. For this example the former way is chosen. The shape of the business service is changed to *cogwheel* to differentiate it from the internal business services.



• Internet Service (from the Internet Service provider). This service is used by the *Back office Clerk* to inform the customer about the status of the claim via email. It is also used by the *Financial Department Clerk* for transferring the claim amount to the Customer, after the claim has been evaluated and processed. The shape of the business service is changed to *cogwheel* to differentiate it from the internal business services.



 Claim Delivery (by the Postage Service Provider). The postage service delivers the claims to Archinsurance via regular post and realizes the event *Claim received*. It is shown below by the *used-by* relation between the business service *Claims Delivery* and the business event *Claims Received*. The shape of the business service is changed to *cogwheel* to differentiate it from the internal business services.



**Step 2: Choosing the starting element** - The value provided to the customer, is realized by one or more products or services. The problem faced by Archinsurance is that the customers are not satisfied with the information provided by them about the status of their claims. Thus, the value proposition here is "Claim Information". This value is provided by the business service "*Customer Information Service*" and is the starting element for application of the algorithm.



**Step 3: Application of the Algorithm -** Once we have chosen the service/product corresponding to the value proposition, we can proceed ahead with tracing it to activities and resources which realize it. The algorithm is applied to the EA of Archinsurance model with *"Customer Information Service"* as the starting element. Due to space constraint a step by step working on the algorithm is not presented here. The resultant model is shown below.



Figure 45: The value model for Customer Information Service<sup>21</sup>

The application of the algorithm has resulted in above model. This model is the *value creation model* for value proposition 'Customer Information'. The model also shows that the entire process consists of three business processes namely, Register Claim, Accept/Reject Claim and Notify Customer. Based on the classification of process presented in Section 3.1 we can classify these processes as primary, secondary and management. While *Notify Customer* can be classified as a primary process, *Accept/Reject Claim* and *Register Claim* are support process.

**Step 4:** Now, the main processes/activities in the value creation model have to be identified. The criteria for identifying "main" processes/activities will be dependent on level of analysis, the motive of analysis and the person doing the analysis.

For this case, the main processes identified are 3 business processes i.e the *Claim Registration, Accept/Reject Claim* and *Customers Notification.* These processes will act as input for the next step where *Value Tables* are constructed.

<sup>&</sup>lt;sup>21</sup> External Services are shown as *cogwheels* in this model, but it is not the case in the actual output from the tool. Here these services are shown differently just to bring out the differences between the internal and external processes.

**Step 5:** For each of identified main processes, a *Value Table* is created in which those internal resources are enumerated that have not been represented in the value creation model using ArchiMate elements but are used in value creation.

	Value	Element	Description
Register Claim	Computer Skills	Front Office Clerk	The front office clerk should have neccesary software skills to enter the Claim Details in the Document Management System.

#### Table 17: Internal Value Table for Customer Notification

	Value		Element	Description
Accept/Reject Claim	Claim knowled	Acceptance ge	Back Office Clerk	The back office clerk should have necessary expertise to make decisions on claims

#### Table 18: Internal Value Table for Decision on Claims

Internal value table for the process *Customer Notification* is empty.

These value are then mapped to the ArchiMate element in the value creation model as shown below.



**Step 6:** This step involves creation of external value tables for each of the identified main processes. In these value tables those external resources and activities are mentioned which have not be represented in the value creation model using ArchiMate elements, but are used in value creation. No such resource/activity is identified for any of the three processes. So, the external value table are empty.

If there would have been external values, they would have been made to the value creation model as the mapping of interval values shown in Step 5. A different graphical shape is used to differentiate between external value and internal value.



Figure 46: The Value Creation Model for Customer Information Service

The final model after above 6 steps is shown above and is same as after Step 5. We call this model, the value creation model for the value proposition *Customer Information*. This model could be presented to the CEO of Archinsurance as a report on how the *Customer Information Service* is realized. CEO of Archinsurance with the help of this model, can now focus on much smaller section of the entire EA. Also, the value creation model gives a more comprehensive view of value creation.

# 6. Evaluation

Evaluation is a key activity of the Design Science Research Methodology. It is concerned with verifying the merit of the artifact, based on the objectives which had to be met using the artifact. Evaluation methods can either be qualitative or quantitative. Evaluation can be performed by comparison of the artifact's functionality with the objectives of the solution by doing satisfaction surveys, interviews, simulation or any other proof deemed suitable in the context. (Peffers et. al., 2008)

## **6.1 Surveys**

Surveys are an efficient method of collecting information from a small, representative group of people and then generalizing for a larger group (Altizer, 2013). Although, surveys are usually thought of aiding quantitative research only, but they can be used for qualitative research as well. Surveys can have different contributions depending upon the type of IS research. (Klein & Myers, 1999). For the usefulness of surveys in Informations Systems refer to Newsted et. al. (1998).

In this research, *Evaluation* of the methodology is done by a survey research. Survey research can be broadly divided into 4 types, based on the medium adopted. There can be *mail surveys*, where the survey questions are sent to possible respondents via post. On one hand, this method of survey gives respondents a comfortable situation to respond about private questions (since there is no face to face communication), on the other hand, there is a lack of possibility to ask questions or demand clarifications.

The second kind of survey can be done over the telephone. The problem with *telephonics surveys* is that respondent might not be willing to answer a long survey over the phone, in the middle of a work day. Also, surveys which are based on a complex topic, might not be best suited to for an telephone survey. But, this medium of conducting survey is better than *survey by mail* approach because it allows respondents to ask for clarifications about the survey.

The third kind of survey are *internet surveys*. Surveys can be posted on popular message boards, social networking sites, professional blog sites etc. where the targeted population is expected to see the survey. Although, internet surveys are inexpensive and have the advantage of reaching out to a much larger audience, they have problems of their own. In internet surveys, it is difficult to find out whether the respondent is talking the survey seriously or not. Also, how many times certain respondent is answering a survey is usually difficult to control.

Surveys can also be conducted by *Personal Interviews*. These interview usually take place at a mutually agreed location which is comfortable to the respondent. The researcher asks questions from respondents and the replies are recorded. Although, these surveys can be time consuming, they are usually the most productive ones. The researcher has the option of explaining the survey questions in case of a doubt or question by a respondent. Such surveys also have demerits, e.g. the researcher can be biased in writing the response of the respondent. He/She may record only those responses which align with his or her view, thereby ignoring some other important points made by the respondent.

A efficient survey in the field of Information Systems (I.S) should ideally include the following attributes (Grover, Lee, & Durand, 1993) :

- 1. Reporting the approach used to randomizing or selecting samples
- 2. Reporting a profile of the sample frame
- 3. Reporting characteristics of the respondents
- 4. Using a combination of personal, telephone and mail data respondents

# 102

- 5. Appending the whole or part of the questionnaire
- 6. Adopting a validated instrument or perform a validity or reliability analysis
- 7. Performing an instrument pretest
- 8. Reporting on response rate
- 9. Performing a statistical test to justify the loss of data from non respondents.

The survey conducted for evaluting the artifact of this research is conducted on a small level, because of time limitation. The survey is only a small part of the research work and is not the primary activity for this research.

## 6.2 Method

The process of conducting the survey has been briefly explained below. Out of the 9 attributes of a survey in IS field mentioned above, most of the attributes have been incorporated in the survey for this research. 2 attributes could not be met, due to small population and time constraint. Firstly, instrument pre test has not been done. Secondly, a validity or reliability analysis is not done over the instrument. The response rate of the population was 100% so a statistical test to justify loss of data from non respondents was not required.

#### 6.2.1 Profile of the respondents

For obtaining an unbiased and complete response data, the target population is divided into 2 groups' academics and practitioners. Representatives from academics are researchers who can evaluate the academic contribution of this research. Representatives from the practitioner community are IT architects and analysts. They are included to obtain their views and evaluation of the research from a practitioner's viewpoint.

Their viewpoint is necessary to evaluate, applicability of the methodology. The population for conducting the survey is not large. A total of 5 respondents, 2 researchers and 3 practitioners are selected for the survey. All the respondents have expertise in ArchiMate and ample knowledge of e3 value, value creation and of various enterprise architecture approaches.

#### 6.2.2 Choice of Survey

A combination of personal interview and internet survey is chosen as the evaluation method for this research. The reasons for choosing Personal Interviews is that respondents are easy accessible and explanation of the methodology is required before the responses can be recorded. Also, in case of personal interview, doubts of the respondents can be clarified. The questionnaires are put online because of two specific reasons. *Firstly*, the aim is to maintain a written record of the response. *Secondly*, allowing the respondents ample time to reflect back to the interview and also conduct peers about the usefulness of this research. Actions in the personal interview are as follows:

**Personal Interview:** Firstly, a 20-30 minutes presentation is done to explain the context of the research and the artifact developed. The respondent is free to ask questions in between the presentation. After the presentation, some questions are asked to the respondents and a detailed, verbal answer <sup>22</sup> is requested. Their response is recorded via a voice recording device for future reference and analysis.

**Internet Questionnaire:** After the presentation and personal interview, a web link for the questionnaire is provided. The respondents have to answer the same questions, which were asked

<sup>&</sup>lt;sup>22</sup> The verbal response of every respondent are written in Appendix C – Personal Interview Responses

during personal interview. This time the answer of respondents would be on a Likert Scale (Likert, 1932) which measures the agreement of the respondent with the statement.

**Data Interpretation:** The answers by the respondents during the personal interview which had been recorded are written down in question-answer format and are shown in Appendix *C, Personal Interview Responses.* Important points from the interviews are written down in Section 6.4.

The important derivations and suggestions from the responses have been included Chapter 7, Conclusion and Future Work. The responses by the respondents for each statement of internet survey is shown as bar graphs in Appendix D, *Survey Responses*. The analysis of the survey responses is done in Section 6.5.

# 6.3 Formulating the questionnaire

The questions to be asked from the respondents of the survey are aimed to evaluate whether the artifact i.e. the methodology is in accordance to the objectives it was supposed to meet. Two types of questionnaires had to be formulate for the purpose of evaluation. One questionnaire is for the personal interviews with respondents for getting detailed verbal response (critical evaluation, suggestion, remarks and improvements). The other questionnaire is for recording the response on a Likert Scale. It would be appropriate to call the content of the second questionnaire as *statements* rather than questions. This is so because they are affirmative statements and the degree to which the respondent agrees with this affirmative statement is measured by the Likert Scale.

Solution Objectives	Question for personal interviews	Construct measured
The methodology should be practical and can be applied to real cases by the practitioners	Do you think the methodology is practical – can be applied in practice.	Applicability of the methodology
The methodology should bring out the distinction between value in use and value proposition.	What do you think about the classification of ArchiMate elements as resources, activity, process and value (proposition)?	Correctness of the methodology
The methodology should relate resources and activities to value propositions.	Are the resultant model and value tables a good representation of <i>value</i> <i>creation</i> at process level?	Completeness of methodology
It should be able to show value captured from the network for value creation	Is the value network perspective represented appropriately in the methodology?	Network aspect of value creation in the methodology.
Must improve business IT alignment	Can the resultant model and the value tables can be used as input for Business IT alignment.	Practicality of the methodology

The questionnaire for personal interview were derived from solution objectives and are shown below.

Table 19: Questions for the personal interview

The above questions are then simplified further so that they can be used in conjunction with a measurement instrument (Likert Scale) in the internet survey. Following aspects were taken into consideration while formulating the questionnaire for internet survey.

- The wording of statements should be simple and clear.
- The statements are compatible with experiences of the respondents.
- Minimize the statements which cause the respondent to think too much or too hard.
- The survey should not be too long.
- The statement should be not vague and generic.
- The statements and the construct which it measure should be tightly coupled.

The first draft of questions (not included in this report) is discussed with the supervisors of this research and improved. The final version of the question for the personal interview and the internet survey are shown below.

Questions in the Personal Interview	Statements		
	The methodology is convenient and lightweight.		
Do you think the methodology is practical – can	The methodology as a whole provides useful insights.		
	The application of the methodology to real case will be suitable.		
	I may apply the methodology or a part of it in future cases.		
	The methodology models resources/activities of a firm correctly in terms of ArchiMate elements.		
What do you think about the classification of	The methodology models value proposition of firms correctly in terms of ArchiMate elements.		
process and value (proposition)?	The distinction between value in use and value proposition is clear.		
	All ArchiMate elements which represent value in use have been included.		
	The resultant model and value tables are a representation of value creation?		
Is the resultant model and value tables a good	The resultant model and value table are at the process level of abstraction.		
representation of <i>value creation</i> at process level?	The resultant model and the value table are useful to show value creation.		
	The methodology provides a comprehensive view of value creation.		

Is the value network perspective represented appropriately in the methodology?	The <i>external value tables</i> show the Inflow of network value objects.		
	Mapping of network value object to processes		
	shows network aspect of value creation.		
Can the resultant model and the value tables can be used as input for Business IT alignment.	The resultant model can be an input for Business IT alignment analysis, like portfolio analysis, new product/service creation and quantitative analysis.		
	Value tables can be inputs for Business IT alignment analysis.		

#### Table 20: Questionnaire for the internet survey

The questions are in the form of affirmative statements and the respondent have to choose one option from the Likert Scale which shows how much they agree with the statements. Also for each of the question, the respondents can leave a comment or a remark, where they can write down their additions, improvement or flaws they feel about the methodology.

## 6.4 Some important points from Personal Interviews

Responses from *Personal Interviews* have been written in Appendix C. Below we enumerate some important points which came up during the interviews.

- The respondents were of the view that, we should be clear as to who is the target audience for the methodology. Which managers would like to use and are most likely to benefit from the value creation model? Since the value creation model includes business process and IT infrastructure as well, so we have to decide which person in the organizational hierarchy would be best suited to use it.
- Every respondent agreed over the classification of ArchiMate elements, as resources, activity and value which has been done in this thesis. Suggestion for improvement was the inclusion of the *Business Actor* element as a resource.
- One of the objectives for developing the methodology was that it should improve Business IT alignment in an organization. Response from the personal interviews indicated that Business IT alignment depends on a lot of factors like politics, organization culture and size of the firm. Insights into *Value Creation* can be a part of the Business IT alignment as it has many different aspects as well under its umbrella.

So, although the methodology can be an input for Business IT alignment, yet it might not be sufficient as other factors also play a role. The respondents said that the value creation model is a good business tool for showing how IT supports business thereby showing the business value of IT.

• While modeling resources and activities acquired from the network, as *services*, we have to be sure about the nature their value. Whether they have *use value* which is used by the firm to create the value proposition or they add to the value proposition by the firm i.e. involved in value co-creation. It may be possible that due to the use of *e3 value* incorrect capabilities or resources are modeled as *services*.

- Another important point which came up during the interview is that some organization use ArchiMate differently, having different understanding and semantics for ArchiMate elements which differ from those that are stated in the ArchiMate metamodel. In such cases we have to find a way so that the methodology is still applicable. This may require changes in the algorithm for traversing an ArchiMate EA model. One respondent was of the view that the methodology is more applicable for firms which have been using ArchiMate to model their EA for quite some time and are not new to usage of ArchiMate. In cases where the firm is in the earlier stage of ArchiMate usage, the *value model*
- The value creation model has ArchiMate elements from all 3 layers of ArchiMate i.e. Business, Application and Infrastructure. The respondents suggested the use of some techniques to decide upon the importance of each element in the value model toward *value creation*. The respondents also suggested that the relationships in the value model can be assigned weights (manual or automatic) to indicate the extent of influence of a particular element towards the value proposition.

might not be able to provide useful insights as the EA model is still in infancy.

• Most respondents were of the view that the methodology is applicable to real cases and can also be used for quantitative analysis. Still, some improvement may be required.

## 6.5 Data Analysis and Results

From the above tables (Table 19 and Table 20) it can be seen that the first four statement of the internet questionnaire measure, the *applicability of the methodology*. The next four statement measure the *correctness of the methodology*. The following four statements measure the *completeness of the methodology*. The next 2 statements measure the presence of the *network aspect of value creation in the methodology*. The final 2 question measure *practicality of the methodology*.

For every statement in the internet questionnaire, the responses by respondents have been shown in Appendix D using bar graphs. The bar graphs show the number of responses for each option on the Likert Scale. To analyze the responses w.r.t each construct, we take the average of responses for each statement (for a given construct) and then show it as a percentage. For example, the first construct to be is measured was the *Applicability of the Methodology*. Pertaining to this construct there were four questions are shown in Table 19 and Table 20. For each of the 4 question the responses were added and then divided by 4 (the no. of questions). Then it was shown as a percentage of 5 (the total number of respondents).

Strongly Agree (Applicability) = [[Strongly Agree (Q1) + Strongly Agree (Q2) Strongly Agree (Q3) Strongly Agree (Q4)]/4]\*5

This is shown in the 5 bar graphs shown below.



Chart 1: Applicability of the Methodology



Chart 2: Correctness of the Methodology



Chart 3: Completeness of the Methodology



Chart 4: Network aspect of value creation is covered in the methodology



Chart 5: Practicality of the methodology - is an input for improving Business IT alignment

The Data analysis provides important insights about the methodology. On one hand, based on the responses it can be said that there is strong positive indication that the methodology is applicable in real cases (85% respondents agreed), while on other hand, the response are at best, neutral, about the methodology being an input for Business IT alignment (60% respondents either disagreed or were neutral). Another point of concern is that 45% of the respondents were either neutral or disagreed on the methodology being correct. But, more than 60% of the respondent agreed upon the completeness and comprehensiveness of the methodology in modeling *value creation*.

It would not be suitable to draw conclusive deduction from the survey, as the population is very small. But the survey provides good starting point for improvement of the methodology and brings forward the areas of concern. There is also a need to redo the survey over a larger audience so that conclusive evidence made be derived. The validity and reliability check on the measurement instrument should also be done since for this survey, these check were not done.

As mentioned before, the response of the respondents in the personal interviews are presented in Appendix C.

# 7. Conclusion and Future Work

We have now come to the last chapter of this thesis report where we summarize and highlight the major contribution of this research. Section 7.1 below provides a summary of the research and Section 7.2 discusses the contribution of this research to the academic and practitioner community. Section 7.3 discusses the limitation of this research and finally Section 7.4 suggests some areas of future research.

## 7.1 Summary

This research has addressed two important topics in the fields of economics and strategic management, *the concept of value* and *value creation*. Existing literature suggests that, although these topics form the very basis of business, yet, there exists some disagreement about their true nature and features, among academics.

The most important motive of this research was to model the value creation process of a firm. Since the domain of analysis was the process level of abstraction, ArchiMate was chosen to model value creation. Another motivation for conducting this research was to attempt in narrowing the gap between strategy formulation and strategy execution in firms, since people who formulate strategy in organizations are rarely the ones who implement it. We think that a model of value creation at the process level can be of good use and provide useful insights to product managers.

The research questions were formulated in such a way, so as to first model *value* at the process level and then show how it is created/realized, using the EA modelling language ArchiMate. With the help of an extensive literature survey *value creation* was understood, leading to a *value creation framework*. Then according to this framework ArchiMate element were classified into *resources, activities and value proposition*. E3 value model was used to identify value inflow from the network. ArchiMate elements representing *Value proposition* were then traced to other element in the EA model, which directly or indirectly influence them, with the help of an algorithm.

The output of the algorithm is smaller model which shows only those resources and activities which realize the value proposition. This model is called the *Value model*. Tables are used to enumerate those values which are not modelled by ArchiMate, yet used in the value creation. These values are then mapped to appropriate ArchiMate elements, leading a comprehensive model of value creation, called the *Value creation model*.

All the above steps are combined to form a 6-Step methodology, which is the artifact of this thesis. An example case (*Archinsurance*) is used to demonstrate the methodology. Also, the algorithm was implemented in the EA designer tool, BiZZdesign Architect<sup>®</sup>. Possible uses of the Value (creation) model are discussed in a separate section (Sec 3.4) with the help of another example case (*Advertising Gift case*).

The methodology was evaluated by experienced practitioners and academics via an internet survey. Personal interview sessions are also conducted with the survey respondents. Their responses, suggestions, advice and viewpoints are recorded.

Below, contribution of this research, limitations and future works based on this research are discussed in detail.

# 7.2 Contributions

This research contributes to the existing literature on reducing the gap between strategy formulation and implementation by modeling value creation in term of ArchiMate elements. It also answers the

question, where is value represented in ArchiMate? With the help of the algorithm, a business service/product can be traced to those elements, across all three layers, which directly or indirectly realize it.

Some major contributions of this research are mentioned below and are classified between theoretical and practical contributions.

#### 7.2.1 Theoretical contributions

Following are some theoretical contributions of this research.

- This thesis report discusses the concept of value, and briefly mentions the different features of value based in some literature sources. A **definition of** *value* is also given in Chapter 2. This definition will aid in better understanding of business value in firms.
- The **value creation framework** developed in 3<sup>rd</sup> Chapter of the thesis brings out the constituents of value creation at the process level. These constituents can be the basis of modeling value creation for different BPM techniques.
- This research adds to the existing literature on representation of the *value* concept using ArchiMate elements. A comprehensive representation of value (internal i.e. owned by a firm and external i.e. acquired from the network) is provided in the thesis. Based on the value creation framework ArchiMate elements are classified into resource, activity and value proposition. This representation consolidates that the concept the *value* is **inherent in all layers** of ArchiMate and not only in the business layer. Similar classifications have been attempted in literature before. (lacob, et al., 2012a)
- By the use of e3 value model as the first step of the methodology, the thesis has tried to **bridge the gap** between e3 value model and ArchiMate. Also the value model can be used as a starting point for modeling the *value activity* concept of e3 value model.
- As shown in Section 3.4.2 the methodology, is an input to designing a **network enterprise** architecture.

#### **7.2.2 Practical Contributions**

Following are some practical contribution this research.

- The value creation model can be an input for **Service Oriented Architecture** (SOA) as the model is focused on the composition of a service being offered to the customer.
- Previous researches have demonstrated the use of ArchiMate model for cost benefit analysis in an organization (lacob, Quartel, & Jonkers, 2012b). By implementing the algorithm in the tool Architect, this research proposes a **formal way of tracing** the *value* offered to the customer (business service or product) to resources which realize it. The value model will assist managers to calculate the cost of providing the service/product to the customer by adding up the cost/expenditure on using/acquiring or sustaining the resources.
- The value creation model can be used as a basis for **different kinds of analysis** like quantitative analysis, comparison between as-is and to-be situations and sensitivity analysis. These potential uses have been explained in details under Section 3.4.
- The value model of the algorithm can be added as a **separate viewpoint in ArchiMate**. This viewpoint will trace a business service to elements which directly or indirectly realize it in all the three layers of ArchiMate. Such a viewpoint will give an insight in the composition of a value offering by a firm.

- This methodology allows **traceability** of a product or service not only within the firm but also across participating actors in the network. Improvements, delays or changes in the value proposition can thus be traced to the resources/activities causing it, even if they are acquired from the network.
- Many IT architects face problem while **modeling non IT resources and activities** in ArchiMate like skills, knowledge, money etc. By formulating *value tables* (internal and external) and then mapping them to processes or role or functions, the methodology allows not only the modeling of non IT resources in ArchiMate but also their contribution in value creation.
- The methodology demonstrated the modeling of value inflow from the network as services or collaborations.

## 7.3 Limitations

Some limitations of this research which have been identified are stated below.

- The methodology presented in this thesis has not been applied to a real life case, its use is demonstrated with help of fictional example cases only.
- The value creation framework at the process level, developed in Chapter 3, has not be verified and evaluated.
- The association relationship has not been included in the algorithm for tracing a service/product. This implies that some important elements would end up being omitted from the *value model*.
- The algorithm can result in models where some of the relationships between two elements are not consistent with specifications of ArchiMate.
- In case of a very big organization, having a complex and detailed EA, the *value model* itself can be complex and difficult to analyze.
- Different organizations have different, fixed way of modeling their firm. There may be cases where their model does not adhere to the ArchiMate meta-model. The algorithm might not give expected results in such cases.

# 7.4 Future Research

IT business alignment is an endeavor which demands a multi-dimensional approach. We, in this research have tried to bring business and IT together by showing value creation in terms of ArchiMate models. Our research has answered the question we set out with, and, also has some areas of future research and exploration. Some future areas of research have been identified, and stated below.

- A full implementation of the methodology in the form of a separate tool or as a part of Architect, can be a promising area of future work.
- Use of the value creation model: The value creation model, is the trace of the value proposition in the EA of a firm. This model can be put to diverse uses, as stated in Sec 3.4. These proposed usage should be applied to real cases to test their applicability.
- The concept, definition and formulae for sensitivity factor value proposition with respect to an element in the value is given in Section 3.4.5. The possible usage of this metric for a value proposition has to be further explored.
- Use of the value creation framework: Evaluation of the value creation framework and its use in modeling value creation at the process level can be explored by different Business Process Modeling approaches.

- Networked Enterprise Architecture: Firms in a network are linked together by means of value exchanges. If each firm has ArchiMate model, then these exchanges between firms will be mirrored in their EA resulting in a networked EA. In a networked EA, ArchiMate elements of one firm realize, use or access the ArchiMate elements in the EA of the other firm. In such a networked EA, the value creation model would show a pan-network value creation process. Practical verification of this concept can be an area of future research.
- *Extension of ArchiMate:* Further investigation is required in exploring possible future extension of ArchiMate needed to make ArchiMate EA model more implementable in service oriented firms and non IT intensive firms. The inability of ArchiMate to model varied kinds of resources a firm uses in value creation was made explicit many time during the course of this research.
- The value model: In the value model produced by Architect there is a lot of overlapping between lines representing ArchiMate relationships and elements are not properly ordered in the drawing space, which looks quite unprofessional and not very user friendly. Additions in value.script might be required to make elements in the value model properly oriented allowing it to be suitable for analysis.
- Apart from the uses of the value model mentioned in Section 3.4, further uses can be explored.
- Further studies on e3 value model and ArchiMate are required to attain an even better match between the two. Whether is it possible to show changes made to an existing e3 value model in its EA model ArchiMate and vice-versa?

# References

- Alavi, M., & Leidner, D. E. (2001). Review: Knowledge Management And Knowledge Management Systems: Conceptual Foundations And Research Issues. *MIS Quaterly*, 107-136.
- Allee, V. (2008). Value Network Analysis and the conversion of tangible and intangible assets. *Journal* of Intellectual Capital, 5-24.
- Altizer, L. (2013, June 26). *Survey Research: A summary of Best Practices*. Retrieved from ERC Ethics Resource Center: www.ethics.org/resource/survey-research-summary-best-practices
- Amit, R., & Zott, C. (2001). Value Creation in E-Business. Strategic Management Journal, 493-520.
- Andersson, B., bergholtz, M., Gregoire, B., Johannesson, P., Schmitt, M., & Zdravkovic, J. (2006). From Business Model to Process Model - A chaining Methodology. *BUSITAL '06*. Luxembourg: Springer.
- Bertram, D. (2013, August 1). Retrieved from http://poincare.matf.bg.ac.rs/~kristina/topic-danelikert.pdf
- Bowman, C., & Ambrosini, V. (2000). Value Creation Versus Value Capture: Towards a Coherent Definition of Value in Strategy. *British Journal of Management, Vol. 11*, 1-15.
- Bowman, C., & Ambrosini, V. (2003). *What does value mean and how it is created, maintained and destroyed ?* Seattle: Academy of Management Annual Meeting.
- Buuren, R. v., Jonkers, H., Iacob, M. E., & Strating, P. (2004). Compositons of Relations in Enterprise
   Architecture Models. *Graph Transformations, Second International Conference* (pp. 39-53).
   Rome: Springer Berlin Heidelberg.
- Carr, D. H., Lawson, J., D.R.E. Education, & Schultz, J. (2003). Types of Values. In D. H. Carr, J. Lawson,
   D. Education, & J. Schultz, *Mastering Real Estate Appraisal* (pp. 31-40). Chicago: Kaplan
   Publishing.
- Cavusoglu, H., Al-Natour, S., & Cavusoglu, H. (2011). ICT value creation at four levels of analysis: Review of Extant Research and a new conceptual model. *8th ICESAL*, (pp. 231-274). Thassos Island.
- Constantin, J., & Lusch, R. (1994). Understanding Resource Management. *Oxford, OH: The Planning Forum.*
- Engelsman, W., Quartel, D., Jonkers, H., & van Sinderen, M. (2011). Extending enterprise architecture modelling with business goals. *Enterprise Information Systems*, 9-36.
- Fatemi, H., Sinderen, M. v., & Wieringa, R. (2009). From Business Model to Coordination Process Model. Second IFIP WG 5.8 International Workshop, IWEI 2009, Valencia, Spain, October 13-14, 2009. Proceedings (pp. 941-106). Valencia, Spain: Springer Berlin Heidelberg.
- Fatemi, H., van Sinderen, M., & Wieringa, R. (2011). E3 value to BPMN Model Transformations. 12th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2011 (pp. 333-240). Sao Paulo: Springer Berlin Heidelberg.

- Fritscher, B., & Pigneur, Y. (2011). Business IT alignment from Business Model to Enterprise Architecture. CAISE 2011 Workshops, LNBIP 83 (pp. 4-15). Springer-Verlag Berlin heidelberg 2011.
- Gordijn, J., & Akkermans, J. M. (2003). Value based requirement engineering: exploring innovative ecommerce ideas. *Requirements Engineering*, 114-134.
- Gordijn, J., & Wieringa, R. J. (2003). A Value-Oriented Approach to E-Business Process Design. *CAISE, LNCS 2681*, 390-403.
- Grant, R. M. (1996). Towards a Knowledge-Based Theory of the Firm. *Strategic Management Journal*, 109-122.
- Grover, V., Lee, C. C., & Durand, D. E. (1993). Analyzing methodological rigour of MIS survey research from 1980-1989. *Information and Management*, 305-317.
- Iacob, M. E., & Jonkers, H. (2006). Quantitative Analysis of Enterprise Architecture. *Interoperability of Enterprise Software and Applications*, 239-252.
- Iacob, M. E., & Jonkers, H. (2012c). *Quatitative Analysis of Enterprise Architecture and ArchiMate: A state of the Art.*
- Iacob, M. E., Meertens, L., Jonkers, H., Quartel, D. A., Nieuwenhuis, L. J., & Sinderen, M. J. (2012a). From Enterprise Architecture to Business Models and back. *Software and Systems Modelling*.
- Iacob, M. E., Quartel , D., & Jonkers, H. (2012b). Capturing Business Strategy and Value in Enterprise Architecture to support portfolio valuation. *Enterprise Distributed Object Computing Conference (EDOC), 2012 IEEE 16th International* (pp. 11-20). Beijing: IEEE.
- Janssen, W., Buuren, R. v., & Gordijn, J. (2005). Business Case Modelling for E-Services. 18th Bled eConference eIntegration in Action. Bled, Slovenia.
- Johansson, M., & Jonsson, A. (2012). The package logic: A study on value creation and knowledge flows. *European Management Journal*, 535-551.
- Johnson, P., Iacob, M. E., Valja, M., van Sinderen, M., Magnusson, C., & Ladhe, T. (2013). Business model risk analysis: predicting the probability of business network profitability. 5th International IFIP Working Conference, IWEI 2013, (pp. 118-130). Enschede: Springer Berlin Heidelberg.
- Jonkers, H., Band, I., & Quartel, D. (2012). Archinsurace Case Study, White Paper. The Open Group.
- Kinderen, S. d., Gaaloul, K., & Proper, H. A. (2012a). Bridging value modelling to ArchiMate via transaction modelling. *Software Systems Model*.
- Kinderen, S. d., Gaaloul, K., & Proper, H. A. (2012b). Intergrating Value Modelling into ArchiMate. *Third International Conference, IESS 2012* (pp. 125-139). Geneva: Springer Berlin Heidelberg.
- Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in Information Systems. *MIS Quaterly Special Issue*, 67-94.
- Kundisch, D., & Thomas, J. (2012). Business Model Representation Incorporating Real Options: an Extension of e3-value. 45th International Conference on System Sciences (pp. 4456-4465).
   Hawaii: IEEE.

- Lankhorst, M., & van Drunen, H. (2007, March 21). *Enterprise Architecture Development and Modelling - Combining TOGAF and ArchiMate.* Retrieved from www.novay.nl: https://doc.novay.nl/dsweb/Services/Document-72847
- Lepak, D. P., Smith, K. G., & Taylor, M. S. (2007). Value Creation And Value Capture : A Multilevel Perspective. *Academy of Management Review*, 180-194.
- Likert, R. (1932). A technique for the measurement of attitudes. Archives of Psychology, 1-55.
- Meertens, L. O., Iacob , M. E., Nieuwenhuis, L. J., Sinderen, M. J., Jonkers, H., & Quartel, D. (n.d.). Mapping the Business Model Canvas to ArchiMate.
- MIT, S. (2013, August 10). *Enterprise Architecture*. Retrieved from MIT Sloan Management, Center for Information Systems Research: http://cisr.mit.edu/research/research-overview/classic-topics/enterprise-architecture/
- Newsted, P. R., Huff, S. L., & Munro, M. C. (1998). Survey Instruments in Information Systems. *MIS Quaterly*, 553-554.
- Nickerson, J. A., & Zenger, T. R. (2004). A Knowledge based Theory of the Firm -- The Problem Solving Perspective. *Organization Science*, 1-16.
- Normann, R., & Ramirez, R. (1993). From Value Chain to Value Constellation : Designing Interactive Strategy. *Harvard Business Review. Vol.71. Issue 4*.
- O'Cass, A., & Ngo, L. V. (2011). Examining the Firm's Value Creation Process: A Managerial Perspective of the Firm's Value Offering Startegy and Performance. *British Journal of Management, Vol. 22*, 646-671.
- Osterwalder, A. (2004). *The Business Model Ontology A Proposition In a Design Science Approach.* Universite de Lausaane.
- Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2008, Winter 2007-08). A Design Science Research Methodology for Informations Systems Research. *Journal of Management Information Systems, Vol. 24*(No. 3), 45-77.
- Peppard, J., & Rylander, A. (2006). From Value Chain to Value Network : Insights for Mobile Operators. *European Management Journal*, 128-141.
- Pijpers, V., & Gordijn, J. (2008). Consistency Checking between Value Models and Process Models: A best of breed approach. *BUSITAL* (pp. 58-72). Montpellier: CEUR.
- Pombinho, J., Aveiro, D., & Tribolet, J. (2012). A Value oriented approach to Businee/It alignment -Towards formalizing purpose in systems engineering. *CAiSE 2012 Workshops LNBIP 112* (pp. 555-566). Springer-verlag Berlin Heidelberg 2012.
- Porter, M. E. (1985). *Competitive Advantage: Creating and Sustaining superior performance.* New York: The Free Press.
- Priem, R. L., & Butler, J. E. (Jan 2001). Is the resource-based "view" a useful perspective for strategic management research? *The Academy of Management Review* ;26,1, 22-40.
- Rajnoha, R., Sujova, A., & Dobrovic, J. (2012). Management and economics of business processes added value. *Procedia Social and Behavioral Science* (pp. 1292-1296). Elsevier.

- Rayport, J. F., & Sviokla, J. J. (1995). Exploiting the Virtual Value Chain. *Harvard Business Review*, 75-85.
- Schuster, R., & Motal, T. (2009). From e-3 value to REA: Modeling multi-party eBusiness
   Collaborations. *Commerce and Enterprise Computing, 2009. CEC '09. IEEE Conference on*, (pp. 202-208). Vienna.
- Sirmon, D. G., Hitt, M. A., & Ireland, R. D. (2007). Managining Firm Resources In Dynamic Environments to Create Value: Looking Inside the Black Box. *Academy of Management Review, Vol. 32, No. 1*, 273-292.
- Stabell , C. B., & Fjeldstad, O. D. (1998). Configuring Value for Competitive Advantage : on chains shops, amd networks. *Strategic Management Journal*, 413-437.
- The Open Group. (2012). ArchiMate 2.0 Specifications. Zaltbommel: Van Haren Publishing.
- Vargo, S. L., Maglio, P. P., & Akaka, M. A. (2008). On Value and value co-creation: A service systems and service logic perspective. *European Management Journal*, 145-152.

Wernerfelt, B. (1984). A Resource-based view of the firm. *Strategic Management Journal*, 171-180.

Wieringa, R. (2009). Design Science as Nested Problem Solving. DESRIST '09. ACM.

# Appendix A - Some question on the algorithm

#### Q1: How it can be proved that the algorithm will not keep running in a cycle?

A1: It is necessary to make sure that the algorithm will not run in a loop forever. For the algorithm to run in loop there must be a loop present in the EA model we run the algorithm on.



From the figure above, we can see that Service A uses Service B, Service B uses Service C and Service C uses Service A, leading to a loop.

Let's assume that such a situation exists in given ArchiMate of a firm. We run the algorithm on the above partial model to show that the algorithm will not keep running in an endlessly when encountered with a loop in the model. Let's assume that the parent and relationship field of all elements are equal to NULL. The starting element is *Service A*. It is put in the *Stack* and also in the new model.

**Step 1**. Service A uses Service B. Here  $E_0$ = Service A, X is Service B and Y: *Uses*. X is an element of N and Y is an element of E. So the first condition is true. So addition is made in the new model showing a *used by* relationship between Service A and Service B. Also Service B is put in S (as its state field is not equal to 'is checked') with its parent and relationship attribute = NULL.

**Step 2.** Since all the relationships for Service A is checked, the control moves to Step 5 and then sent to Step 2. Its state field is marked as "is checked". *S* is not empty and one element is popped out, which is *Service B*.

**Step 3.** Service B uses Service C. Here  $E_0$ =Service B, X is Service C and Y: *Uses*. X is an element of N and Y is an element of E. So the first condition is true. So addition is made to the new model showing a *used by* relationship between Service B and Service C. Also Service C is put in S (as its state filed is not equal to 'is checked') with its parent and relationship attribute = NULL.

**Step 4:** Since all the relationships for Service B is checked, the control moves to Step 5 and then sent to Step 2. Its state field is marked as "is checked". *S* is not empty and one element is popped out, which is *Service C*.

**Step 5:** Service C uses Service A. Here  $E_0$ =Service C, X= Service A and Y: *Uses.* X is an element of N and Y is an element of E. So the first condition is true. So addition is made to the new model showing a *used by* relationship between Service C and Service A. The state field of *Service A* is equal to 'is checked' so it not put in *S*.

**Step 6:** Since all the relationships for Service C is checked, the control moves to Step 5 and then sent to Step 2. S is empty and the algorithm stops.

Thus, by using the *state field* for every element of the given model we can avoid endless loops by the Algorithm. The above clarification is also supported by the implementation of the algorithm in BiZZdesign Architect. It results in the same new model and the does not continue running in a loop.

# Q2: Can the same element in the stack have different parent and relationship fields, because of two different paths. How will this affect the result of the algorithm?

A3: Yes, there can be a situation when the same element occurs in the stack more than once with a different parent. We want to check that whether the relationships via 2 or more different paths will be preserved. This can be explained with the help of the diagram below.



Remember that the *Application Interface* is not an element of N. Also let's say that the algorithm starts with the *Service A* in stack, having parent and relationship field equal to NULL. We want to preserve the derived relationship between *Service A* and *Service C* and also the derived relationship between *Service A* and *Service E*. We run the run algorithm on the above model fragment and the output is shown below.



The output model shows that the algorithm preserves the relationship between in case of two or more diverse between involving an element which is not an element of N. As we can see from the output model above, in spite of *Application Interface*, not being an element of N, the derived relationships have been preserved. *Service D*, was put in the stack twice, representing 2 different derived relationships.

Q3. There can be a situation that there are two or more consecutive elements which fulfill the 2 condition of the algorithm, what will be the output of the algorithm them? In other words, can there a situation there an element is parent of another parent?

**A3:** To explain the above situation, let's consider the example figure below. The Application Interface and Infrastructure Interface are not elements of N.



We run the algorithm on the above model and the output is given below.



The business service, during the execution of the program be will the parent of parent i.e. first it will be made the parent of Application Interface and then it will be made the parent of Infrastructure Interface, via inheritance.

# Appendix B– Object Oriented Pseudo code of the Algorithm

An object oriented pseudo code of algorithm is shown here. This pseudo code consist of 6 function which together traverse an input ArchiMate model and create a the value model.

The table below shows the different functions. For every function, it is shown which other function it calls.

	Function name	Input Attribute	Returns	Calls functions	Description
1.	Push	The element X, Stack	None	None	If an element has not been checked before it is pushed in the stack.
2	Рор	Stack	The element X	None	This functions pops an element from the stack and return that element.
3	Find Lowest Relationship	Element EO, and a relationship (Y).	E0: relationship or Y: Type.	None	It compares the relationship field of the element EO and Y. The type of the lowest weighted relationship is returned.
4	Update Fields	One element of type parent. One element of type relationship and X.	None	None	This function updates the parent and relationship field of the element X.
5	Create model function	The E0 element, X, Y and the new model		Find Lowest Relationship, Push,	This function is used to make the new model. The addition is E0 -> X via Y real.
6	Check	E0 element X, Y	None	Create Model, Make parent and relationship	Main function which decides on the type of X and Y and then calls the different Functions
7.	The main program	None	None	Check	This is the main program

```
Start
{
Push starting element in S and create it in the New Model.
Till S is not empty;
    {
    Let E0 = POP (S)
        {
        For every relationship which E0 has to X via Y;
        CHECK (E0, X, Y);
        }
    Mark E0: state as "is checked"
    }
}
Stop
CHECK (EO, X, Y)
    {
    If (X: type \in_{N}) AND (Y: type \in_{E})
        UPDATE FIELD (Null, Null, X);
        CREATE MODEL (E0, X, Y);
        }
    If (X: type! \in_{N}) AND (Y: type \in_{E})
        {
        If E0: Parent = NULL
            {
            UPDATE field (E0, Y, X);
            }
        If E0: Parent! = NULL
            {
            Let Y (real) = FIND LOWEST RELATIONSHIP (E0, Y)
            UPDATE (E0: parent, Y (real), X);
            PUSH (X);
            }
        }
    If (Y: type! \in_{E})
        {Do Nothing}
    }
POP (S)
    {
    Read Stack
    Pop one element from q
    Return the element
    }
CREATE MODEL (E0, X, Y)
    {
    If X does not exist in New Model. Put X in the model.
    Let Y (real) = FIND LOWEST RELATIONSHIP (E0, Y)
    If E0: parent = NULL then in the model make a link between E0 to X via Y
(real)
    If E0: parent! = NULL then in the model make a link between E0: Parent
to X via Y (real)
    PUSH (X)
  }
```

```
PUSH (X, S)
   {
   If X: State = Not checked
   Push X in stack
    }
UPDATE FIELD (M, N, X)
    {
    X: Parent = M
   X: Relationship = N
   Return (null)
    }
FIND LOWEST RELATIONSHIP (E, Y)
    {
    Let T = lowest weighted relationship between E: relationship and Y;
    Return (T)
    }
```

Assumptions: All assumption which were stated for the earlier version of the algorithm in chapter 3, apply to this pseudo code also.

# Appendix C – Personal Interview Responses

## **Interviewee 1**

#### Q1: Do you think the methodology is practical – can be applied in practice.

A1: Yes, I do think so. You have to be clear as to which stakeholders to approach, because you focus at the application layer, technology layers as well as business layer, in large organization it becomes quite difficult to determine which stakeholders are important for you to use this methodology. In practice it won't be the architect, it will be the product owners or the process owners high in the hierarchy of the organization, but I think it can be quite useful to answer some questions which they have. So, I think it is very useful.

# Q2: What do you think about the classification of ArchiMate elements as resources, activity, process and value (proposition)?

A2: Yes, it is correct. Just the concept of actor, was the only thing which I had a struggle with in understanding. In practice the business role is not often used but the actor is used instead. The only concept that can be become more difficult part in this methodology. So you have to find a solution for adding the concept of actor. The actor concept needs to be involved as a substitute of the business role. The other ends are quietly good used.

#### Q3: Is the resultant model and value tables a good representation of value creation at process level?

A3: Yes but we miss different attributes like soft skills, which play a major role in being able to perform different business processes and those are mainly captured with attributes in ArchiMate. They need a place in this methodology as well, how can we use attributes to link to those attributes as well. For instance experience, trainings you have been following to make a certain decision in a business process. I miss those concepts in this is quite a detailed level and in practice I don't think that most of the ArchiMate users are using ArchiMate at such a detailed level. So, that is a tricky part.

#### Q4: Is the value network perspective represented appropriately in the methodology?

A4: I think that is quite good represented. I think that you are almost spot on. I think you done a great job. I think you can plot them one on one.

#### Q5: Can the resultant model and the value tables can be used as input for Business IT alignment?

A5: Business IT alignment is quite a broad subject and I think it can help but Business IT alignment goes further than just adding of a value model, it's also about politics, responsibilities, about business trying to do a part of the role of IT and vice versa. So, I think they can help to form a discussion about the Business and IT alignment but the actual answer goes way further than ArchiMate and the usage of models. It comes down to people and responsibilities and about politics, and how useful ArchiMate can be and how useful models can be their roles are also limited and they have boundaries. One of the boundaries of ArchiMate is that you can't use it to solve political problems and organizational problems. So, I think the methodology can help to discuss those problems but the main problem is not in the insight on these concepts but it is on politics and responsibilities. And I don't think it can give a complete solution to these problems, but it can help to gain the insight.

## **Interviewee 2**

#### Q1: Do you think the methodology is practical – can be applied in practice.

A1: Yes, I think it is a very practical method because you add a script that make possible to simplify the models and analyze the business service; which parts are helping to create a value proposition. So, I think it is relevant and applicable.

# Q2: What do you think about the classification of ArchiMate elements as resources, activity, process and value (proposition)?

A2: I think in general you made a good allocation of the different ArchiMate elements to the different parts of your framework as you use it. But the distinction between processes and task as you made them in your framework and how you make the mapping by putting business processes at a higher level of abstraction than business functions, I find that a questionable choice. For the rest part I think you made a good allocation of mapping the two, but by making an explicit choice in your framework, what is higher abstraction and what is a lower abstraction, I find the allocation of business process and business functions, I was a straction of business process and business function.

#### Q3: Is the resultant model and value tables a good representation of value creation at process level?

A3: Yes, if you make them correctly, then yes. I think you captured both elements.

#### Q4: Is the value network perspective represented appropriately in the methodology?

A4: First of all your methodology gives you an option to add external value. In that sense, yes, it gives you an option. But, that is not a very elaborate way of adding external value. You simply state, that you can add it to a table and then you have to map it to an existing process, which is an internal process, then the question is, what kind of value are you stating there. So, the telephone example, is that an added value to the value proposition or is that a value that you need to execute a process. So, you are now adding to the external table, value things that you wanted to identify, which don't have much to do with the value proposition anymore. It has to do with the value of the process, and not with the value proposition. So I think you have to make a very clear distinction there, whether this is value that which you add to your value proposition that you are offering to the customer or whether this is value you are modeling for your own proposition that you are getting form somebody else. So, it is actually what you are modeling in your external value table, is actually the value proposition somebody else if offering you, namely the option to use a telephone, is the value proposition from another company to you. So now you are incorporating, putting things, on one big pile, which I think you have to really think carefully about what that actually means. Because the question is whether that telephone option is adding to your value proposition. It might be, and then it is part of a complete value chain, which goes thorough different companies, where different companies together create the value proposition. So, then you have to really think what you are actually modelling in that external table. And if you want to incorporate that, (the chain) then you also have to look further, because there might be companies behind that. There might be more value added the just the telephone option. So I think you are showing there, that I am not alone in creating this value proposition and I think it is a good way of showing that, there is more to my business process than just me. But it doesn't cover the whole spectrum. This is where you can use something which is incorporated in e-3 value model, which does allow you to model the whole chain. So, I think it is a good start and it is a good way to show I am not on my own creating this, I am a company that works with other companies. I think it is also difficult to put numbers on the value which other companies make for you. So, I think it is useful how you did it, but it does not cover

the whole spectrum. I also think that it is not necessary to cover the whole spectrum. But you have to aware that this is the limitation of your methodology.

#### Q5: Can the resultant model and the value tables can be used as input for Business IT alignment?

A5: It really gives you a good starting point that ok, we are looking at this business service and how does my IT help create this business services. So that makes it a very nice starting point.

### **Interviewee 3**

#### Q1: Do you think the methodology is practical – can be applied in practice.

A1: Yes, it is but one important point to address is when you look from the point of the client which has complex models and in the methodology you say that you have to normalize the models, but I think you always have to look, at what is the situation of the customer, which kinds of models he/she has and how can we then apply, because I really think that it really depends on which maturity level the company has on Architecture, whether they can apply it; so I think it is more applicable for customers that have higher maturity level, which already have more complete Architecture models and also more coherent modeling that a client who is just on a lower level and just starting with Architecture. I think for those companies it is not that applicable yet.

# Q2: What do you think about the classification of ArchiMate elements as resources, activity, process and value (proposition)?

A2: I find the hierarchy of a business process above that of a business function questionable. You have the business role as a resources, I would also add the business actor to resource field, because I see in practice that also customers usually use either actors or roles. They don't want to use them both, because the diagrams become too complex. So, if you want to cover that aspect then you need to include the business actor in the resources part of your framework as well. For, the rest it was a good classification.

#### Q3: Is the resultant model and value tables a good representation of value creation at process level?

A3: Yes, I agree, but I think the tables should be combined with the models, to form a new diagram. Only the tables, separate from the model, then there is still one more step to go, to combine them, so it would be even more valuable if you can combine into a view. Then you have one view with the complete result.

#### Q4: Is the value network perspective represented appropriately in the methodology?

A4: It is difficult to see it with the tables, in my opinion. The nice thing would be to include it in a diagram and then you can nicely say that we see here all kinds of other values may be in a different color. It is far better to explain in a graphical way than the table.

#### Q5: Can the resultant model and the value tables can be used as input for Business IT alignment?

A5: Yes, these are good inputs, but Business IT alignment is a very broad term. It is not only about value. It is also about how well our applications use used for executing business processes, all kinds of questions which you can put under the umbrella of Business IT alignment, this value question is an important one but it is only one part of it. So probably when you have to talk about Business IT alignment, you must have other inputs, but it can serve as a nice point for start of discussion. Like, if you look form a value perspective, this is the result, what are we going to do, what are we going to do with it. But then other elements, come into this discussion. So that is something you have to be aware of, but to start a discussion, I think it will serve well.

Sometimes you have companies who are only focusing on IT and there is still a big gap between Business and IT. Still a lot of companies are struggling with this. So, I think that the value perspective is one which can give new insights. In most of the times, it is like, ok, how we are going to build a new application, because we have an old application which needs to be replaced, but it is very complex, and the project takes 5 years longer than expected. The questions which is not discussed may be, is that what kind of value it will give to the company as a whole. So, it could be a really good perspective.

### **Interviewee 4**

#### Q1: Do you think the methodology is practical – can be applied in practice.

A1: Most companies that have mature enterprise architecture capability, they have these customized models that are not complaint to the ArchiMate specifications, in which they have added some concepts, for instance. Whereas, Clients who are just starting with ArchiMate, they are just using the specifications, so their models are ArchiMate complaint. So I think if you have a more mature level of Enterprise Architecture, they might take more time to normalize the model, and I think lot of customers don't want to normalize their models, they want to use their models. So that it one critical not but for rest of the methodology itself I think it is really applicable.

# Q2: What do you think about the classification of ArchiMate elements as resources, activity, process and value (proposition)?

A2: The classification of the business process as a process and above in hierarchy to that of a business function is not clear. Also, the business actor should be included as a role.

#### Q3: Is the resultant model and value tables a good representation of value creation at process level?

A3: I think for an impact analysis it could be really useful, but I still think you really need some sort of strength in your methodology, so you can really say, this adds more value, or this is more important for added value than some other concept. Because, now in your final model you have some infrastructure elements and some business elements, so I think you really want to know some kinds of strength of the relationships from the elements to the value concepts.

I think that there should a mix of automatic and manual allocation of strength to relationships and elements. The inbuilt strength of relationships can be starting point for that. You need human knowledge to be able to add a weight or strength to an element. This is probably something for future research.

#### Q4: Is the value network perspective represented appropriately in the methodology?

A4: No, not really I think. Because you really focus on internal value for one company, for the one you use some ArchiMate models for. I can see the link may be for the value in the network of companies, but that's about it.

#### Q5: Can the resultant model and the value tables can be used as input for Business IT alignment?

A5: I think that it can be an input definitely, but it is not the final view to say something about the Business IT alignment. I think you can say that for this proposition these infrastructure elements are very important but that's it. So it is just an input. I think for Business IT alignment most important is the mindset, computational resources should add business value, somehow.

Lot of people say that we are way past the Business IT alignment discussion, we are all business and have to deliver something to the customer, whether we do it in terms of business or in terms of IT. The IT eventually should deliver business value. Many companies say that, we are all business. And Business IT alignment, it's very broad and some people say that we are say that we are way past that discussion.

### **Interviewee 5**

#### Q1: Do you think the methodology is practical – can be applied in practice.

A1: It might be. Some steps need to be worked out a bit further, because there are a lot of manual steps.

# Q2: What do you think about the classification of ArchiMate elements as resources, activity, process and value (proposition)?

A2: I think the classification is very good. There are some minor things which might change but in general they are very good.

I am not sure if process is at the process level, as placed by you, on its own, for me it is part of behavior and it might be a good way to group other activities, but then still it is one the same level as the activities.

#### Q3: Is the resultant model and value tables a good representation of value creation at process level?

A3: I think they represent a part of value creation, some parts might be missing but then again, those might be the parts which usually you don't have at the process layer, but at the strategic layer.

#### Q4: Is the value network perspective represented appropriately in the methodology?

A4: I am not convinced that it is. I think that they need to be better specified, who is in the network, what value do they add and how they add. External value tables can be one way of writing it down, but I think parts are being missed out. If I am in a value network, I would like to see an overview or picture of the value network, which shows the relations of not only the partner to you but also to the other partners. ArchiMate doesn't usually capture this either. It might not be possible with is methodology to do it at all.

#### Q5: Can the resultant model and the value tables can be used as input for Business IT alignment?

A5: I am not sure if they are suitable for alignment. There is very little to actually points to alignment. Right now it mainly seems as a Business Tool to see 'how is my value created', and not such a connection with IT. Actually, I think we can make these models without including IT altogether. I think the most important thing for Business IT alignment is, in fact one part of it, is what you are trying to show i.e. the value which the IT offers to the business, that must be made very clear, the business should know, the value of the IT, and this methodology might help in that. On the other hand IT needs to know what they offer to the Business, what more they can offer to the business, than they are doing now.

Now that I am talking to you, I am getting a better idea of how this may help. It is after all about value, showing people the value being offered.

I think the resultant model can be an input for quantitative analysis. The form you give to the model is much easier to work with than most of the original models. The hard part is not so much in your methodology but in definition and quantification of the value object altogether. You could put costs in these models, then it would be quite clear, but it is the benefits which are much harder to quantify.

# Appendix D – Survey Response



Chart 6: Responses for Question 1



Chart 7: Responses for Question 2


Chart 8: Responses for Question 3



Chart 9: Responses for Question 4



Chart 10: Responses for Question 5



Chart 11: Responses for Question 6



Chart 12: Responses for Question 7



Chart 13: Responses for Question 8



Chart 14: Responses for Question 9



Chart 15: Responses for Question 10



Chart 16: Responses for Question 11



Chart 17: Responses for Question 12



Chart 18: Responses for Question 13



Chart 19: Responses for Question 14



Chart 20: Responses for Question 15



Chart 21: Responses for Question 16