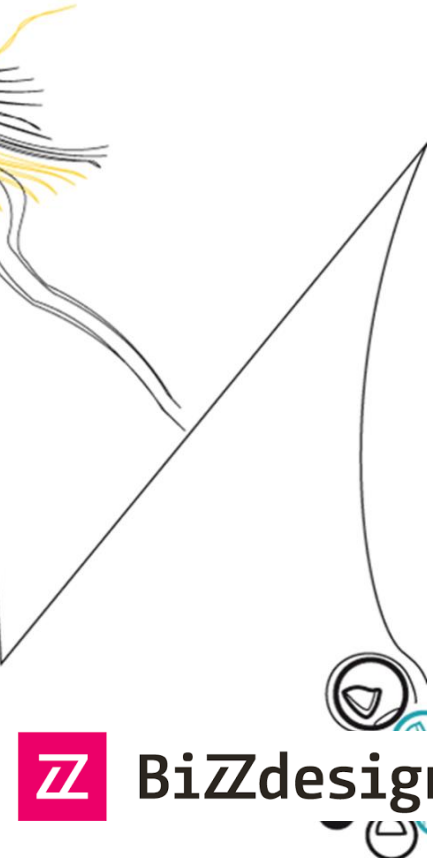
UNIVERSITY OF TWENTE.

Faculty of Electrical Engineering, Mathematics & Computer Science

Modeling and Analyzing Digital Business Ecosystems

Marcella Cindy Kusumaningrum
M.Sc. Thesis
May 2017



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MASTER THESIS

MODELING AND ANALYZING DIGITAL BUSINESS ECOSYSTEMS

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Acknowledgement

This master thesis concludes my master study majoring 'Business and Information Technology' at the University of Twente. This thesis also signifies the end of my student life, which I consider as an unforgettable and memorable journey. At first, I was a bit doubtful that I am able to finish this study, as the subjects are slightly different with my background. However, with the help and support of people around me, now I have gotten to the point that I have completed my study. Therefore, I would like to acknowledge them for their encouragement and contribution, that I am able to finish this graduation project in order to get my master's degree.

First of all, I want to express my gratitude to the Lord for the blessings and guidance during my study here. I would like to extend my gratitude to the University of Twente for giving me the opportunity to pursue my master degree, as well as providing the funding for my studies. I also want to thank Mr. Jan Schut who helped me in getting the scholarship. My educational pursuits would not be possible without generous support from them.

Second, I would like to express my sincere gratitude to my thesis supervisors: Dr. Maria-Eugenia Iacob and Dr. Maya Daneva for the guidance, trust, and supports that I can finish the thesis earlier than expected. I also want to thank Mr. Dick Quartel from BiZZdesign who gave me the opportunity to do my graduation project as an intern in the company. I would like to extend this gratitude to Dr. Adina I. Aldea, as my company supervisor who has given me continuous supervision and support. I highly appreciate your time and effort in providing valuable advice and insights for my thesis. It has been an honor and pleasure to work with you all.

Third, I would like to thank all my friends and classmates for all help and supports during my study here. Moreover, I would like to say thank you to my housemates in Calslaan 1-1 for the togetherness and great experiences, especially during the first year of my study. Also, I would like to express special thanks to my friend, Latifah Helmy Masyhur, who is my classmate, teammate, travel partner, and working partner during the internship period.

Finally, I would like to give thanks to my family and my boyfriend in Indonesia, who allow me to pursue a master's degree abroad, as well as providing me with unfailing support and continuous encouragement throughout my years of study. This accomplishment would not have been possible without them.

Enschede, May 2017

Marcella Cindy Kusumaningrum

About BiZZdesign

BiZZdesign is a business design company that supports organizations in designing business change. With more than a thousand customers worldwide, BiZZdesign owns staff offices in many countries with the main headquarters located in the Netherlands.

Besides being in the consultancy field, BiZZdesign is also known as a software company that provides an advanced platform for planning, tracking and executing business change. The main product is BiZZdesign Enterprise Studio, which is a collaborative business design platform that offers powerful, integrated modeling across multiple disciplines. It provides all the capabilities needed to seamlessly plan, track and execute change in a single software platform. BiZZdesign Enterprise Studio enables the integration of several disciplines within an organization, such as supporting enterprise architecture, business process management, portfolio management, business model & strategy, governance, risk, & compliance, business logic, and data management.

Founded in 2000 as a spin-off from an applied R&D institute, the company has strong roots in research and innovation. The products are based on company's expertise on business design and change. The company also partners with leading consultancies, distributors and resellers to provide the customers with the best support possible. The company's dedication to fulfilling customer needs is reflected in the company's rapid growth and long-standing customer relationships. Company's field force of consultants brings the company with the latest information on customer needs and market trends. Analysts recognize BiZZdesign as a market leader with class-leading products.

Some achievements have been accomplished by the company, including TOGAF® 9 Tool Certification for BiZZdesign Architect 3 by the Open Group[1], "Best Newcomer"-award at the Open Group Conference[2], and acknowledgment as a Leader in Gartner Magic Quadrant for Enterprise Architecture 2011[3].

A lot of companies have experienced fruitful results after designing their digitization with the help of BiZZdesign and its software. Furthermore, BiZZdesign Enterprise Studio is suitable not only profit organizations, but also non-profit organizations. One of the non-profit organization which has a success story of implementing BiZZdesign Enterprise Studio is Dutch Tax Office.

[1] https://certification.opengroup.org/register/togaf/bizz_togaf_atc_cert.pdf
[2] https://blog.opengroup.org/tag/mike-lambert/
[3] https://www.gartner.com/doc/1839614/magic-quadrant-enterprise-architecture-tools

Table of Contents

List of Figures

List of Tables

1. Introduction

Collaboration among companies nowadays is a common trend, but it is also necessary to be ahead of the competition, as well as to survive in the current dynamic and turbulent business market (Hoyer & Stanoevska-Slabeva, 2009). Moreover, the collaboration may aid the enterprise to address the customer needs, while keep focusing on its core business (Peter James & Arnoud De, 2012). However, the emerge of advanced technology brings more complexity in managing the collaboration amongst the business players, while implementing technology may have significant effects in accomplishing the enterprise goal.

Thus, to manage the complexity and to deal with the dynamic environment, enterprises should consider the possibility of collaborating with other organizations within an ecosystem. The collaboration in an ecosystem is considered crucial for the organizations as it can provide more value for the stakeholders (Tencati & Zsolnai, 2009), as well as to support value delivery to the customers (Peter James & Arnoud De, 2012). Thus, to facilitate digital based collaboration, the Digital Business Ecosystem (DBE) emerges.

The digital business ecosystem term was firstly introduced as the coevolution of business ecosystem and digital ecosystem (Nachira, Nicolai, Dini, Le Louarn, & Leon, 2007). The digital business ecosystem (DBE) is a "digital environment" populated by "digital species", such as software components, applications, services, and so on (Nachira, 2002), which fits not only for digital businesses but also for any other types of enterprise.

Although it may be beneficial for the companies, the current research regarding digital business ecosystem is considered as still young, as not too many researchers investigate the topic. At the same time, the practitioners recognized that the ecosystems are powerful tools that brings the company to be ahead of the competition, which is also corroborated by the CEOs from some big companies, including Alibaba, Japan's Softbank and Nokia (Kelly, 2015). Thus, conducting research in the field is expected to give contribution not only in the academic area but also for practical needs of enterprises.

In order to address the previously identified research gap, we conduct the research presented in this thesis. This study is expected to provide the modeling and analysis of digital business ecosystems, which enables companies to evaluate the prospective advantages of becoming a member of an ecosystem. Some of the possible analysis for measuring ecosystems includes profitability analysis, goal analysis, and resource analysis. Therefore, the analysis provided in this research is aiming at supporting the companies in assessing the potential benefits of joining the ecosystem, as well as to identify the future opportunities as the result of being a member of an ecosystem. In addition, within this research, we propose modeling support for digital business ecosystems, which uses the ArchiMate modeling language. To sum up, an architecture-driven approach, which is represented by ArchiMate, contributes to the modeling and analysis of digital business ecosystems.

In order to provide a detailed explanation regarding the issues as mentioned above, this study is divided into several chapters. A brief background of the research is described in this chapter (*Chapter 1*), while other chapters aim at answering the research question

of the study. To be more specific, *Chapter 2* explains the current situation of digital business ecosystems in order to answer the first sub-research question. *Chapter 3* provides a comprehensive explanation of modeling and analysis of digital business ecosystems, which covers the second and third sub-research question. *Chapter 4* presents the demonstration of the proposed approach in a case study. As the digital business ecosystems is considered crucial in practice, evaluation by the practitioners in the field is conducted, and the results are provided in *Chapter 5*. In the last chapter (*Chapter 6*), the overall result of the study will be presented in order to give a comprehensive view of the research purpose.

In the end, the results of the study presented in this thesis are expected to contribute not only in the academic field but also in practice. For the academic purpose, the research can be considered as the extension of the current study related to digital business ecosystems. In practice, this study is expected to provide guidelines for modeling and analysis of ecosystems, which can be used by the practitioners in the companies, in particular for the stakeholders at CxO level. To be more specific, the purpose of this research is to assist the enterprise either to be a member of a digital ecosystem or to stay within a digital business ecosystem, and the result should contribute to the organization long-term planning by helping the stakeholders to adopt an ecosystem view of the firm.

As an addition, since the research is related to the digital environment, the result is expected to give more contribution to the electronic businesses, such as e-commerce. However, the result of the research is not limited to the electronic commerce purpose only.

Although this study is expected to bring contributions to the field, there are several limitations found in this research. First, as there is a limited amount of data available for the case study, the result of the proposed approach may be different if applied to other cases. Therefore, further investigation to find out where the approach is applicable should be conducted. Second, the approach provided in this study only limited to several numbers of analyses, while there are more types of possible analysis available to assess the ecosystems. Thus, it is expected that there is a further research in the future with the purpose to extend the analysis based on the result of this study.

1.1. Problem Statement

A digital business ecosystem is constructed when the “adoption of Internet-based technologies for business” is on such a level that “business services and the software components are supported by a pervasive software environment, which shows an evolutionary and self-organizing behavior” (Nachira, 2002). The term is derived from the study of the business ecosystem by J. F. Moore (1996), which is defined as an economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world.

The digital business ecosystem topic is getting more attentions, in particular for the practitioners, as it is considered as an important for an enterprise to survive in dynamic environment (Hoyer & Stanoevska-Slabeva, 2009). In addition, the collaboration between enterprises in the digital business ecosystem is considered crucial, as it can

provide value to the organizations in the ecosystem, which indirectly related to the sustainability of the company itself (Tencati & Zsolnai, 2009).

As more and more companies transforming into the digital environment, leveraging the strategy of the digital business ecosystem will assist the e-business players to respond to the market changes. One of the most successful e-commerce companies in maximizing its digital business ecosystem is Amazon. In addition, the emerge of complex business environment requires the company to be better in managing its ecosystem. Thus, the digital business ecosystem is considered to be effective in improving overall business strategy, especially for certain types of enterprise, such as e-business and e-commerce.

As an addition, practitioners are realized that digital business ecosystems can bring success to the firm, which can be done by enabling a cooperative network (Kelly, 2015). In order to facilitate the cooperation, it is necessary to provide an ecosystem, in particular for the digital businesses. Thus, besides contributing to the research in the academic area, this study is also expected to give a contribution in practice, specifically by providing a specific guideline for modeling and analyzing digital business ecosystems.

Although a lot of benefits of digital business ecosystems can be found, it is still unclear how to model and analyze the digital business ecosystem. Various approaches and methodologies may be helpful in managing digital business ecosystems. Still, particular tool and framework for modeling and analysis purpose are needed. It appears that many researchers have made some efforts to implement various frameworks and methodologies as the basis for ecosystem modeling, but none have completely fulfilled the necessity of an ecosystem. Hence, modification and extension of the frameworks and methods are arising in the field. Currently, the most potential research, which is able to define the logic of the digital business ecosystem, is the v^4 ontological structure of business model by Al-Debei and Avison (2010). The proposed ontology shows a promising future as it combines various elements and concepts of several business models which are grouped into four dimensions in order to help an organization in capturing the values in return.

As the v^4 ontological framework of business model does not show the language necessary for modeling and analysis, the enterprise architecture concept will be referred in this thesis. Enterprise Architecture (EA) is believed to be a good representation as it enables a high-level view of a firm's business processes and IT systems as well as increasing knowledge about the organization and its goals (Tamm, Seddon, Shanks, & Reynolds, 2011).

In order to follow up the modeling process, additional analyses related to digital business ecosystems are also needed. Possible analysis for digital business ecosystems can be adopted from the available business analysis, such as profitability analysis, goal analysis, and so on. However, to conduct these analyses, specific methods are also required. Thus, this study is also expected to define possible methods which are relevant to motivate the analysis, such as linear programming method and analytical hierarchy process (AHP) method. Detailed explanation regarding the analyses will be provided in *Chapter 2*.

1.2. Research Objective

The objective of the research is to provide a specific approach to model and analyze digital business ecosystems, which is presented to answer the problems as previously mentioned. The proposed approach is expected to bring advantages to the enterprise by enabling the organization to assess the benefits of joining a digital business ecosystem. Moreover, if a company is already a member of an ecosystem, the approach is considered beneficial as it can help the organization to identify possible opportunities in the future, or to assess the inefficiencies in the current business.

In order to present thorough guidelines for managing digital business ecosystems, a specific approach to model and analyze the ecosystem should be provided. Moreover, as many types of business are available, the proposed approach should be flexible and extensible for any kinds of business environments. Thus, the proposed approach arises from the adoption of existing methods in the fields, which later reconfigured based on the requirement of digital business ecosystems.

With the purpose to fulfill the objective of this study, the following steps are proposed in modeling and analyzing digital business ecosystems:

i. A systematic literature review is conducted in order to extract relevant theories regarding the topic
ii. The relevant analysis, as well as the main concept as the result of the literature review, are gathered and presented in a concept mapping
iii. Model the design of digital business ecosystems
iv. Specific methods for each possible analysis based on the design are defined
v. Possible usage of the approach (modeling and analysis) is presented in a case study
vi. The proposed approach is evaluated by conducting a workshop
vii. The limitation, as well as possible further research based on the current study, are discussed, along with the result of doing this research

1.3. Research Question

Based on the problem statement and research objectives as mentioned in the previous sections, the following research question has been formulated:

1.3.1. Main Research Question

How to support digital business ecosystem modeling and analysis by using an architecture-driven modeling approach?

As mentioned previously, the digital business ecosystem constitutes of various "digital species" (Nachira, 2002), and it is clear that the players within the ecosystem are more than one. As it consists of various players, roles, mechanisms, and any other relevant aspects, managing the business ecosystem is not a simple task for the executives. Thus,

having a particular instrument to aid the company executives in modeling, as well as assessing the digital business ecosystem is considered useful (Graça & Camarinha-Matos, 2015).

As an addition, to provide the tool for modeling and analysis purpose, an architecture-driven approach will be conducted in this study. The use of architecture-driven approach is considered suitable for this case as it has particular framework necessary for modeling digital business ecosystems. During this study, the modeling of digital business ecosystems is supported by ArchiMate modeling language.

Moreover, the methods used for the analysis in this study will refer to the quantitative analysis for business. The detailed explanation of the analysis, as well as the methods, will be described in the next section.

With the purpose to answer the main question, several sub-research questions are formulated. Detailed explanations of each question will be provided in the next section.

1.3.2. Sub-research Questions

- *SRQ1: What is the current situation of the digital business ecosystem research?*

A literature study will be done to provide the answer of SRQ1. The study follows the guideline of systematic literature review, with the purpose to find the current situation of the digital business ecosystem research. Afterward, a concept mapping will be presented to give a clear view of the current status of the studies in the field. Besides providing an overview of currently available research in the field, several advantages, as well as the disadvantages, will be given as the result of conducting a literature review.

- *SRQ2: What kind of quantitative analysis is relevant for the digital business ecosystem assessment?*

Quantitative analysis is necessary in operating a business as it supports the executives in the decision-making process. In addition, quantitative analysis may provide accurate information for decision making, as probability and statistics may not enough to meet the challenge of a complex reality (Brandimarte, 2012). Brandimarte (2012) also presented that quantitative analysis can also be used to find the optimum utilization for resource allocation problems, in order to maximize profit.

Following the statement, it can be said that one of the advantages can be gained by conducting quantitative analysis in digital business ecosystems is to remove inefficiency in resource allocation. Thus, providing quantitative analysis along with the methods for digital business ecosystems is considered crucial.

In order to answer RQ2, several steps are conducted during the study. First of all, various types of quantitative business analysis are gathered and reviewed whether it is suitable to assess digital business ecosystems. Second, the chosen analysis generated from the previous step are matched up with the related elements of digital business ecosystems, such as actors, resources, and any other aspects contained within an

ecosystem. Last, some analysis that has potential benefits for assessing digital business ecosystems are chosen to be the basis of the analysis for this research.
After completing the steps as mentioned above, the relevant analysis will be used for the research include profitability analysis, goal analysis, and resource analysis. Later, the resource analysis will be divided into two different analysis, which is resource prioritization analysis and resource optimization analysis.

- *SRQ3: How to model and analyze the business ecosystem?*

To model the digital business ecosystem, the ArchiMate modeling language will be used. The concepts of the enterprise architecture and ArchiMate language that are used during the study includes the representation of the viewpoint, modeling notation, and so on. The viewpoint mentioned in this study aims to provide a clear view for each stakeholder involved in a digital business ecosystem. Meanwhile, the ArchiMate concepts and relationships are needed to give a clear picture of the ecosystem itself. Afterwards, the analysis as mentioned in RQ2 will be implemented to assess digital business ecosystems, as well as to extend the modeling of digital business ecosystems.

- *SRQ4: How to validate the proposed approach in practice?*

In order to answer the SRQ4, a case study of an e-commerce company will be conducted. The proposed approach will be applied to the enterprise with the intention to demonstrate how the approach can be applied to a real-world business case. In addition, the case study is expected to bring some improvements of the result, as it may help in removing the inefficiencies, as well as to identify possible opportunities by implementing the proposed approach. Furthermore, the proposed approach will be presented to the practitioners in the field to see whether the solution is feasible for the practice.

1.4. Research Methodology

This study refers to Design Science Research Methodology (DSRM) as the guideline in conducting the research. Design science is the design and investigation of artifacts in context, where the artifact is expected to interact with a problem context in order to improve something related to the context (Wieringa, 2014). In this research, the context is digital business ecosystems modeling, while architecture modeling is the approach to creating the artifacts to improve the problem, specifically the improvement of enterprise capabilities using digital business ecosystems modeling.

As there was a lack of a methodology to serve as a standard framework in design science, Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) proposed a particular method, namely design science research methodology (DSRM). The approach is considered to be a comprehensive method as it incorporates principles, practices, and procedures required in carrying out an information system research. In DSRM, several phases have been introduced, those are problem identification & motivation, define objectives of a solution, design & development, demonstration of the solution, evaluation, and communication. In order to get a clear view of the research stages in DSRM, a picture of DSRM process model is provided as follows:

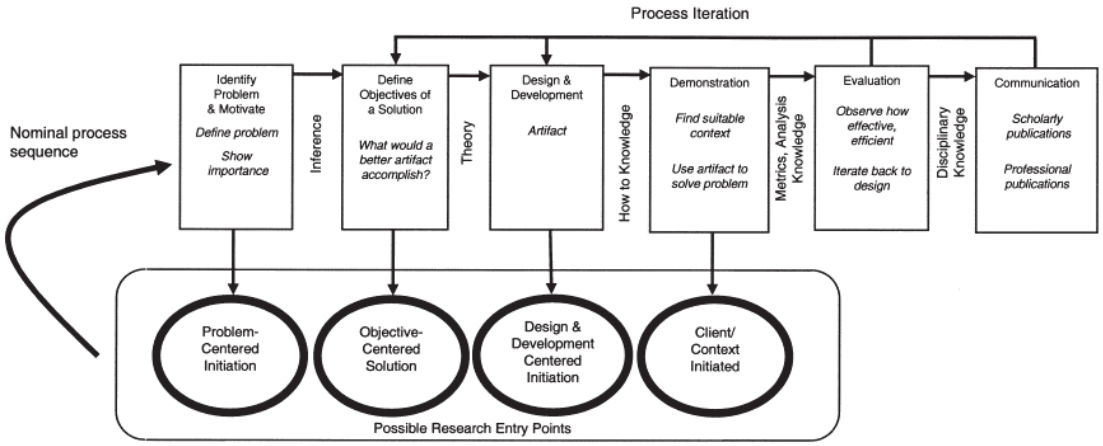


Figure 1 DSRM Process Model (*Peffers et al., 2007*)

As this study makes reference to DSRM approach, each section of the research is reconstructed based on the DSRM process model as mentioned before. The detailed description of each section is shown below:

- **Problem identification & motivation**

  The purpose of this step is to define the specific research problem and justify the proposed approach. This step is presented in Chapter 1, where the main research question, as well as sub-research questions, are formulated. This section also contains the problem statement, which shows the definition of particular research problem related to the context.

- **Define objectives of a solution**
  Setting the objectives are aimed to disclose the knowledge in order to bring what is possible and feasible. This study is presumed to bring a qualitative solution, where the proposed approach as the result of the research is expected to overcome the problem. The objective of this study is shown in section 1.2.

- **Design & development**
  Creation of the artifact as the proposed solution along with the development are the main points of this phase. A proposed approach for digital business ecosystems modeling will be designed in Chapter 3. This section also consists of the proposed measurement tool to assess the value of enterprise capabilities.

- **Demonstration of the solution**
  To show that the proposed idea works in the real-world business, a demonstration of the artifact should be conducted. The proposed approach of this study will be implement a case study of an e-commerce company, which will be provided in Chapter 4.

- **Evaluation**
  In order to see how well the artifact supports a solution to the problem, an evaluation should be done by comparing the objectives of a solution to the result of actual observation. A small workshop which is attended by the practitioners in the field

will be conducted during this research, as to see whether the proposed approach brings positive impacts as mentioned in the research objective. The result of the workshop can be found in Chapter 5.

- **Communication**
  The purpose of this phase is to communicate the problem and its importance, along with its effectiveness to researchers and other relevant audiences, such as practicing professionals. As the result of the study is aimed to contribute to the field as well as to be used in practice, the proposed approach and other relevant results will be introduced to other researchers, while the professionals in the field will be guided in implementing the method for actual practice.

1.5. Structure of The Report

The report of this thesis consists of 6 chapters, in order to give a clear view to the readers about the creation process of the proposed approach. Additionally, each chapter may be divided into several sections, which is shown by the sub-chapters.
The introduction of the project, as well as the background/motivation of the research, are explained in *Chapter 1*. In order to find relevant knowledge related to the topic, a literature review and its approach will be described in *Chapter 2*. The results of the literature review will be used as the theoretical background of the thesis, which will be mentioned in the same chapter. *Chapter 3* contains the development process of the approach along with the result, which is the proposed approach itself. Afterward, the proposed idea will be tested with a case study, which is demonstrated in *Chapter 4*. The approach will also be evaluated by presenting them to the professionals, and asking their opinion whether it is feasible for the real-world practice. The interview result will be shown in *Chapter 5*. The last section of the report, which is *Chapter 6*, consists of conclusion and results of the research, where it is expected to integrate the answer of the research questions stated in the first chapter.

To give a clear view regarding the highlight of each chapter, a table of the research structure is presented below:

Table 1 Research Structure

Chapter	**Sub-chapters**	**Relevant Research Question(s)**
1. *Introduction*	• Problem Statement • Research Objective • Research Questions • Research Methodology • Report Structure	
2. *Theoretical Background*	• Literature Review • Underlying Theories • Modeling Framework and Language • Analysis Technique and Method	SRQ1, SRQ2
3. *Design and Development*	• Stakeholder Interests • Viewpoints • Visualization and Analysis of Digital Business Ecosystems	SRQ3

	• Value Measurement	
4. *Demonstration*	• Case Description • Application of Digital Business Ecosystems Analysis to the Case Study	SRQ4
5. *Evaluation*		
6. *Conclusion*	• Summary • Contributions • Research Limitations and Recommendation	All research questions
References		
Appendix		

2. Theoretical Background

The aim of this chapter is to come up with a conceptual understanding related to the topic, along with the relevant technique and language needed during the research. In addition, possible analysis to be implemented to the proposed method of this study will be explained in this chapter as well.

This chapter is divided into four sections as follows: Section 2.1 describes the approach used in finding relevant theories for the thesis, including the research strategy and the source of database. Section 2.2 describes the result of the literature review, as explained in the previous sub-chapter. At the end of the section, the current status of the research will be explained, in order to identify the area for improvements, so that the answer of SRQ1 can be presented. As technique and language play a crucial role in the research, a brief explanation of the concept should be provided. Therefore, section 2.3 will disclose the framework and language that are most suitable as the basis for the study. In purpose to answer SRQ2, applicable analysis for proposed approach in the study will be explained in section 2.4.

In order to show a comprehensive view of the overall process, an illustration presents every stage required during the study is provided in *Figure 2*. The first step is to evaluate the currently available research in the field, with the purpose of gaining a comprehensive view related to the innovation from time to time. After having a deeper understanding of the topic as the result of the systematic review, it is expected that appropriate methods, frameworks, and other tools can be extracted, in order to be used as the basis for the research. Subsequently, the underlying theories are applied and developed with the purpose of coming up with a new approach to model the digital business ecosystem. Afterwards, the provided model is used to conduct a model-based analysis for the digital business ecosystem.

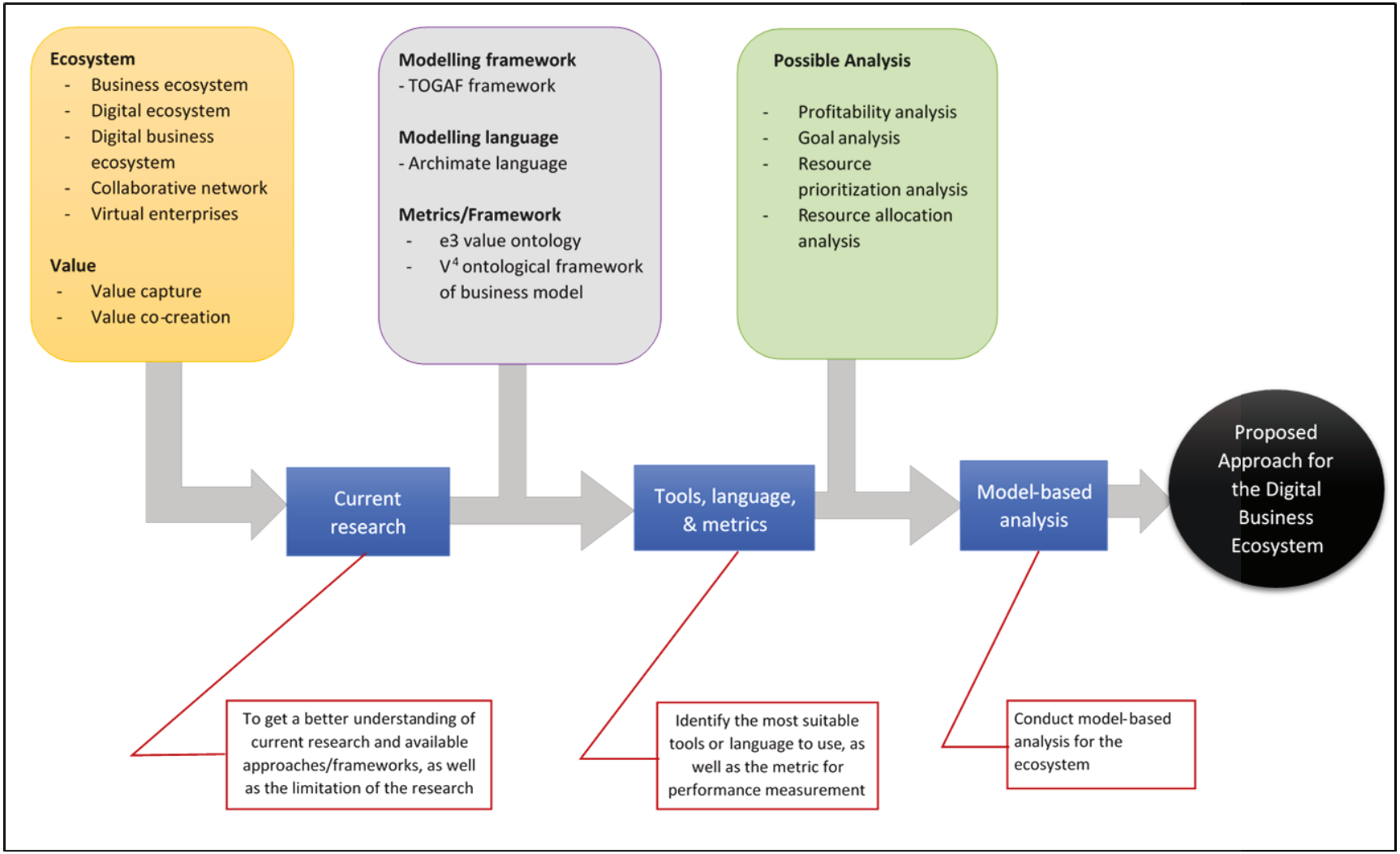


Figure 2 Steps Required for This Study

2.1. Systematic Literature Review

The aim of conducting a literature review is to get a comprehensive collection of articles and papers in order to acquire a clear understanding of the topic by referring to the literature. In addition, the literature review is expected to provide additional knowledge and ideas regarding the methodologies and tools that are currently available and used widely in practice.

In order to provide a comprehensive literature review, the first searching process was intended to seek not only for scientific research but also gray literature, such as thesis, white papers, and books. The gray literature was found with the help of search engine, namely Google (www.google.com). After having a clearer insight into the current practice related to the study based on gray literature, an additional scientific literature review is needed to provide theoretical support for the research findings. For this study, the database sources used are a mostly electronic scientific database, includes the following:

a) Scopus (https://www.scopus.com/)
b) JStor (https://www.jstor.org/)
c) IEEE Xplore (http://ieeexplore.ieee.org/Xplore/home.jsp)
d) ScienceDirect (http://www.sciencedirect.com), and
e) Google Scholar (https://scholar.google.com/).

The method used for the literature review in this study is the systematic literature review (SLR) by Kitchenham et al. (2010), where the guidelines for developing the review refers to the systematic guidelines by Okoli and Schabram (2010).

Various search strings are used in searching the database, including:

- "digital business ecosystem"
- "digital business ecosystem" AND enterprise architecture
- digital business ecosystem AND enterprise architecture
- "digital business ecosystem" AND trends
- "business ecosystem" AND enterprise stakeholder
- "business ecosystem" AND governance
- business ecosystem AND architecture viewpoints AND enterprise architecture
- "digital business ecosystem" AND business model
- balance scorecard AND business model
- balanced scorecard AND business ecosystem
- balanced scorecard AND ecommerce

Other keywords were also used during the research process. However, it sometimes shows either very limited results or no result at all. Therefore, the strings mentioned above are the results after some other keywords are omitted.
Since the result sometimes irrelevant and too broad, some inclusion and exclusion criteria during research process were defined. As corresponds to the screening criteria for internet research by Fink (2013), the inclusion and exclusion criteria underlying this study are listed in the following.

The inclusion criteria to find relevant literature are:

(1) The study should be from these areas: (a) Computer Science, (b) Business, Management and Accounting, (c) Engineering, (D) Social Sciences, (e) Economics, Econometrics, and Finance.
    This inclusion criterion is considered crucial since the research regarding digital business ecosystem may produce irrelevant results, as the term "ecosystem" itself mostly related to the environmental science and similar areas.
(2) The study should be written in English
(3) The study should be scientific papers, books, or an official report (white paper). Any other types of literature are for brainstorming purposes only.

In addition to that, the exclusion criteria for selecting the literature are:

(1) The study that does not fit the inclusion criteria
(2) Similar studies that are using same data set. Only the one provides more comprehensive result will be used as reference in order to avoid redundancy
(3) The study that covers only one setting, such as in a particular country or situation
(4) Study with insufficient information within (e.g. no defined research question, unclear data analysis process or methodology)

After filtering papers from the database based on inclusion and exclusion criteria, an additional process to narrow down the results is needed. Therefore, a study selection process to find more appropriate material should be done. There is a step-by-step guideline in making a study selection as referring to Meline (2006), specifically:

Step 1: Apply inclusion/exclusion criteria to titles and abstracts
Step 2: Eliminate studies that clearly meet one or more exclusion criteria
Step 3: Retrieve the full text of the remaining studies
Step 4: Evaluate the remaining studies for inclusion and exclusion
Step 5: Include studies that meet all inclusion criteria and no exclusion criteria
Step 6: Exclude studies from systematic review with reasons

Afterward, the quality of the extracted data from the study selection process was checked as to ensure the selected literature meets the requirements.

After having an understanding regarding the inclusion and exclusion criteria, a literature study is conducted in order to find the knowledge relevant for the research. It is found that there is a large number of the research available related to the topic. In order to generate a more appropriate result, inclusion and exclusion criteria as mentioned previously has to be applied, and the refinement result of the papers used in this study is provided below:

Table 2 Number of Literature Found based on the Keywords after Applying Inclusion/Exclusion Criteria

Keywords	Number of Literature from the Sources				After applying inclusion/ exclusion criteria
	Scopus	JStor	IEEE	Science Direct	
"digital business ecosystem"	141	2	25	39	11
"digital business ecosystem" AND enterprise architecture	16	1	9	19	3
digital business ecosystem AND enterprise architecture	60	88,326	42	478	9
"digital business ecosystem" AND trends	6	1	2	16	6
digital business ecosystem AND ecommerce	2	577	3	239	1
"business ecosystem" AND enterprise stakeholder	10	37	1	142	4
"business ecosystem" AND governance	15	26	4	152	5
business ecosystem AND architecture viewpoints AND enterprise architecture	6	14,797	4	207	5
"digital business ecosystem" AND business model	58	2	33	39	11
balance scorecard AND business model	468	601	108	2,258	6
balanced scorecard AND business ecosystem	3	31,274	0	173	3

The last column of the table shows the number of the literature selected after removing several papers based on inclusion/exclusion criteria. However, different keywords may produce an identical result, which may lead to redundancy. Due to the issue, the sum of the numbers in the above table does not indicate the total papers used during the study. After removing the duplicate results, the number of selected publications is 34, which are listed in *Appendix A*.

The literature in the table as mentioned in *Appendix A* brings underlying theories as referred to the previous section. In addition, not only the principles related to the digital business ecosystem can be extracted, but also the relationships between the concepts can be established as the result of the literature review. In order to clarify the relationships between the concepts, a clear presentation is provided, as shown in *Figure 3*. In the picture, the digital business ecosystem becomes the primary focus. The digital business ecosystem term derived from the business ecosystem concept.

In order to implement the concept of the digital business ecosystem, specifically related to the technological environment, an architectural approach is required. Therefore, an Enterprise Architecture takes place to assist the application of the digital business ecosystem within the organization. Furthermore, a language of the Enterprise Architecture will be used in this study, with the purpose to give a representation required for modeling and analysis of the digital business ecosystem.

Moreover, the digital business ecosystem is conducted with the purpose to support value co-creation. The purpose of the value co-creation process is to provide additional value for both stakeholders and customers of a business.

The detailed explanation of each theory associated with the digital business ecosystem will be discussed in the next section.

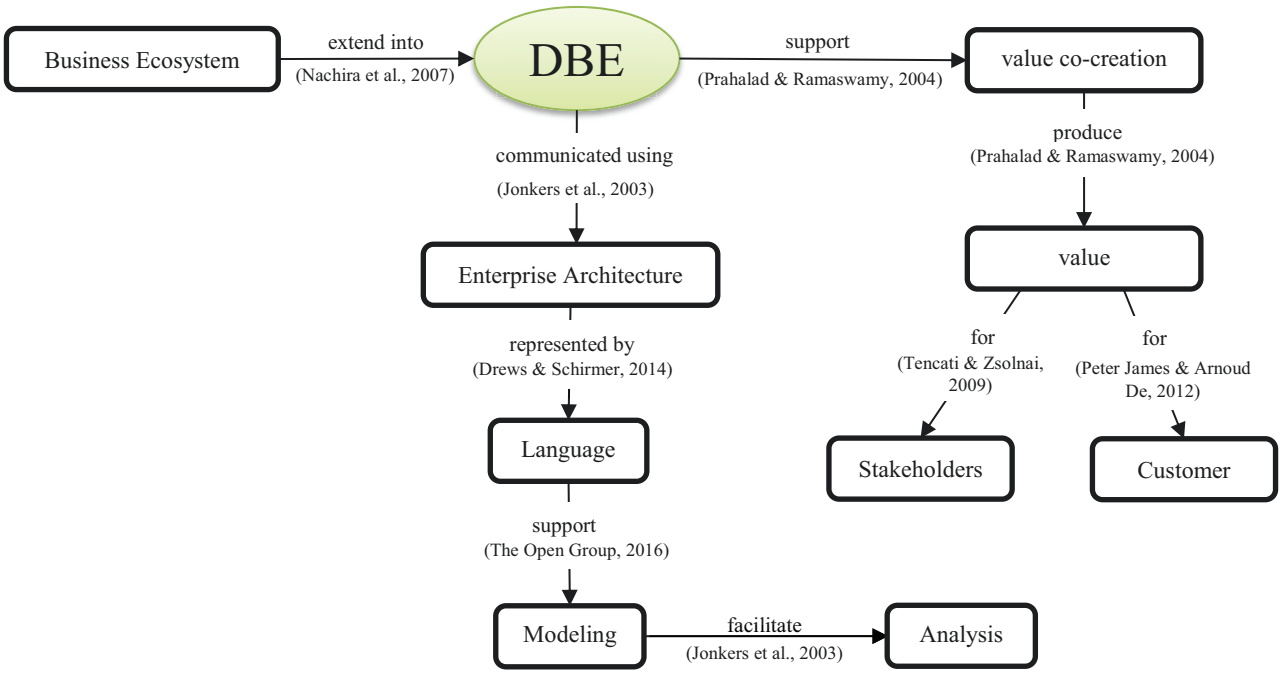


Figure 3 Conceptual Mapping

2.2. Underlying Theories

The literature review came up with some ideas and concepts for this study. However, not all the theories have a direct linkage with the notion of the digital business ecosystem or other main points of the study. Thus, the additional filtering process is considered needed in order to avoid enormous listing of theories.

This section contains the list of the knowledge relevant to the study. At the end of the section, a summary will be provided in order to sum up the result of the literature research.

2.2.1. Digital Business Ecosystem

The concept of the digital business ecosystem at first was introduced by M. Moore (2003), where the digital business ecosystem was focused specifically on the developing countries. Later on, Nachira (2002), comes up with a more explicit concept of digital business ecosystem, where the digital business ecosystem is not only applicable for developing country only, but also for Small and Medium Enterprises

(SMEs). The term digital business ecosystem itself came up as an extension of business ecosystem theory, which is related to the strategic planning. This systematic approach arises as an answer to the current dynamic business environment (J. F. Moore, 1993). Since the enterprise is part of business ecosystems, a further study in the area is considered crucial.

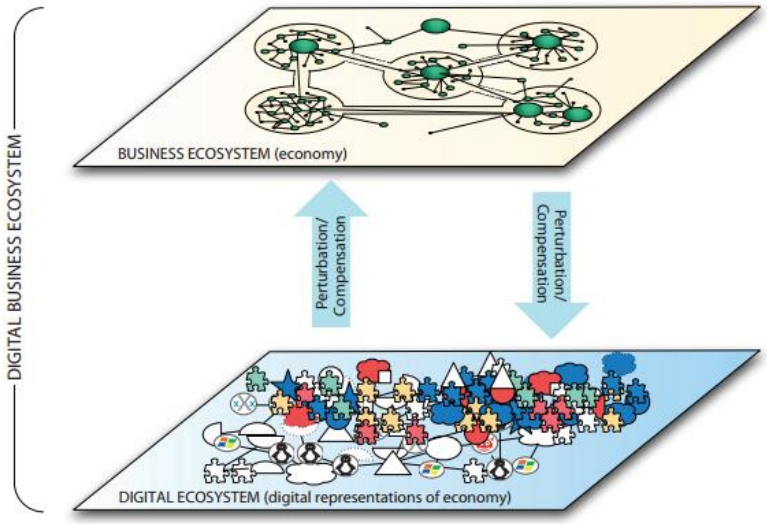


Figure 4 Relationship between Business Ecosystem and Digital Business Ecosystem (*Nachira et al., 2007*)

These days, enterprises face rapid change market with uncertain trends. Therefore, in order to deal with the problem, such innovative approaches are needed to stay in the competition. With the purpose to answer the situation, an integrated network of an organization to extend the capabilities is required. By taking advantage of a collaborative network, it is expected that the enterprise can address the customer needs while keep focusing on its core business (Peter James & Arnoud De, 2012). This collaborative network is also known as a business ecosystem, as introduced by J. F. Moore (1993). In other words, possessing a vibrant value-add network will likely contribute to the competitive advantages of an enterprise.

One of the evidence that a partner ecosystem could create better outcomes can be found through a case study of two ERP vendors in Denmark (Antero & Bjørn-Andersen, 2011). Based on the report, it is clear that the company adopting collaborative network gained a competitive advantage by means of larger sales capability as well as enterprise performance enhancement. Another advantage of having a digital business ecosystem is stated in the study by Iansiti and Levien (2004). In this study, the author stated that a keystone, as the center of the business ecosystem, is able to get more advantages by focusing on the network of ecosystem, instead of focusing primarily on their internal capabilities.

As regards to the business ecosystem, several concepts are associated with it can be found. Business ecosystem term itself sometimes interchangeable with service ecosystem. However, both are similar but not the same. Service ecosystem adopts traditional service concept, where the IT system cannot correspond to its business services (J. Zhang & Fan, 2010). Therefore, a higher level of service to solve more complex issues and to deal with unpredictable disruptions is needed, which brings out the concept of the digital business ecosystem (DBE).

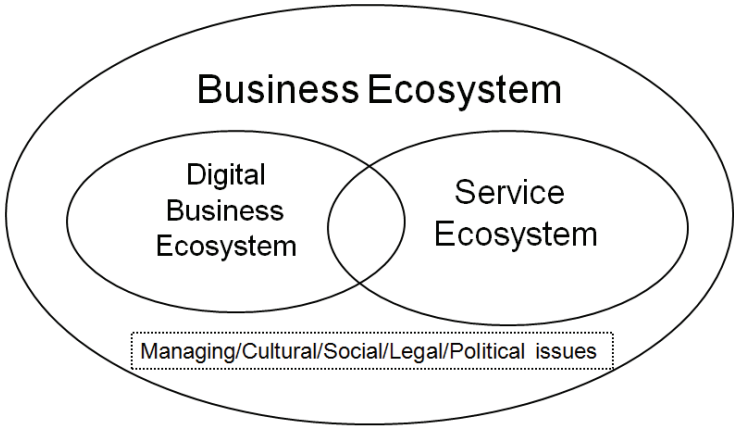


Figure 5 Connection of the Three Ecosystem Analogies (*J. Zhang & Fan, 2010*)

Although there is a considerable number of contributions in the field, several research limitations can also be found. *Table 3* shows the comparison of advantages and disadvantages of the digital business ecosystem, which is presented as the result of conducting a literature study. The numbers stated in the table refer to the literature listed in *Appendix A*.

Based on *Table 3*, it is can be seen that the numbers between advantages and the disadvantages are pretty similar. However, some aspects are considered to be more significant than others. In order to see the most crucial elements based on the above table, additional pictures to show the numbers of paper mentioned the aspect during the literature study are provided as follows:

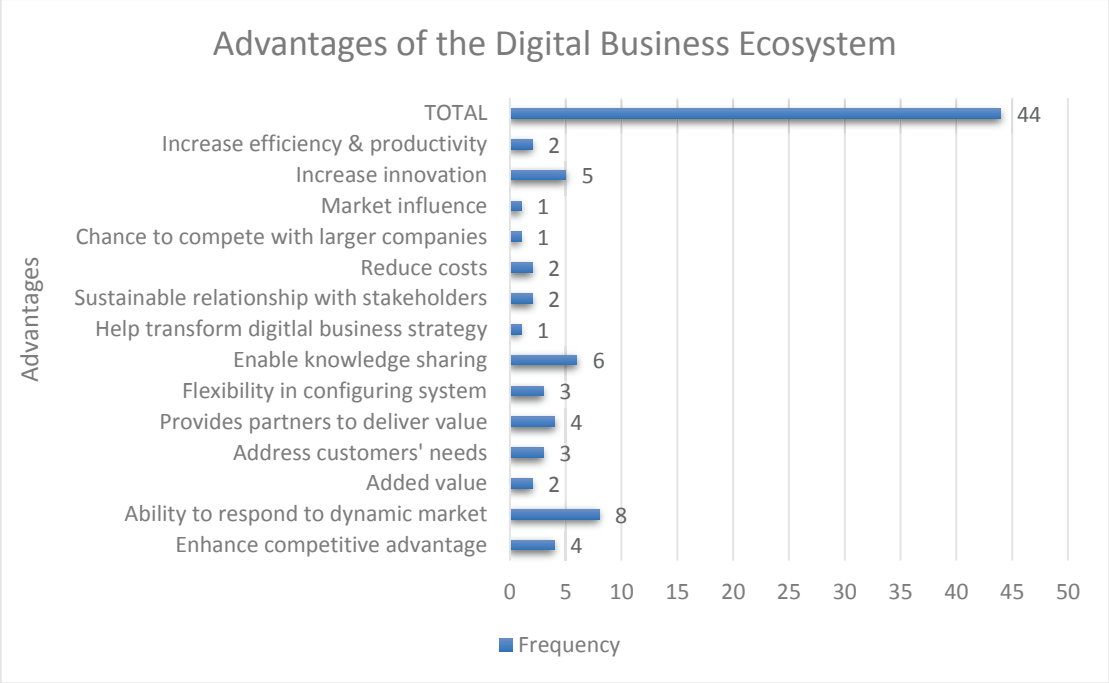


Figure 6 Advantages of the Digital Business Ecosystem

Table 3 Advantages and Disadvantages of the Digital Business Ecosystem

#	Advantages	Disadvantages
1.	Enhance competitive advantage by setting up multiple alliances (4, 8, 10, 17)	Traditional hierarchy may have more benefits (e.g., lower transaction costs, alignment maximization between specialist activities and players) (4)
2.	Support or survive in dynamic environment; agility; fast response to market changes (1, 4, 5, 10, 14, 18, 19, 24)	Risk of profits will leak away to partners (create "dominant species") (4, 15)
3.	Added value (13, 17)	More suitable for organization where the customer needs are complex (4)
4.	Meet customer demand; address customer needs (4, 13, 20)	No standard of measurement of benchmarking of the success of ecosystems (15, 16)
5.	Partners can support to deliver value (4, 10, 14, 19)	Considerable preparation costs/time (19, 22)
6.	Flexibility in the configuration of business system (4, 19, 25)	Partners readiness (e.g. interoperable and compatibility of infrastructure) (19, 22, 25)
7.	Knowledge sharing; ability to learn faster than single organization to improve performance (4, 14, 15, 19, 21, 25)	Fear of not having ROI (19)
8.	Help transform digital business strategy (5)	Losing decision making power (19, 22)
9.	Sustainable relationships with stakeholders (17, 20)	Intellectual property problems (19, 21, 22)
10.	Lower costs (e.g. transactions costs, marketing costs (17, 19)	Required high commitment level between partners (e.g. participation, trust) (19, 21, 22, 25)
11.	Chance to compete with larger companies (19)	The agenda being hijacked; long-term strategy is stolen by other partners (21)
12.	Market influence (branding/marketing) (19)	Difficult to manage due to different actors and heterogeneity in goals (2, 25)
13.	Increase potential for innovation (19, 20, 21, 25, 26)	
14.	Increase (operational) efficiency & productivity (20, 26)	

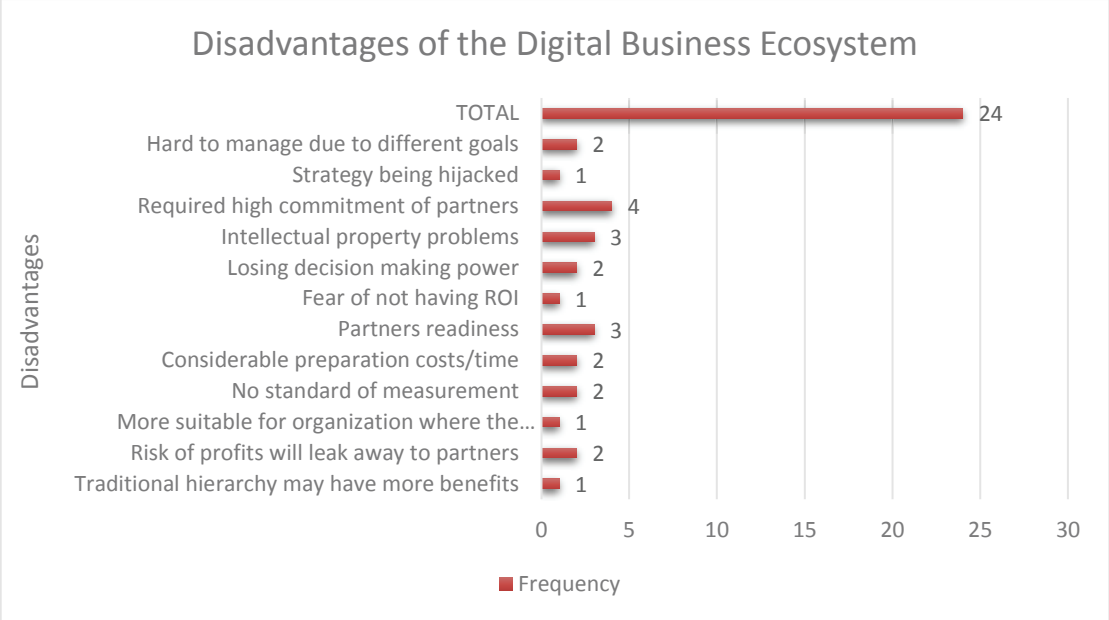


Figure 7 Disadvantages of the Digital Business Ecosystem

Based on the figure, the most important benefit of the digital business ecosystem is it provides the ability to respond quickly to the dynamic market. In addition, being a part of the digital business ecosystem is also beneficial, as it enables knowledge sharing between the companies, as well as to increase the innovation within the companies. Based on the advantages, it can be concluded that it is important for organization to join the digital business ecosystem.

However, the company has to keep in mind that to achieve a success, it requires high commitment between partners within the ecosystem, as well as partner readiness, which are also presented in *Figure 7*. In addition, the company should also beware of intellectual property problems, which may occur after joining the digital business ecosystem.

Although several possible disadvantages may emerge as the result of being a part of the digital business ecosystem, the figures above shows that the benefits still outweighs the drawbacks. Thus, it is considered that the digital business ecosystem is still beneficial for the companies.

Besides analyzing the potential benefits of the digital business ecosystem application, the literature study also came up with the characteristics of the concept. The following table shows the main features of the digital business ecosystem:

Table 4 Main Characteristics of Digital Business Ecosystems

Category	Identified Characteristics
Business activities	1. Conducted by means of long-term transactions
Networking	1. The topology of a digital business ecosystem mostly relies on the networks interconnecting the participating organizations 2. Distributed, open-source network architectural modules
Interactions and governance	1. Coordinated in a loosely coupled 2. The interactions (transactions) as core business activities predominately use the Internet that works on SOC (Service-Oriented Computing)
Type of organizations benefiting	1. e-business/e-commerce enterprise 2. The non-commercial organization, such as government

This section is expected to give an overview of the digital business ecosystem concept, as well as to understand why it is important for the companies to consider joining an ecosystem.

2.2.2. Value

The value term has various meanings depend on the position of the value itself. Martinez-Hernandez (2003) stated that value resides in the satisfaction and fulfillment of customers' expectations, at the same time, generating wealth for organizations. In the business model concept, the term value can be divided into several contents, such as value delivery, value creations, value proposition, and value maintaining, as mentioned by Junmei Zhang, Gang, and Jianwen (2010). Meanwhile, in supply chains and other industries, the value is mostly related to the value proposition concept, where it directly impacts the business strategies and operations (Martinez & Bititci, 2006).

Since the study in this thesis focuses on the enterprises within an ecosystem, the value within the organization itself will indirectly be impacted. It is expected that an ecosystem partnership with the involved of the business executives will improve the business performance in the organization (Ceccagnoli, Forman, Huang, & Wu, 2011). The previous statement fits with the concept of value co-creation, where the collaboration between multiple stakeholders are taken place (Prahalad & Ramaswamy, 2000).

As value co-creation involves the value co-creators in the ecosystem, it is crucial to understand the roles of the stakeholders involved and take actions in real time in response to the changing needs of the customers and stakeholders. To emphasize, during the transformation of a co-creative organization, the participating stakeholders are customers, partners, and the employees within the enterprise itself (Ramaswamy, 2009).

2.2.3. Enterprise Architecture

An enterprise architecture can be defined as a collection of enterprise activities which is organized into a set of business processes that collaborate to produce desired outcomes (Presley, Sarkis, Barnett, & Liles, 2001). Furthermore, Fritscher and Pigneur (2011) explained that enterprise architecture is useful to describe components of an enterprise across domains and helps in communicating how they interact with each other. Based on the explanations above, an enterprise architecture can be defined as a conceptual model that support the business by providing the means of communication within the firm, which lead to the achievement of desired results. The enterprise architecture itself consists of framework and language, which will be explained as follows.

An enterprise architecture framework (EAF) is necessary to map all of the software development processes within the enterprise and how the interact to fulfill the enterprise's goal (Urbaczewski & Mrdalj, 2006). Urbaczewski and Mrdalj (2006) compared top four enterprise architecture frameworks, including Zachman Framework, Department of Defense Architecture Framework (DoDAF), Federal Enterprise Architecture Framework (FEAF), and The Open Group Architectural Framework (TOGAF). Each framework has different key features and specifications, which makes it harder to pick up one as the best framework. However, the best-fit framework may vary depend on given project along with the stakeholder needs of the project itself. In the end, they came up with the conclusion that the Zachman framework is the most comprehensive one as it has a number of viewpoints for different aspects.

Currently, there is no particular framework to support the development of enterprise architecture for the digital business ecosystem. However, various studies in the field have been done. One of the most promising research is about a framework for exploring digital business ecosystem by Korpela, Kuusiholma, Taipale, and Hallikas (2013). In that paper, a modified Zachman framework to establish a digital business ecosystem model is proposed, which is also mentioned in the previous section.

In this study, TOGAF® framework by Open Group and its specifications (Josey, 2011) will be referred as the foundation for the research, since it is summed up as the most appropriate for the research. Moreover, the framework is considered suitable for the study because it offers both business architecture and technical architecture view, that can cover the needs of the various type of stakeholders in the enterprise. In addition, TOGAF® supports the decision-making process, while other frameworks do not provide this feature. Based on the above-mentioned advantages, using the framework is considered to be beneficial, not only for the research purpose but also for the practical use in the enterprise.

Following the framework, specific language for modeling the enterprise architecture, specifically for the digital business ecosystem is required. Currently, various modeling languages to illustrate the business process are available, such as Unified Modelling Language (UML), Business Process Modelling Language (BPMN), Architecture of Integrated Information System (ARIS). However, there is no language specifically aimed at describing the enterprise architecture. Therefore, UML is broadly used as a modeling approach within ICT and keep expanding into other areas. Unfortunately, it is not readily accessible in practice, such as for managers and business consultants (Lankhorst, 2009).

At this moment, ArchiMate Specification by Open Group Standard is currently considered as the most common language for developing an enterprise architecture. The language comes with a set of default iconography for describing, analyzing, and communicating concerns of enterprise architectures as they change over time (The Open Group, 2016). In addition, Fritscher and Pigneur (2011) stated that modeling with ArchiMate is considered attractive as it provides a visual representation with the use of visual cues, such as colors to highlight the different modeling layers.

2.2.4. Relationship between Theories

Value co-creation is the joint creation by stakeholders in solving the problems and creating the innovation (Prahalad & Ramaswamy, 2004). Therefore, value co-creation in a digital business ecosystem can be defined as a cooperation between parties (i.e. customers, companies, or partners) by exploiting the innovation of information technology to communicate and collaborate with each other.

On their paper, Romero and Molina (2011) focused on the value co-creation in digital ecosystem specifically for customers. They see customer communities as value co-creators, where the customers have a role either as co-designers, innovators, marketers, or even socially responsible actors. In this case, the customer communities can be seen as the digital business ecosystem, while the roles are the process of value co-creation.

Meanwhile, Amit and Zott (2001) emphasized the value co-creation for the business conducted over the Internet, which also well-known as e-business. The results of the analysis in the paper shows four potential factors as the drivers to enhance value creation in e-business. At the end of the research, the authors found that the drivers led to the needs of integrative value chains, as it may bring benefit for the enterprise to survive in highly networked markets.

The study above confirmed that company and its partners have a critical role in digital business ecosystems, which acts as a single communication channel for all parties to interact with each other. By having a connection between the partners and suppliers to make up an ecosystem, they can deliver services and products to their customers in a more integrated fashion (Kandiah & Gossain, 1998). Thus, it can be said that the ecosystem results to the additional value for the stakeholders of the organization, as well as for the end customers of a business (Peter James & Arnoud De, 2012; Tencati & Zsolnai, 2009). Still, value co-creation can be achieved not only by the stakeholders as the co-creators of value but also by transforming the engagement and relationship between the institution of management and its employees (Ramaswamy, 2009).

Therefore, it is necessary for a company to have a healthy business ecosystem in order to support the value co-creation, which is also mentioned previously. As there currently no modeling and assessment tool exist, this study is conducted with the purpose to answer the situation. In this study, the modeling and analysis provided refers to one of the modeling languages for the Enterprise Architecture, namely ArchiMate standard. More detailed information regarding the use of ArchiMate in this study will be explained later.

2.2.5. Current Research Gaps

Although digital business ecosystems show promising future, current limitations are still found in the area. Currently, digital business ecosystem concept has not received full attention from the researchers yet. Meanwhile, a digital business ecosystem is considered important for business because it can aim to success, which can be done by creating a collaborative network (Kelly, 2015). Therefore, the study presented in this thesis is expected to fill the gap of the research in the academic area, as well as to give practical contributions to the companies. To be more specific, hereunder are several opportunities to improve digital business ecosystems, as well as its related concepts.

As mentioned previously, currently there is no particular framework available to model and assess digital business ecosystems. Meanwhile, a unified guideline to model and analyze digital business ecosystems is considered crucial, as it can support the engagement between stakeholders within the ecosystem (Cheah, 2007). To answer the current situation, Korpela, Kuusiholma, et al. (2013) came up with a study which provides a framework to explore the digital business ecosystem by modifying currently available enterprise architecture framework, precisely Zachman framework. Although the study contributes to the enterprise architecture field, it does not provide a language to model and analyze ecosystems, which is considered as a gap of the current research. Therefore, the study presented in this thesis is expected to fill in that gap.

As to follow the previous statement, it is necessary to choose a complete language available to support the modeling and analysis of digital business ecosystems. Currently, one of the most widely-used languages for modeling the enterprise architecture is ArchiMate® language by the Open Group. The latest version of this language offers several updates, including the addition of a new layer, specifically motivation layer, which contains the stakeholder viewpoints, which makes ArchiMate can be considered as the most suitable language available for modeling and analysis purpose.

As an addition, analysis of the stakeholder concerns is considered required, as it may help during the modeling and analysis of digital business ecosystems. However, currently, only little support is available in addressing the stakeholder concerns, which corroborated by the research by However, Quartel, Engelsman, Jonkers, and Van Sinderen (2009). Based on the statement, it can be seen that stakeholder and its interest should be taken into consideration for the further research opportunities as they play a significant role not only regarding the enterprise architecture but also from the point of view of digital business ecosystems. In addition, Goel, Schmidt, and Gilbert (2009) also mentioned that there is a lack of analysis in CxO level stakeholder concerns for transforming into an ecosystem, which also corroborates the view. Thus, this thesis is also expected to analyze the stakeholder concerns, which will be presented in the viewpoints based on ArchiMate modeling language.

The lack of specific analysis to be the standard for digital business ecosystems, as well as the limitation of the currently available modeling language brings this study to explore deeper in the area, with the purpose to provide a particular approach for modeling and assessing digital business ecosystems. However, the proposed approach mentioned in this research has not been tested yet as it needs to be evaluated with real meta-models, data, and tools, which provide another window of opportunity for improvement.

Provided explanations bring to the view that there are many rooms for improvement in the area, either for academic purpose or practical matters. Thus, as previously mentioned, this study is also expected to fill in the gap in the field by giving more insights as the answer to some constraints in the area.

2.3. Modeling Framework and Language

After having more understanding regarding the underlying theories used during the study, it is necessary to determine specific language to model and analyze digital business ecosystems. Thus, the theoretical framework provided in this section is expected to fulfill the requirements to conduct modeling and assessment of digital business ecosystems.

2.3.1. Theoretical Framework

With the purpose to model and assess digital business ecosystems, several aspects of the ecosystem should be evaluated and analyzed to see whether it comprises the standard requirements as well as to see the possible added value to be generated in the future. Thus, a particular approach that covers the elements construct a digital business ecosystem is necessary.

As already discussed in the previous section, currently there is no specific standard for investigating digital business ecosystems. Thus, during this study, the theoretical framework will refer to the business model approach, as a business model is needed to show the resources required to achieve the objectives of business, along with the strategic decisions to accomplish them. Osterwalder, Pigneur, and Tucci (2005) define a business model as a blueprint of how a company does business. However, the business model notion is considered as an abstract concept, as each business model ontology may cover different domains of the firm.

Based on the statement above, it is clear that the elements covered in the business model may differ one to another. Thus, a table to show the components for each type of available model is presented in *Appendix B*. Based on the table, it can be said that some approaches are able to cover the elements of the ecosystem, while others are not. However, currently, only the v^4 ontological framework of business model, proposed by Al-Debei and Avison (2010), that can provide the most comprehensive components contains within the ecosystem.

The dimensions form the v4 ontological framework includes value proposition, value architecture, value finance, and value network. Following that, each dimension in the model also contains several elements relevant to assess digital business ecosystems, which makes the approach suitable for analyzing digital business ecosystems. In addition, this framework came up as the result of combining various business model available, such as the model by Osterwalder and Pigneur (2010), Amit and Zott (2001), and much more, which makes this framework is considered as the most comprehensive framework available.

As an addition, the only ecosystem modeling that has been done was supported by e3 value by Gordijn, Akkermans, and Van Vliet (2001). However, it should be taken into

account that not all required values within an ecosystem, especially as stated in the v^4 ontology, can be found in the e3 value model. The detailed comparison between the models will be discussed in the next section.

After comparing some approaches, the v^4 ontological framework of business model will be appointed as the basis for this study, as it is considered to be the most suitable and relevant for modeling and assessing digital business ecosystems. Therefore, the following analysis stated in this study will refer to the concept of the v^4 ontology.

2.3.2. v^4 Ontological Framework of Business Model

As stated in the previous chapter, the v4 ontological framework of business framework by Al-Debei and Avison (2010) will be used as one of the underlying theories during this study. The proposed framework by Al-Debei and Avison (2010) provides four main dimensions of a business to be assessed. Those dimensions are value proposition, value architecture, value network, and value finance, which are also shown in *Figure 8*.

Each dimension in the model is extracted from the currently available literature regarding the business model concept. Subsequently, each dimension consists of several elements construct the dimension itself. As the detailed explanation about each element of the dimensions already mentioned in the previous chapter, only a brief explanation will be described in this section.

Value-network dimension shows the way of an organization enables transaction among parties and multiple companies, where the concept came up from the notion of value creation by Amit and Zott (2001) and e-business models by Gordijn, Akkermans, and Van Vliet (2001). As this attribute represents the inter-organizational perspectives, the elements mostly show the coordination and collaboration among parties. To be more specific, the elements construct this dimension are actor, role, relationship, flow-communication, channel, governance, and network-mode.

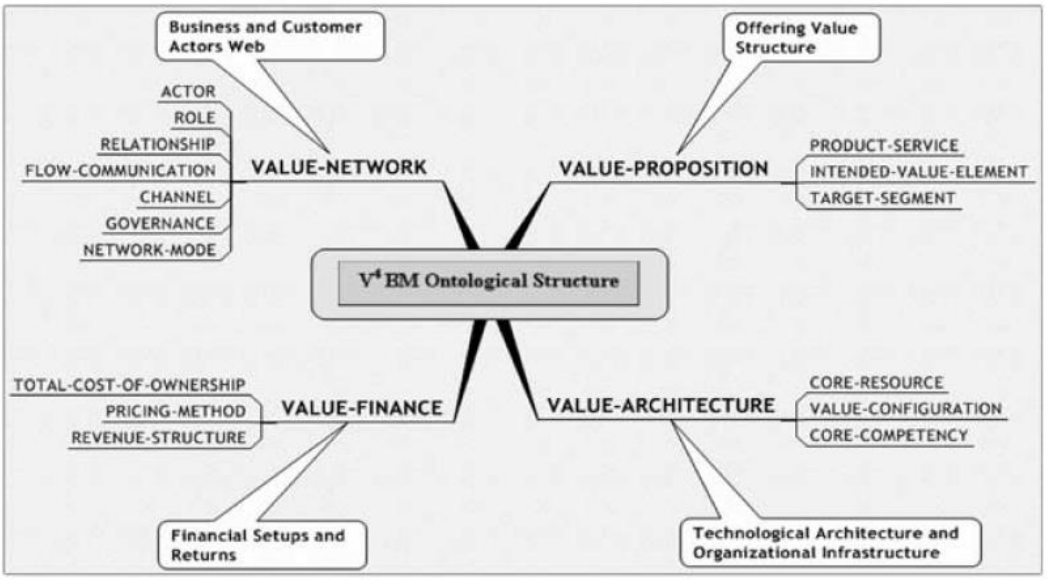


Figure 8 The v4 Ontological Structure of Business Model(*Al-Debei & Avison, 2010*)

The second dimension in this ontological structure is value proposition, which shows the value creation not only for the end customers but also for other stakeholders involved with the purpose to satisfy the needs of the organization's target segments. Some references contribute to this dimension are the concept of value creation by Amit and Zott (2001) and the literature on business model innovation by Osterwalder, Pigneur, and Tucci (2005). The elements that can be found within this value are the product or service, intended value, and the target segment.

In order to generate value proposition, a specific configuration is needed, which is called value architecture in the v^4 ontological structure of business model. This value shows the technological architecture as well as the organizational infrastructure required to allow provisioning of products and services along with the relevant information flows. The elements of this value are core resource, value organization, and core competency of the organization.

The last dimension to be taken into consideration is value finance, which is related to the way of organization managing issues regarding costing, pricing, and revenue breakdown in order to sustain and increase the income. Main focuses of this dimension including total cost of ownership, pricing method, and revenue structure.

2.3.3. Modeling Language

Besides conducting the analysis of digital business ecosystems, presenting some models of the ecosystem is also considered required. Thus, a concept for modeling purpose is necessary for this study, which will be described in this section.

With the purpose of modeling and analyzing digital business ecosystems, ArchiMate language will be used during the research. Since this study will investigate various stakeholders as a part of a digital business ecosystem, the viewpoints should be examined as well. A study by Steen, Akehurst, ter Doest, and Lankhorst (2004) shows that it is possible to link the viewpoints with the ArchiMate language. Thus, ArchiMate language is considered capable of supporting the modeling requirement as needed for this study.

2.3.4. Comparing the Ontologies with ArchiMate Language

As the concept of v^4 ontological framework comes up from integrating various business models, it is considered to be the most comprehensive framework, if compared to other business model concepts currently available. Thus, assigned this framework as an underlying theory for the research is expected to bring more opportunities for further improvement, especially in extending the practice regarding business modeling.

One of the most prominent business model concepts to be used as the guideline for illustrating a business ecosystem is e3 value ontology by Gordijn et al. (2001), because it enables the mapping of ecosystem network, along with the value flow from one party to another. Although it is a rather comprehensive model, it does not cover all elements found in the business, such as resource and capabilities, while those components are

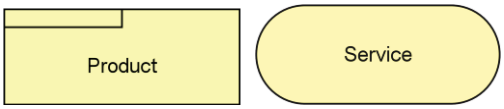
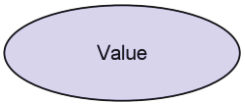
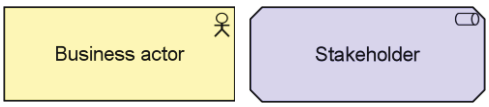
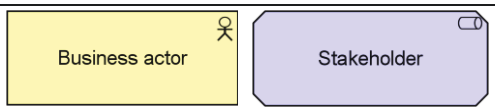
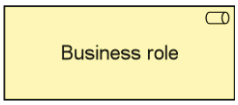
essentials in illustrating a business. Meanwhile, the v^4 framework provides the representation of those elements, which makes it more complete than e3 value model.

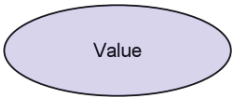
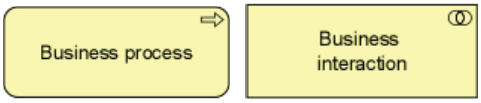
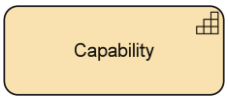
As the representation of the enterprise commonly refers to the principal of enterprise architecture, the study is expected to contribute to the field as well. One of the most popular enterprise architecture languages for modeling the business architecture is ArchiMate language by The Open Group (2016), which will also be used during the research.

Although ArchiMate framework enables the modeling from various perspectives within an organization, it does not support the delineation of all elements in the v^4 ontological framework. Thus, this study is expected to give contribution not only in the business model area but also to the field of enterprise architecture, specifically by enable the extension of ArchiMate language.

In order to provide a better view regarding the theories, a table showing the comparison of e3 value business model and v^4 ontological framework, along with the possible mapping into ArchiMate language will be given below.

Table 5 Comparison Between v^4 Ontology, e3 Value Ontology, and ArchiMate Modeling Language

V^4 Ontology	**e3 Value-Ontology**	**ArchiMate Modeling Language**
Product service	Value Object	
Intended value element	Value Offering	
Target Segment	Market segment	
Actor	Actor	
Business Role		
Relationship		
Flow communication	Value Exchange; Value Transaction	
Channel	Value Interface; Value Port	

Governance		This element cannot be mapped into any elements of ArchiMate, because it is considered as a business collaboration with external parties, while ArchiMate supports only the relationship within internal parties of an organization (single company).
Network mode		This element cannot be mapped into any elements of ArchiMate, because it is considered as an inter-organizational relationship, while ArchiMate supports single organization modeling only.
Value Finance	Value Offering	
Core resource		
Value Configuration (Resource configuration)		
Core Competency		

Based on the comparison above, it can be concluded that there are some limitations of Archimate and e3 value if compared with the v^4 ontology. Firstly, governance and network mode elements from the v^4 ontological structure of business model cannot be modeled using ArchiMate modeling language because it does not support inter-organizational modeling. However, those elements can be linked to the architectural pattern of enterprise architecture, which is considered still related to the modeling principles. Detailed description of the pattern for governance and network mode will be discussed later.

Secondly, Al-Debei and Avison (2010) use the term value configuration in the v^4 ontological structure of business model, while there is no specific explanation related to the concept in their study. The only available description available about the term is related to the resource configuration, which in this case may lead to ambiguity. Thus, in this study, value configuration is assumed as a resource configuration of the enterprise.

The last limitation found based on this comparison is related to the e3 value ontology. In the table, it can be seen that most of the elements in the v^4 ontological framework do not exist in the e3 value, and some of them regarding resource and competency, which corroborate the previous statement about the barriers of e3 value model.

The above comparison brings to the conclusion that the v^4 framework is the most complete amongst other business models, which is also considered as an advantage of

the framework. Thus, the given comparative table is provided with the v[4] framework as the main perspective.

In order to come up with a better understanding regarding the mapping of the ontologies into ArchiMate modeling language, several models are provided as follows.

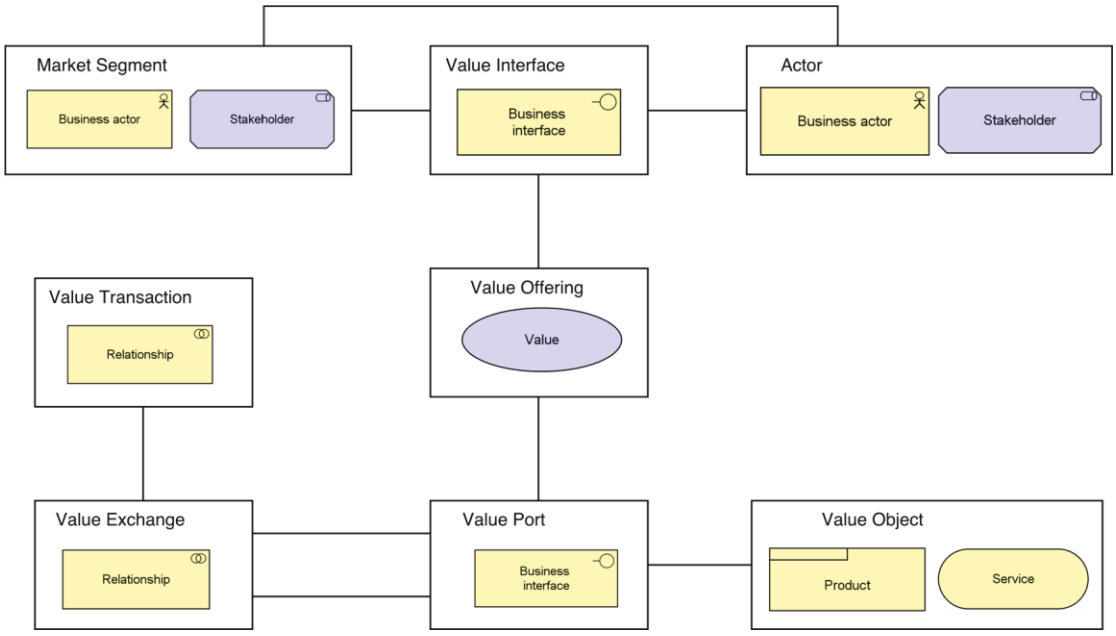


Figure 9 Mapping e3 Value Ontology into ArchiMate Modeling Language

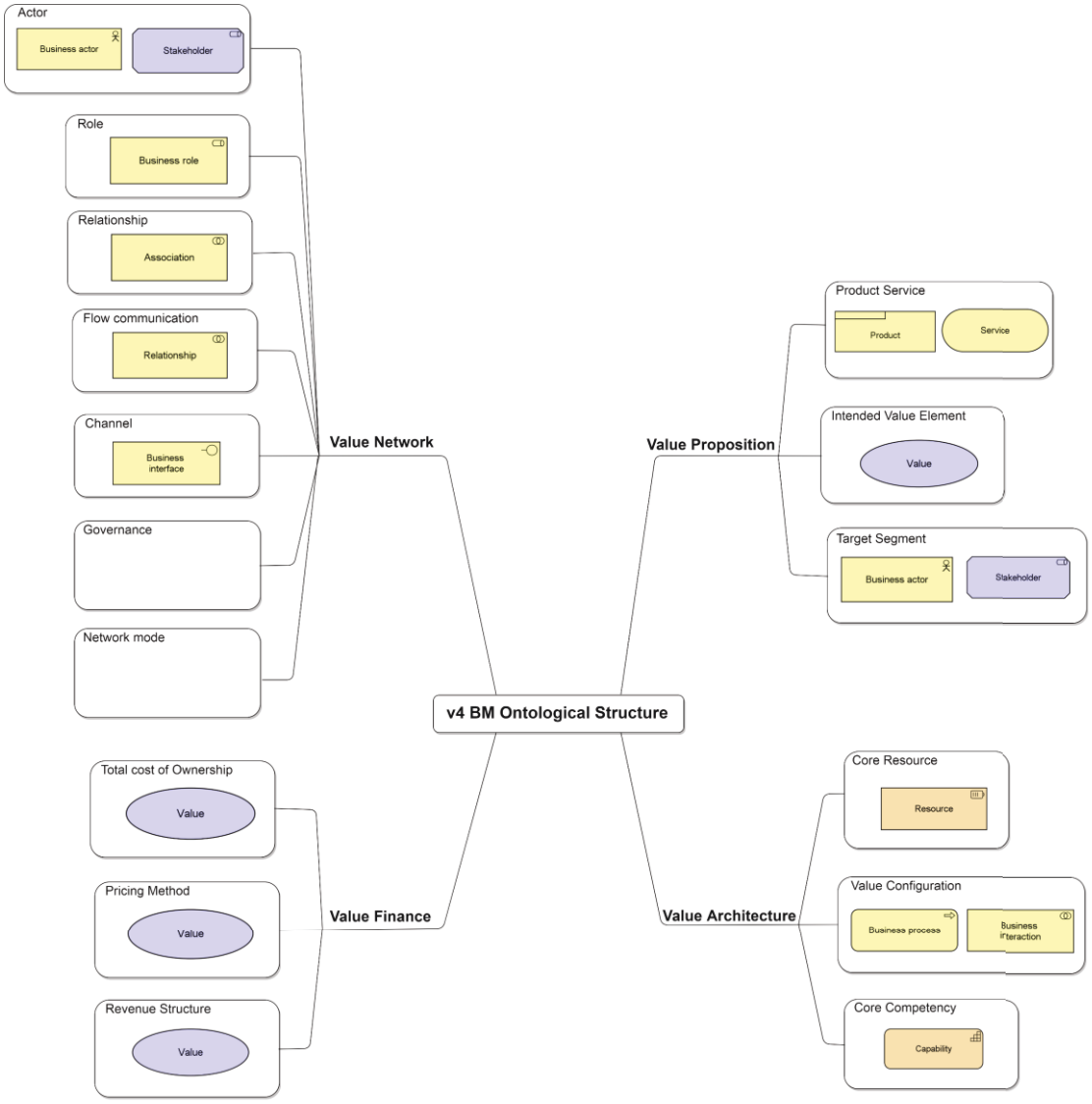


Figure 10 Mapping v[4] Ontology into ArchiMate Modeling Language

As previously stated, currently there is no proper notation of ArchiMate language that is able to support the modeling of governance and network mode. Therefore, another suitable approach should be referred in modeling those elements, which is Enterprise Architecture Patterns (EAP). Enterprise Architecture Patterns can be seen as a way to document collected experiences, formulated practices, and documented solutions to recurring problems as regards to Enterprise Architecture (Perroud & Inversini, 2013).

Figure 11 shows the pattern for modeling governance and network mode, which refers to EAP concept. Based on the picture, it can be seen that governance can be explicitly put in the pattern. Meanwhile, the network model is shown by the open network and closed network, which is considered as the type of the governance.

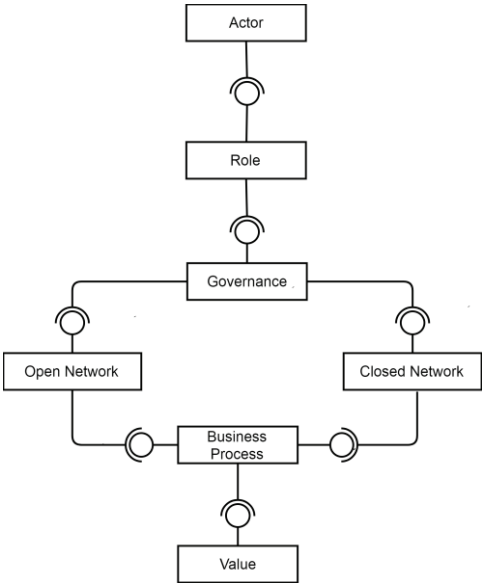


Figure 11 Enterprise Architecture Patterns View for Governance and Network Mode

2.4. Analysis Techniques and Methods

After having a deeper understanding regarding the concepts related to digital business ecosystems, further investigation to analyze digital business ecosystems should be conducted. The analysis is considered as one of the most critical processes during the planning. However, a lot of organizations do not take analysis as a critical success factor for a project, which often leads to the project fail (de la Vara, Sánchez, & Pastor, 2008). The same situation happens in business, where the failure of the firm can bring substantial losses to the interested parties (Deakin, 1972). The fact motivates the involvement of appropriate analysis for each planning process in order to reduce the risk of business failure in the future, as well as to help the decision-making process.

As regards to overcoming the problem, this section will specifically describe a possible approach to analyzing the future implementation of the digital business ecosystem, which indirectly related to business analysis. The purpose of the business analysis is to ensure that all the changes are in line with the mission, objectives, and strategy of the organization (Cadle, Paul, & Turner, 2010). Besides adopting the business analysis as a foundation, the study also captures some value chain analysis theories, since it is considered to have a secondary connection with the value network concept (Battistella, Colucci, De Toni, & Nonino, 2013).

In this section, suitable analysis, along with the methods for each correspond analysis will be explained with the purpose to define the theoretical framework required for this study.

Profitability Analysis

Analyzing the profitability is one of the metrics to assess the financial situation of the company. Meanwhile, the financial analysis itself is an integral part of the financial

statement analysis. Thus, it is assumed that during the study, the profitability analysis is conducted based on companies' financial statement as the sources of the data.

The purpose to find the profitability is to assess whether the firm will be able to control its expenses in order to generate an acceptable rate of return (Groppelli & Nikbakht, 2000).Meanwhile, financial statement analysis can be defined as a method or technique to evaluate various financial matters, including financial risks, performance, health, and the prospects of an organization (White, Sondhi, & Fried, 1994). In addition, profitability analysis is considered required to assess the future of the business, as presented in the study by Johnson et al. (2014). Thus, profitability analysis is considered useful for the stakeholders, especially to help investors and creditors to make better economic decisions.

As the study is related digital business ecosystems, the profitability analysis can aid the stand-alone company to assess whether joining an ecosystem will bring advantage, regarding the financial benefit. Moreover, if a company is already a part of an ecosystem, this analysis is expected to forecast the future economic performance of the ecosystem, which will facilitate the business executives to make a long-term business planning.

Based on the statements above, it can be said that financial analysis for an ecosystem, will be useful during the preparation stage before a company transforming into a digital business ecosystem, until when the enterprise already a member of the ecosystem. Moreover, the analysis can also be used to assess the prospect of the business in the future. As an additional information, profitability analysis is considered to be very beneficial for the Chief Financial Officers (CFOs) of an enterprise, since decision-making regarding the financial aspects can be done by the CFOs[4].

Goal Analysis

Goal analysis is simply defined as an analysis technique to translate the enterprise objectives into specific, observable, and desired performance. Goal analysis can also be defined as a procedure to help the enterprise to describe the meaning of the desired goal, which can be related to attitudes, appreciations, or understanding towards the goal (Mager, 1972). The purpose of this analysis is to support the decision-making process, which aiming at the corporate goal itself.

One of the methods to realize the analysis is by creating a decision tree model. A decision tree is a decision support tool which can be linearized into decision rules (J. Ross Quinlan, 1987). By applying the rule into available options, the value based on the specified priority will be presented in the tool, which can aid the decision-making process.

[4] http://www.digitalistmag.com/finance/2016/10/20/cfos-role-in-digital-transformation-04578102

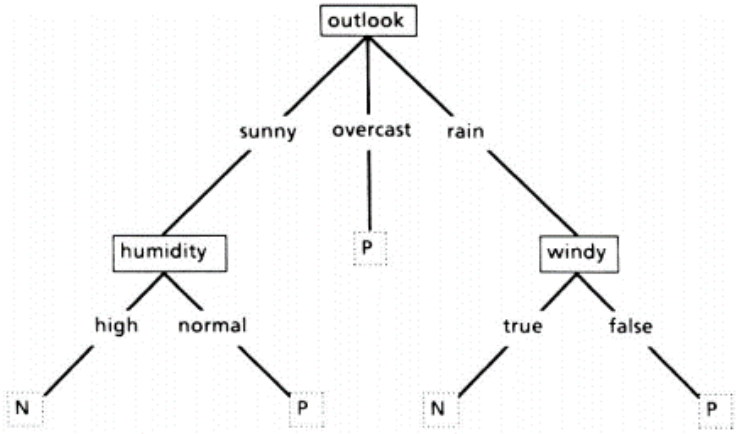


Figure 12 Simple Decision Tree Example (*J. R. Quinlan, 1986*)

As regards to digital business ecosystems, the goal analysis is expected to bring insights about which member can support the objectives of the company in order to achieve the enterprise goal. If the result of the analysis shows that the company is still the one who can provide the best capabilities if compared to other companies, then it is recommended for the organization not to cooperate with other members in an ecosystem. Based on the statement, it can be said that goal analysis is necessary for reviewing the current situation, as well as to see whether joining an ecosystem can bring more advantages for the company.

Resource Prioritization Analysis

The resource is one of the aspects which is closely linked to the capabilities possessed by the companies since the capabilities execution depends on how optimal the resource is. It is important to bear in mind that resource plays a crucial role in the business as the success or failure of the day-to-day operation resemblance the quality of the resource itself.

As mentioned in the previous section, the objective of each organization may differ from one to another. Thus, the strategies of the company may also vary depends on the enterprise goal itself. The result of the dissimilarity may lead to the different primary focus, which in this case is related to the resource and its associated elements. As it is viewed as the essence of the success, having a proper analysis regarding the resource is a crucial point to determine the future of the organization.

In order to evaluate the primary issue regarding the resource within an ecosystem, a resource prioritization analysis is recommended. This stage refers to analytical hierarchy process (AHP) method, which often used for group decision making since the method support multi-criteria concerns depend on the situation. The concept of AHP proposed by Thomas L. Saaty (1980), where firstly it was used to compute the resource allocation. Later, the author published literature about decision-making process using the AHP method (Thomas L Saaty, 2008). In this paper, the pairwise comparison matrix to compute the priority between available alternatives is explained.

The above description brings to the conclusion that the AHP method is one of the most appropriate methods to assess the resource, especially in the case of prioritizing the

resource allocation. After having a clear objective of the resource to be focused on, resource allocation analysis to find the optimum result based on the defined resource priority can be conducted later. Detailed explanation about the analysis to optimize available resources will be discussed in the next section.

Resource Optimization Analysis

After having the highest priority of resource type to be considered, the enterprise should start finding the specific assets or elements related to the resource. However, it is better to bear in mind that additional resource allocation analysis is still needed to be conducted, namely resource optimization analysis. The purpose of having this assessment is to find out the best arrangement regarding the elements of the resource in order to produce the most optimal results in minimum costs.

To support the analysis, linear programming method is appointed as the underlying theory of the analysis. Linear programming calculation, which also known as linear optimization method, is one of the applications of the mathematical model to obtain the best outcome amongst the available possibilities. The method firstly introduced by Kantorovich (1939), which was applied to the production planning case, with the purpose of finding the optimum utilization of the reserves of industry, specifically materials, labor, and equipment.

As the method is considerably relevant for the analysis as well as for the research, the linear programming method will be used during the study.

Digital Business Ecosystems Measurement

After performing all analyses as mentioned above, an additional step is required to ensure that becoming a part of a digital business ecosystem is beneficial. Therefore, measuring the value after joining the digital is important. The purpose of the measurement is to show that an ecosystem brings added value both for the whole parts of the ecosystem, as well as the individual member of the ecosystem.

As there is no standard for assessing the value of an ecosystem, this study is expected to provide a specific instrument for measuring digital business ecosystems. The tool will be created as the result of modifying currently available tool, specifically the balanced scorecard by Kaplan and Norton (1996).

The balanced scorecard translates mission and strategy into objectives and measures, which later can be used to articulate and communicate the business strategy, as well as align the individuals, organizational, and cross-departmental towards the achievement of a common goal (Kaplan & Norton, 1996). In addition, the balanced scorecard is able to assess the current performance of the company, as well as to design the required further strategy. As the balanced scorecard is considered quite comprehensive and it provides various perspective from the stakeholders, it will be used as the principal instrument of the study.

As the balanced scorecard aims for the performance measurement for a single company, it can be said that the direct implementation of the balanced scorecard is not suitable for measuring digital business ecosystems, as it comprises more than one player. In addition, the components to be examined by the balanced scorecard do not correspond to the elements of digital business ecosystems, by keeping in mind that the main purpose of the balanced scorecard is to measure the performance of an enterprise.

In order to the answer the limitations as previously stated, a proposed instrument to measure the value possess by digital business ecosystems will be provided during this study. The provided tool will be quite similar as the balanced scorecard, with some additional adjustments based on the requirement of digital business ecosystems. The detailed explanation of the measurement tool will be discussed in the next chapter.

The analyses mentioned above will be used later during the study. To be more specific, it will contribute to the development of the proposed approach, as the analysis is a crucial part needed during the strategic planning process. In addition, the analysis is intended to assist in managing digital business ecosystems after the organization has been transformed into an ecosystem type company. Thus, analysis plays a prominent role in the enterprise, before transforming into a member of an ecosystem, as well as after the implementation. Further application of the analysis will be incorporated in the next chapter.

3. Model-based Analysis for Digital Business Ecosystems

This chapter will explain the proposed approach based on the underlying theories stated in the previous chapter. To be more specific, step-by-step modeling and analysis for digital business ecosystems will be described thoroughly in this section. At the end of the chapter, the result of implementing the proposed approach to digital business ecosystems will be discussed briefly.

As refer to the previous chapter, the v^4 ontological structure of business model by Al-Debei and Avison (2010) will be used during the research as the theoretical framework. In addition, the study also related to the balance scorecard concepts by Kaplan and Norton (1996). The balanced scorecard concept is referred for the measurement purpose, specifically to evaluate the prospective ecosystem as well as to assess the performance of the currently available ecosystem.

With the purpose to present an overview of digital business ecosystems, ArchiMate modeling standards by The Open Group (2016) will be used as the guidelines for constructing the model. Later, the provided model will become a ground basis for conducting the model-based analysis, with the purpose to assess digital business ecosystems.

To sum up, this chapter is expected to answer one of the sub-research questions of the project, more particularly about analyzing and modeling of digital business ecosystems.

3.1. Stakeholder Interests

As refer to the previous chapter, stakeholder interests help the modeling and analysis of digital business ecosystems. In addition, stakeholders support the collaboration in the ecosystem in order to create value (Prahalad & Ramaswamy, 2004), with the purpose to improve the business performance of the organization (Ceccagnoli, Forman, Huang, & Wu, 2011). Therefore, the study presented in this thesis comes up with the proposed approach that considers the stakeholder interests as well.

The purpose of this section is to describe the stakeholder interest in the form of the v4 ontological framework. As an addition, the stakeholder interests shown in the figure presented are based on the available literature. To get a clear insight regarding stakeholder interests, an example of a business stakeholder interests, specifically CFO, is presented in *Figure 13*.

As refer to the title, it can be seen that the Chief Financial Officer (CFO) has to deal with financial matters, which is also shown by their interest in value finance (*Figure 13*). However, in a digital business ecosystem, CFO should take part not only related to the financial aspects, but also related to other additional elements, such as product/service, intended value, and core resource. This occurs as CFO has to communicate more with CIO in executing the business operation.

Beside CFO, other stakeholders are also considered to have interests in a digital business ecosystem, including CIO, COO, CEO, business analysts, and ICT architect. The figures show the interests of the stakeholders can be found in *Appendix C*.

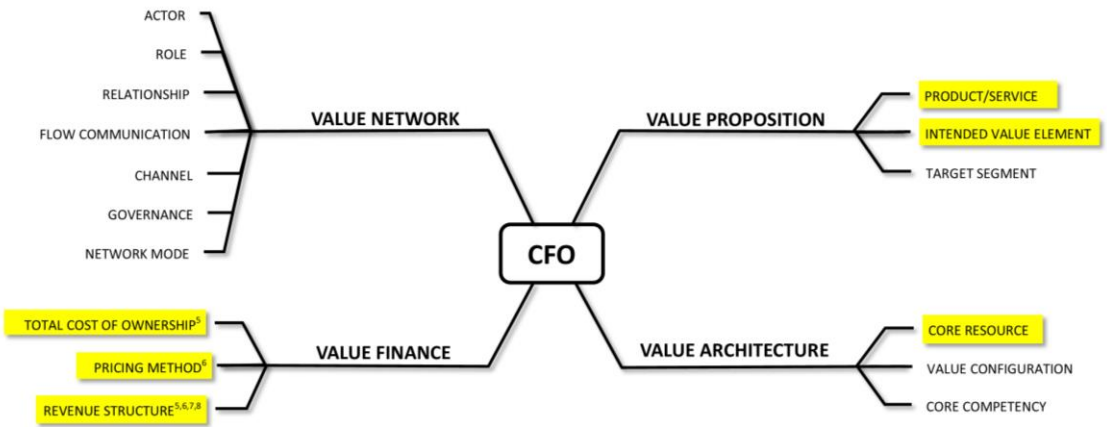


Figure 13 CFO Interests

3.2. Viewpoints

This section will provide several viewpoints that could support the executives in managing an ecosystem. The following viewpoints are provided with the reference of the stakeholder interests as mentioned in the previous section.

The viewpoint is considered required in managing the business, as it specifies the concepts, models, analysis techniques, and visualizations provided by the view, as a part of an Architecture Description (The Open Group, 2016). In short, the purpose of a viewpoint is to facilitate the communication of stakeholder concerns, which can be found in particular aspects and layers of the architecture.

When creating the viewpoints, ArchiMate modeling language concepts will be used as the underlying theory. In ArchiMate language, a viewpoint consists a subset of relevant concepts (elements and relationships), that is needed to address the stakeholder's concerns (The Open Group, 2016). Thus, following viewpoints are established by referring to ArchiMate modeling language notation.

Table 6 shows an example of value network viewpoint, which is made with the purpose to fulfill the interest of CFO, which is one of the stakeholders a the digital business ecosystem.

[5] http://www.digitalistmag.com/finance/2016/10/20/cfos-role-in-digital-transformation-04578102
[6] http://www.slideshare.net/AccentureNL/accenture-digital-business
[7] http://www.forbes.com/sites/oracle/2016/01/13/the-rise-of-the-digital-cfo-the-top-5-strategic-finance-issues-for-2016/#319978ba437a
[8] https://www.acquia.com/blog/5-questions-cfos-should-be-asking-about-digital-transformation

Table 6 Value Network Viewpoint

Value Network Viewpoint	
Stakeholders	Stakeholders, business analysts, enterprise and ICT architects, CIO, CEO, CFO
Concerns	Dependencies between stakeholders, identification of competencies and responsibilities, (financial) value offered by each actor, (financial) value gained from business operations
Purpose	Designing, analyzing, deciding
Scope	Multiple layer/Multiple aspect
Elements • Business Actor • Business Role • Facility • Equipment • Material • Distribution Network	

Based on the table, it can be seen that CFO is included in the stakeholders list, which also corroborates that this viewpoint presented for accomplishing their needs. As previously mentioned, CFO has to deal with financial matters, which is also shown in the table, specifically in concerns section. Furthermore, viewpoint also contains additional information, such as scope and elements, which are considered useful for modeling and analysis purpose.

The complete list of the viewpoints can be found in *Appendix D*.

3.3. Visualization and Analysis of Digital Business Ecosystems Approach

After having an understanding regarding the stakeholder interests and the viewpoints, the next step is to model and analyze them. The purpose of the approach provided in this section is to aid the business executives in decision-making process, as well as to find the possible opportunities for improvement, which can be done by applying a digital business ecosystem in an enterprise.

3.3.1. Flow Process of Modeling and Analyzing Digital Business Ecosystems

The purpose of the digital business analysis is to find out whether a company should consider joining an ecosystem or not. Meanwhile, if an organization is already a part of an ecosystem, the analysis is expected to provide further insights concerning the advantages of the ecosystem. If the opposite situation happened as the result of becoming a member of an ecosystem, the company should consider leaving the ecosystem. The detailed application of the analysis, as well as the result of each evaluation, will be explained later.

As mentioned in the previous chapter, various possible analysis can be used to investigate a business ecosystem. However, only some of the analysis will be applied in this study, including profitability analysis, resource analysis, and goal analysis. The step-by-step analysis for the ecosystem is described in the following figure.

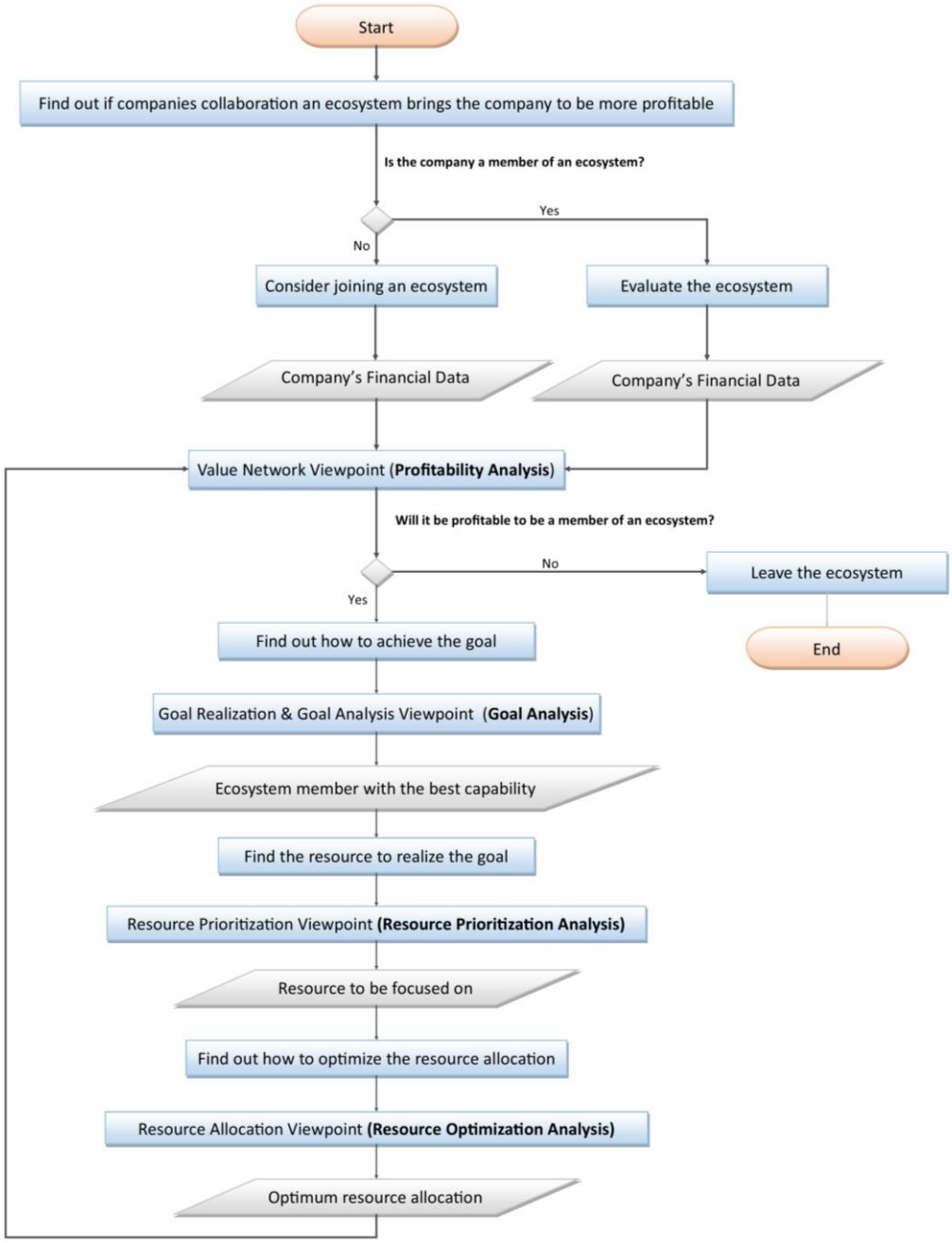


Figure 14 Digital Business Ecosystem Analysis Flowchart

In order get a higher profit, companies can consider collaborating with others in an ecosystem. If a company already a part of an ecosystem, they can evaluate whether the current ecosystem brings the company to be more profitable, if compared to conducting a business without the help from an ecosystem. Meanwhile, if a company is not a part of an ecosystem, the company can consider joining an ecosystem to be more profitable. This can be assessed by conducting a profitability analysis, with the purpose to find out

whether joining an ecosystem will make the company to get a higher financial benefit. If the assessment results show that the ecosystem leads the company to losses, then it is better not to become a part of an ecosystem. In another way, if it supports the company to the financial advantage, then to collaborate with other players in the ecosystem is advisable. The profitability analysis during this study refers to the financial analysis since it enables the company to discover the potential benefit or losses that may occur in the future.

After having more knowledge regarding the financial aspects of the company, the next issue to be taken into consideration corresponds to the objective of the business itself, specifically the enterprise goal. In order to achieve the main objective, company must have more than one specific objectives that can lead to the attainment of the central goal. To achieve those objectives, it is expected that company can acquire the capabilities not only from internal organization, but also from other members within an ecosystem. In addition, if the company found that there is a potential member that possess a good capability, the assessment also can be done using this goal analysis. Therefore, it can be said that goal analysis is expected to help company to find the partner with the best capability in aiming the enterprise goal.

Afterwards, the next step is to have a better understanding of the resources possessed by the members of an ecosystem. The purpose of this stage is to be informed of the type of resource should be focused on, as well as to find out an ecosystem member that possesses the best resource. Subsequently, an optimum resource allocation is required in order to create a higher profit, which can be done by maximizing the revenue and minimizing the cost. Thus, all analyses are expected to bring company to be more profitable by enabling the cooperation in a business ecosystem.

In the end, if the company consider to be a part of an ecosystem, then the company should also re-evaluate the whole ecosystem in order to see the future potential of the ecosystem, which can be done by doing the whole process all over again.

3.3.2. Analysis 1: Profitability Analysis (Value Network Viewpoint)

The first step of assessing digital business ecosystems is to see the players within an ecosystem and how they are related to each other. As the members of an ecosystem consist more than a single enterprise, a clear connection amongst them should be defined from the beginning. To give an overview of the relationship between actors in an ecosystem, an illustration as shown in *Figure 15* is provided. In the figure, it can be seen that there is a collaboration between companies in an ecosystem, specifically in a car manufacturing industry.

After having a clear picture of the relationship between the actors in the ecosystem, an analysis to examine whether the relationship brings additional benefits for the company needs to be performed. One of the analyses that can provide the most obvious result of the comparison between two different situations is profitability analysis.

The purpose of conducting profitability analysis related to digital business ecosystems is to identify the cost-effectiveness of the currently available ecosystem, as well as to find out a potential member to become a part of a business ecosystem. During the study,

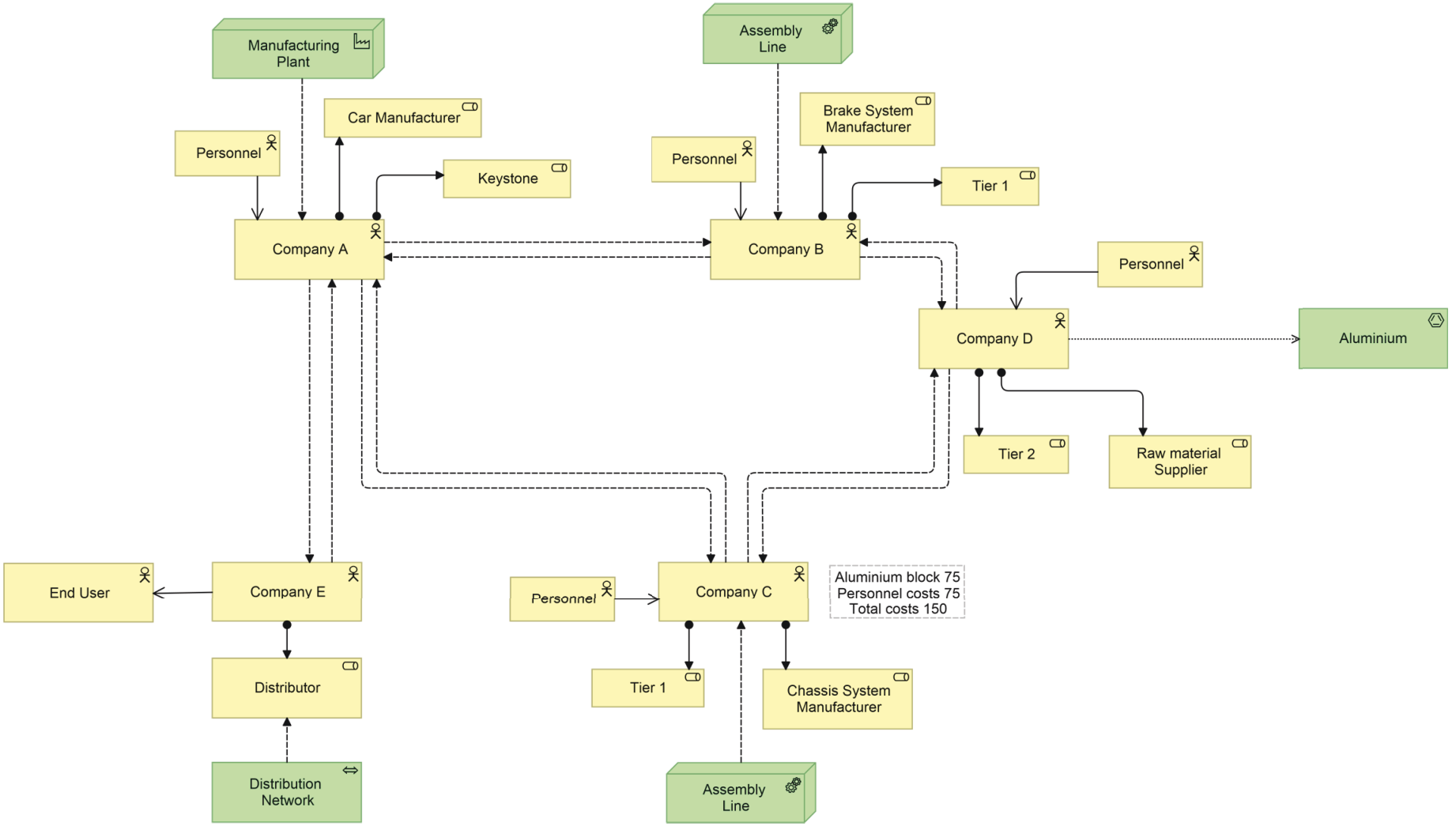


Figure 15 Modeling Value Network Viewpoint

the profitability analysis is linked with the cost and revenue analysis, as it can provide a clear overview of the possible financial advantages or losses of business operation in the future. Thus, it is considered as the most appropriate method to assess the cost-effectiveness of an ecosystem. To get a more comprehensive view regarding the analysis, an example of profitability analysis to evaluate an ecosystem is provided as follows.

Company A is a car manufacturer which conducts in-house production for all parts of the car. The company is considering to join an ecosystem with the purpose to gain financial advantages as well as to improve efficiency to increase customer satisfaction. Therefore, the company should calculate and compare the costs and revenue in order to make a better decision making regarding the ecosystem.

In this example, it is assumed that the company has some information related to the financial statement of other relevant companies, which can be potential members of the ecosystem. To find out whether it is better for the company to be a part of an ecosystem or not, a profitability analysis is conducted. The result of the analysis can be found in the following table (Detailed calculation can be found in *Appendix E*):

Table 7 Comparing In-house Production Costs and Production Costs in an Ecosystem

Company	**Total Cost**	
	In-house Production (Company A)	**Cooperating in the Ecosystem (Company A+B+C+D)**
Company A	€ 560	€ 100
Company B		€ 175
Company C		€ 150
Company D		€ 80
Total	**€ 560**	**€ 505**

The table above shows that it is more beneficial for Company A to collaborate with other companies because the overall production costs are lower if the company is a member of an ecosystem. It can also be said that if the Company A decides to do an in-house production, the total costs will be €55 higher.

Another point that can be generated based on the example is the revenue calculation. Assumed that revenue from selling a car is €750. The income that can be gained by Company A if they are doing an in-house manufacturing is €190, while the profit (income) can be higher if they are considering joining an ecosystem, which is €245. Based on the case, it is possible to get more financial profit as the total costs can be reduced, which emerges as the result of lower production cost by other members from the ecosystem. Both the calculations show that it will be more profitable for the Company A if they become a member of the ecosystem. Thus, it is recommended for the company to cooperate with the partners within the ecosystem.

Later, the result of the analysis can be illustrated by another model in order to give an overview of the advantages of an ecosystem. Providing a picture about the profitability analysis is considered helpful, as it can bring a clear insight of the positive impact resulting from the ecosystem, as well as to enable the comparison of before and after performing the analysis. The model of value network viewpoints after implementing the profitability analysis can be found in *Figure 16*.

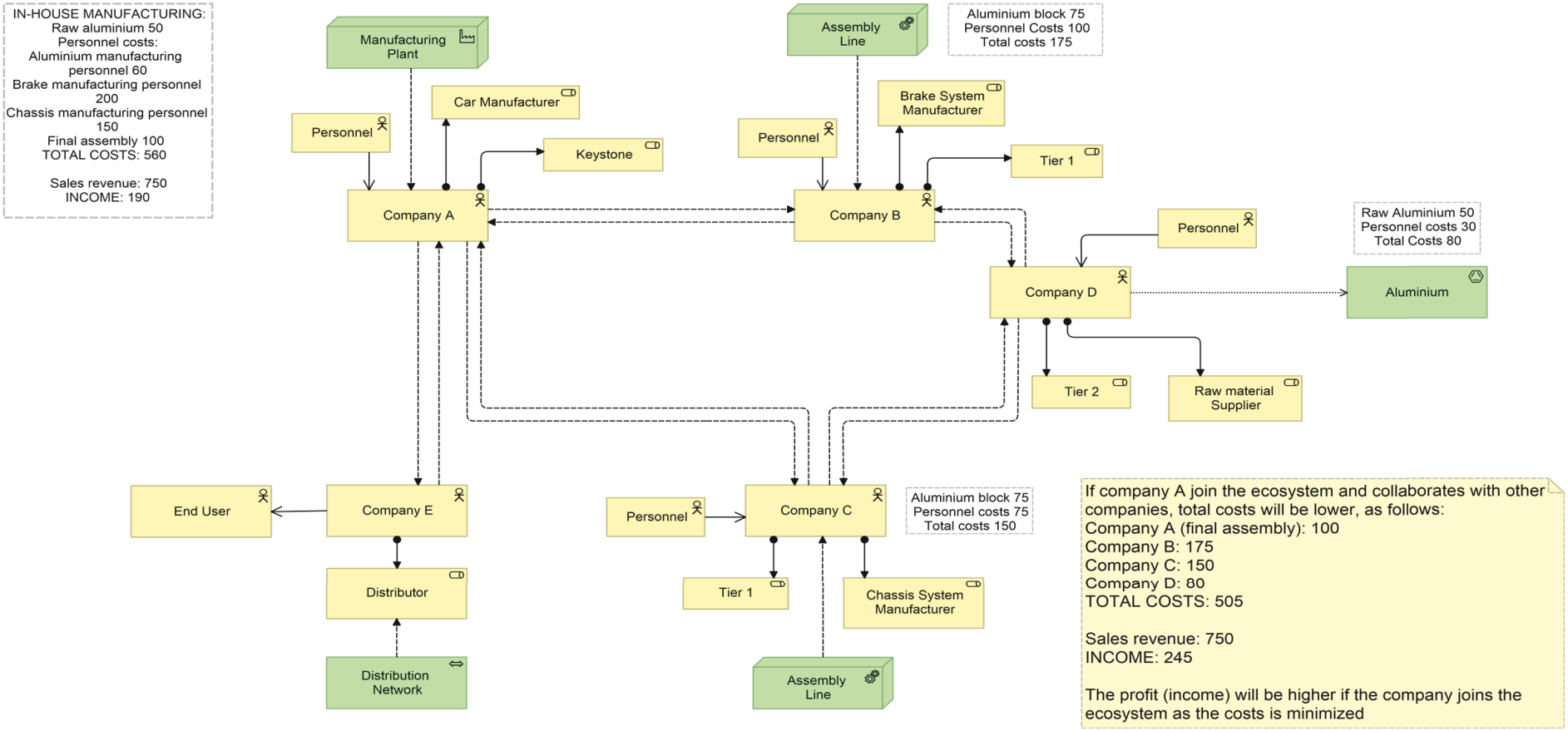


Figure 16 Modeling Value Network Viewpoint after Implementing Profitability Analysis

Moreover, the result of the analysis can support the company to make a better decision making about whether becoming a member of an ecosystem is a right step for the enterprise or not. Thus, the profitability analysis is considered as an important step for digital business ecosystems analysis. In addition, as the assessment is related to the financial value of the companies, this analysis can be considered useful. By having a financial understanding regarding the ecosystem, the organization will be able to have a better recommendation in creating the enterprise plan for the future.

However, there are additional factors should be taken into consideration in conducting the analysis. One of the examples is the possibility of additional variables to be included, the different situation between one organization and another, and so on. Thus, other analyses should be conducted in order to get a better result regarding digital business ecosystems.

To sum up, the analysis provided in this section is expected to be useful as it supports the room for improvement in increasing the profits, which is also corroborated by the result of the sample case.

3.3.3. Analysis 2: Goal Analysis (Goal Realization and Goal Analysis Viewpoint)

In achieving the main goal of the enterprise, there must be several objectives that should be completed first. In other words, the outcome as the result of having strong capabilities within a company can lead to the achievement of the main goal in an enterprise. However, it is possible that the company does not have a strong capability in all sectors. Therefore, the company should consider acquiring those capabilities from other members of an ecosystem in aiming the success.

With the purpose to find out which company can provide a strong capability in particular area, a goal analysis is conducted. After completing several objectives, the outcomes are expected to lead towards enterprise goal realization. In order to give an overview towards enterprise goal realization, an illustration as shown in *Figure 17* is provided.

Based on the figure, it can be seen that to attain the enterprise goal, the company has to achieve the higher objective which resulting to the outcomes that can lead to the enterprise goal itself. In addition, those objectives can be completed as the result of having strong capabilities which is also considered as the drivers in reaching those objectives. However, as previously mentioned, it is possible that company might not have all the capabilities required. Thus, the company can acquire them by collaborating with other companies in an ecosystem. To conclude, with the purpose to bring all together, it is necessary to understand the objectives that can lead the company towards achieving the enterprise goal. Therefore, to find out the member that possessed the best capability in aiming the main goal, a goal analysis is considered required.

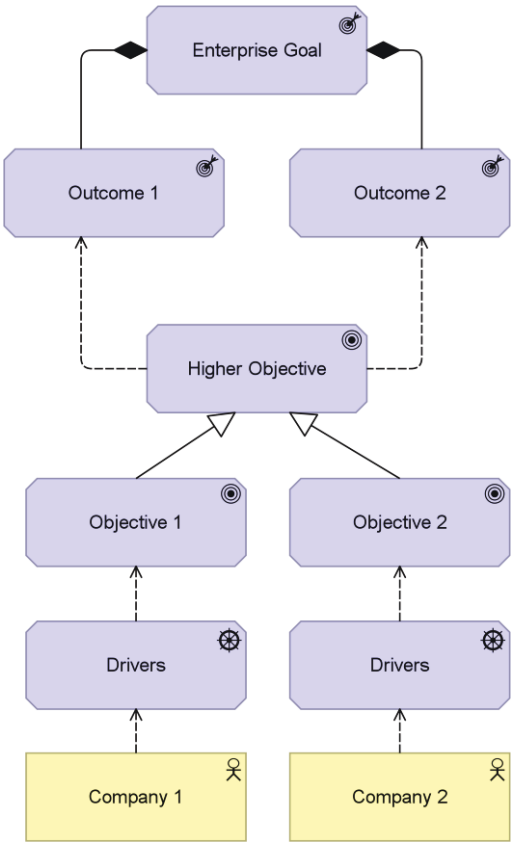


Figure 17 Towards Goal Realization

To conduct the analysis, the first step is to assess the capability of each company, which later will be matched up with the objective. In order to provide a clear picture regarding the evaluation, an example of the goal analysis along with the detailed calculation will be provided as follows.

It is assumed that shared goal of an ecosystem is to reduce production and delivery costs, which can be achieved through improving effectiveness and efficiency. Furthermore, reducing lead time and improving information quality are the best ways towards the enterprise goal achievement.

Afterwards, the capability of each company which can affect lead time reduction, as well as information quality improvement is listed. These factors are considered as drivers towards goal realization. In addition, the prioritization of the capability to be focused on is determined in order to give more attention to the central goal.

Below is the matrix to show the capacity possessed by each company as well as the weight of the priority assigned to each capability with the intention to have a shorter lead time.

Table 8 Capabilities Needed towards Shorter Lead Time

Capability / Company	Availability	Capacity	Flexibility
Company A	++	+	+
Company B	+	+	++
Company C	+	-	--
Priority	0.5	0.3	0.2

Note:
++: 0.4 : 1st priority (highest)
+ : 0.3 : 2nd priority
- : 0.2 : 3rd priority (lowest)
-- : 0.1

Based on the three companies as mentioned above, it can be seen that availability is the first/highest priority amongst all, which is shown by the weight of 0.5 (column with green color). Furthermore, capacity becomes the second priority, with the weight of 0.3 (column with orange color), which followed by the flexibility as the last priority, with the weight of 0.2 (column with pink color). These numbers are provided based on assumption, with the purpose to calculate the weighted average among available options.

Meanwhile, the plus and minus sign on the table shows the quality of the capability possessed by each prospective company to be the part of the ecosystem. It is assumed that each sign has a different value which as described in the note next to the table. Later, the value can be used to calculate the weighted average of the company in order to support decision-making regarding the selection of the enterprise to be assigned into the ecosystem.

Table 9 shows the converted value of the capability as well as the result of calculating the weighted average in order to find the most suitable company based on the priority. The weighted average, as shown in the last column of *Table 9*, can be calculated by summing up the multiplication of priority with the value of capability possessed by each company. As an additional information, it is assumed that the numbers related to the capabilities given in the table below are provided from the survey, assessment, and so on.

Table 9 Capabilities Needed towards Shorter Lead Time

Capability / Company	Availability	Capacity	Flexibility	Weighted Average
Company A	0.4	0.3	0.3	0.35
Company B	0.3	0.3	0.4	0.32
Company C	0.3	0.2	0.1	0.23
Priority	0.5	0.3	0.2	

Table 9 shows that Company A has the biggest number if compared to the weighted average of other companies. Therefore, it is better to select company A to acquire the capability if the keystone company wants to focus on the availability as the main driver to achieve the enterprise goal, which in this case is to improve the lead time. Furthermore, the weighted average numbers can be transformed into another analytical form, specifically a decision tree diagram, with the purpose to support the managerial decision. The figure below describes the decision tree diagram which is converted from *Table 9.*

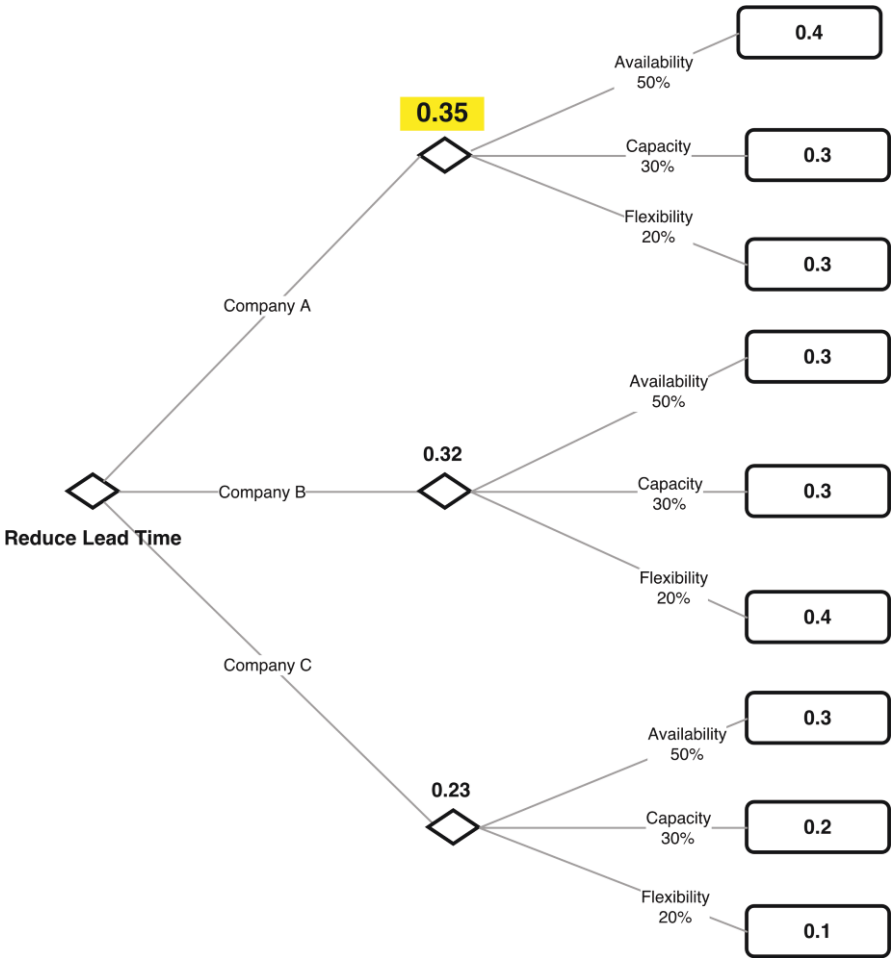


Figure 18 Decision Tree Diagram of Capabilities Needed to Reduce Lead Time

After having the result of the goal analysis, which is supported by the decision tree, a model shows the final decision in reducing lead time can be established. *Figure 19* shows the goal analysis modeling, which also defines the chosen company that can support the lead time reduction.

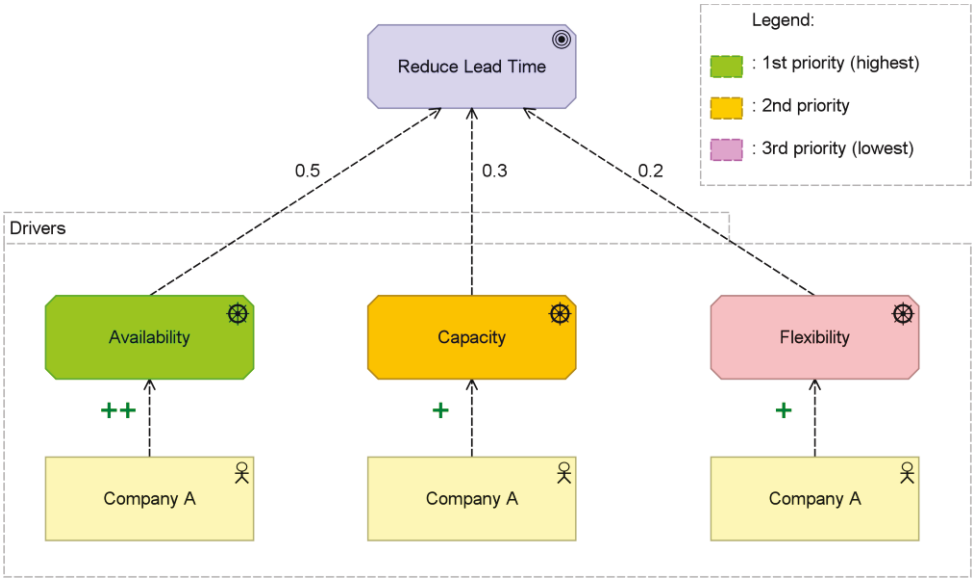


Figure 19 Modeling Goal Analysis towards Lead Time Reduction

As previously mentioned, in this case, there is more than one factor contribute to the target accomplishment. Another influencing aspect in accomplishing the main goal is better information quality of the business. The goal constructs of three drivers, namely security, integrity, and reliability. The same steps to assess the competency can be conducted in order to provide the results, which can be used for the decision-making purpose. The detailed calculation of goal analysis towards better information quality can be found in *Appendix F*.

With the information generated from the goal analysis, another model to show the chosen company towards goal achievement is presented in *Figure 20*.

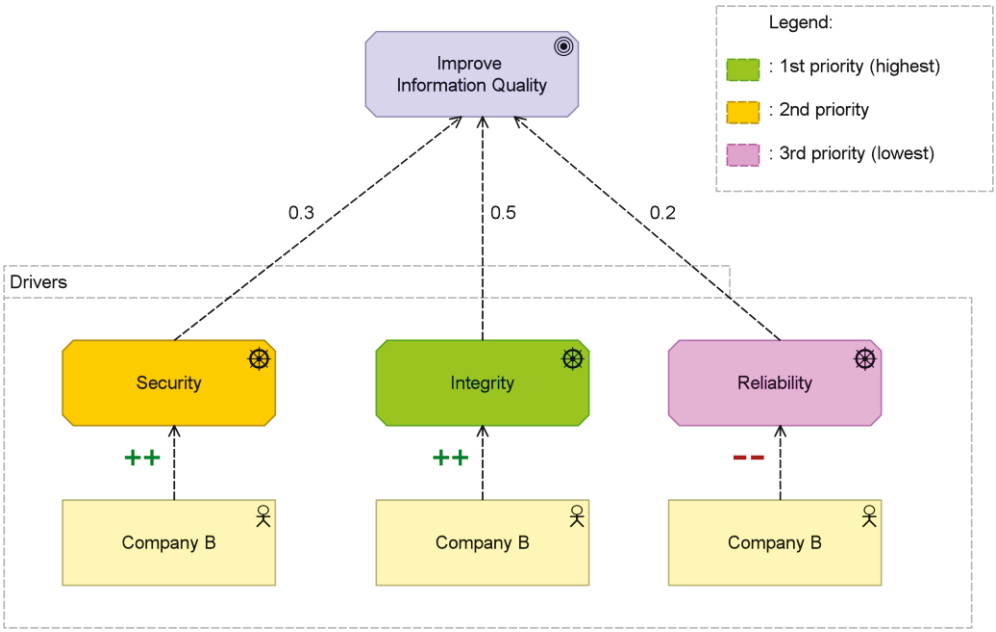


Figure 20 Modeling Goal Analysis towards Better Information Quality

After having the models based on different types of goals, a more comprehensive picture combining those models can be created. The purpose of providing one single presentation of the analysis is to see which company could provide the capabilities

required based on each enterprise's objective. Subsequently, these targets are aiming at the bigger goal of the ecosystem, which is to attain the enterprise goal, specifically to get a higher profit of business operation. The result of goal analysis towards realizing the common objective is presented in *Figure 21.*

The result of this analysis is expected to help the decision maker to pick out the best option among available options. To be more specific, it supposes that goal analysis could aid the business executives to choose the best partners to be added to an ecosystem. In addition, it is assumed that the assessment can contribute to the exploration of the resources and capabilities owned by the companies, which are indirectly related to the requirements of the next step, which is resource analysis.

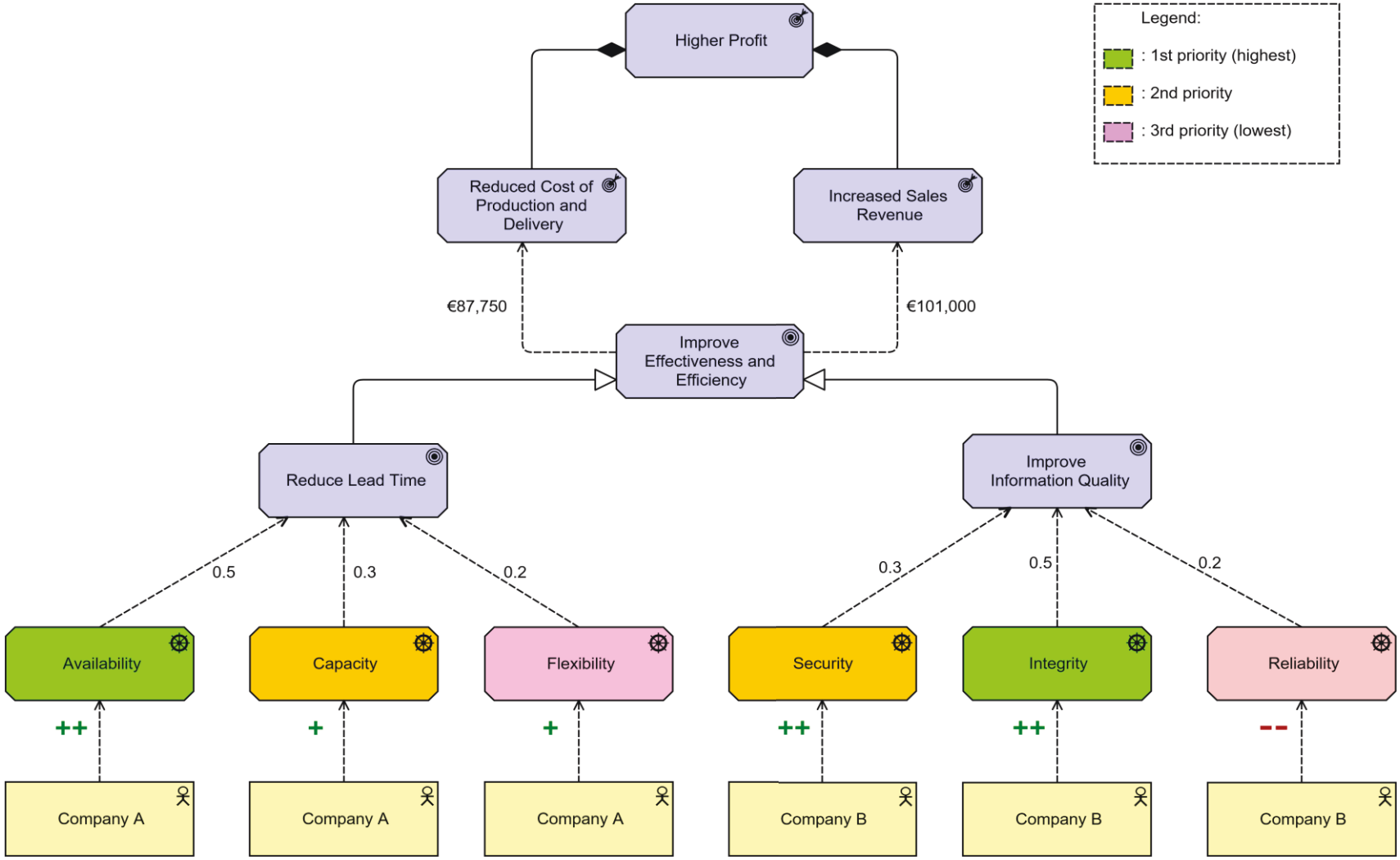


Figure 21 Modeling Goal Analysis

Still, it should be taken into consideration that there might be a variance of the result as the source of the data essentials for the analysis was gathered from various sources, such as survey and interview result, preceding reports, or recorded backlog. In addition, the factors which determine the result of the analysis are considered as qualitative data, where the exact value only measured by characteristics or rough calculation.

3.3.4. Analysis 3: Resource Prioritization Analysis (Resource Prioritization Viewpoint)

As mentioned previously, analyzing the resource along with the capabilities available is necessary as it is aiming to the enterprise goal, as well as to find out the benefit of joining an ecosystem. Thus, having a thorough understanding of the resources possess by each company will support the decision-making process towards achieving the goal. With the purpose of providing an overview of resources owned by the companies as a part of the ecosystem, a sample picture is provided, as can be found in *Figure 22*.

After having a deeper understanding regarding the resources, the next step is to conduct an additional analysis. The applicable analyses related to the resources are prioritization and optimization analysis. As one associated to another, it is important to do it in proper order. In this study, the prioritization analysis, which is followed by the optimization of the resource will be performed.

The purpose of conducting resource prioritization analysis is to determine which resource need more attention as one resource and its capabilities may contribute more towards goal achievement. Meanwhile, although the organization is intended to increase the effectiveness of particular resource, certain requirements may not be possessed by the company itself. Thus, being a part of an ecosystem is expected to support the company, since other partners may able to cover the gap.

In addition, as there are various circumstances to be considered before the decision-making process, the emergence of supporting tool to analyze multiple criteria available is believed to be useful, especially for the business executives to make a better decision result. Thus, resource prioritization analysis, as will be discussed below is considered to be a helpful instrument for assessing digital business ecosystems. In order to get a more comprehensive view of the resource prioritization analysis, a detailed explanation which is shown by a sample case is presented as follows.

It is assumed that Company A is a keystone company that wants to focus on manufacturing resource and to find an enterprise with the best overall manufacturing resource. In order to analyze which member of the ecosystem possesses the most optimal resource based on the requirements, analytical hierarchy process (AHP) method, which is also described in the previous chapter, is implemented. Following is the detail process in finding the best partner based on particular resource by conducting resource prioritization analysis.

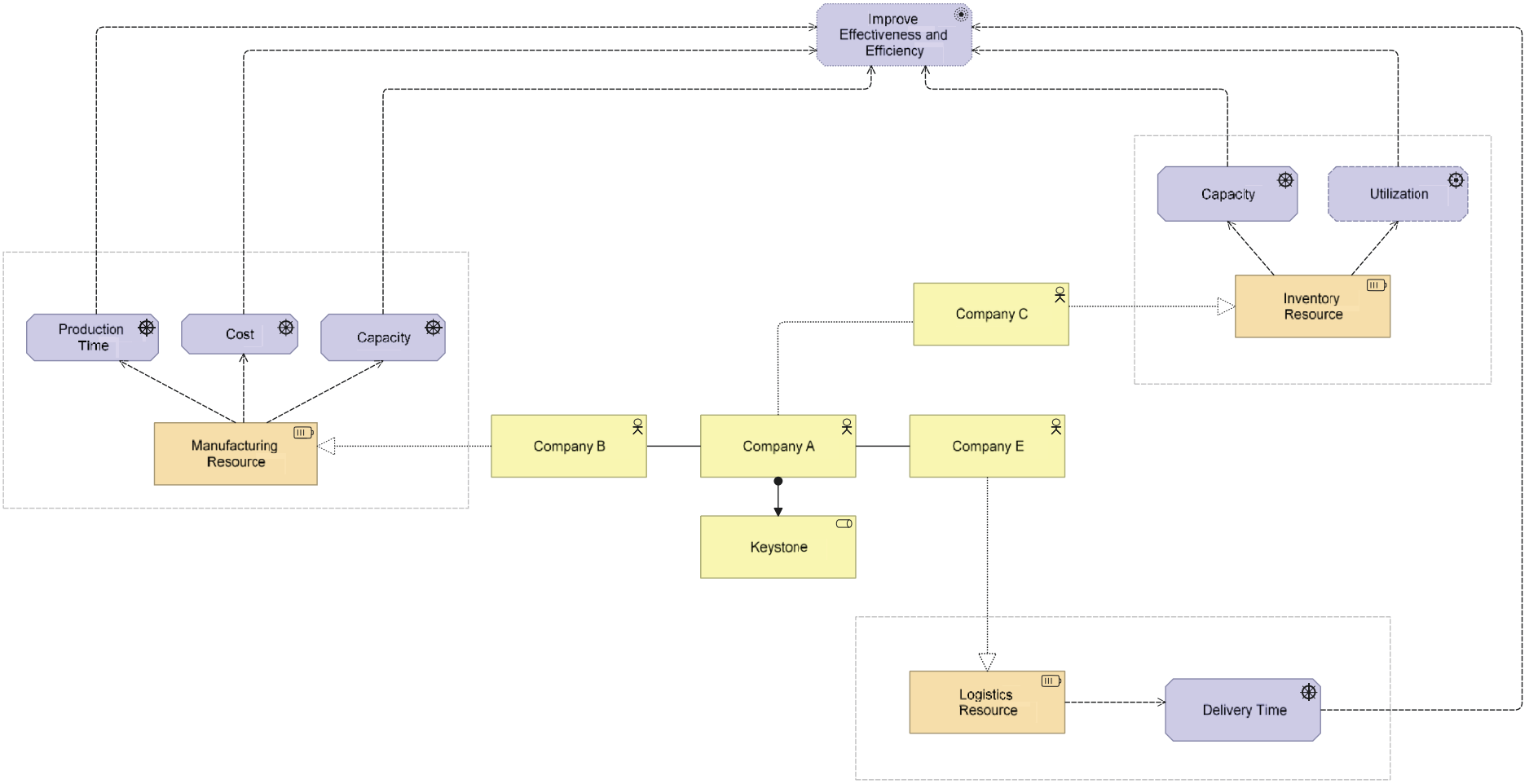


Figure 22 Modeling the Resource of an Ecosystem

Firstly, the company gathered some information regarding the potential partners. Then, based on the received information, the value of the main concerns (priority) of the resources are known. This information is used to calculate the weight by computing the normalized matrix of the criteria, which is also shown *Appendix G*.

After having the data regarding the weight of the criteria, as well as the normalized matrix based on the criteria, the next step is to evaluate the choices available. In this sample, the potential partners are Company B, Company C, Company D, and Company E. The information about the potential partners can be used to create another normalized matrix, which will be used later to calculate the score of each company.

The last step of conducting this analysis is to calculate the products of two arrays, which are criteria and choices. The highest score of the result shows the best company based on the prioritized resource. Thus, the company which has the biggest score should be selected to join the ecosystem. Provided below is the result of applying the AHP method, while the detail of the calculation can be found in *Appendix G*.

Table 10 Resulf of Applying AHP Method

Determining company with the best manufacturing resource	
	Score
Company B	**0,33**
Company C	0,21
Company D	0,26
Company E	0,20

Based on the table, it can be concluded that company B should be picked out amongst the options if the keystone company wants to focus on the manufacturing resource because company B possess the highest score, with the number of 0.33.

To sum up, the resource prioritization is expected to help the company in choosing the right partner that could provide the resource needed by the company, which indirectly related to the profit maximization. Moreover, the main concern of the resource determined by the keystone company in this analysis can be used for further analysis, specifically to optimize the resource allocation, which will be discussed in the next section.

3.3.5. Analysis 4: Resource Optimization Analysis (Resource Allocation Viewpoint)

As previously stated, the resource prioritization analysis is closely related to the resource optimization analysis. Thus, analysis and modeling obtain in this step will refer to the resource prioritization analysis as one of the data sources.

In this section, a step-by-step procedure for performing the analysis will be explained. To begin, as refer to *Figure 21*, it is clear that the company has to reduce cost as well as increase the revenue in order to obtain higher profit. Based on the same reference, a visualization regarding a digital business ecosystem can be provided as follows.

Figure 23 Manufacturing Resources

Figure 23 shows several types of manufacturing resource that may affect the production process. Later, the figure will be divided into two different illustrations based on the goal, which is to increase sales revenue and to reduce cost. Detail descriptions about these groupings will be explained along with the analysis.

In explaining the step-by-step procedure of conducting the resource optimization as a part of resource allocation analysis, a sample case as previously described in the resource prioritization analysis section will be referred. Following is step-by-step procedures to perform resource optimization analysis.

As stated above, it is revealed that Company A as the keystone company is aiming at the profit maximization as the main goal, which is closely related to the revenue and cost. As refer to the economic principle, to get a high profit, the sales revenue or income should be maximized, while any costs incurred should be minimized. Thus, the analysis will be broken down into two steps. The first stage is to obtain the maximum revenue of car manufacturing, which followed by finding out the possible minimum costs required during the production.

Step 1 – Increase Revenue

Following the earlier example, the keystone company is going to focus on the manufacturing resource, which constructs of various kinds of equipment, with different available operational time. The equipment includes assembly machine, handlers, industrial robot, and tools.

It is assumed that Company A is going to produce three types of cars, which are Car A, Car B, and Car C. The revenue from the sales of Car A, Car B, and Car C is €2,000, €2,300, and €1,750 respectively. As an additional information, production time required to make one car is varied depend on the vehicle type.

With the purpose of responding to the demand in the market, there are some constraints about the numbers in producing the car. In order to optimize the resource allocation based on the constraints, linear programming method is used to find out the best allocation of the resource.

After applying the linear programming method to the sample case, the end result is produced, which is shown in the table below:

Table 11 Result of Linear Programming Method

	Car A	Car B	Car C	Maximum Revenue
Decision Variable	15 units	5 units	34 units	**€ 101,000**
Sales Revenue per unit	€ 2,000	€ 2,300	€ 1,750	

Based on the table, it can be said that the company should make 15 units of Car A, 5 units of Car B, and 34 units of Car C to achieve the maximum sales revenue of €101,000. In order to provide an overview, the result of the analysis can be modeled in a single illustration, which is shown in *Figure 24*.

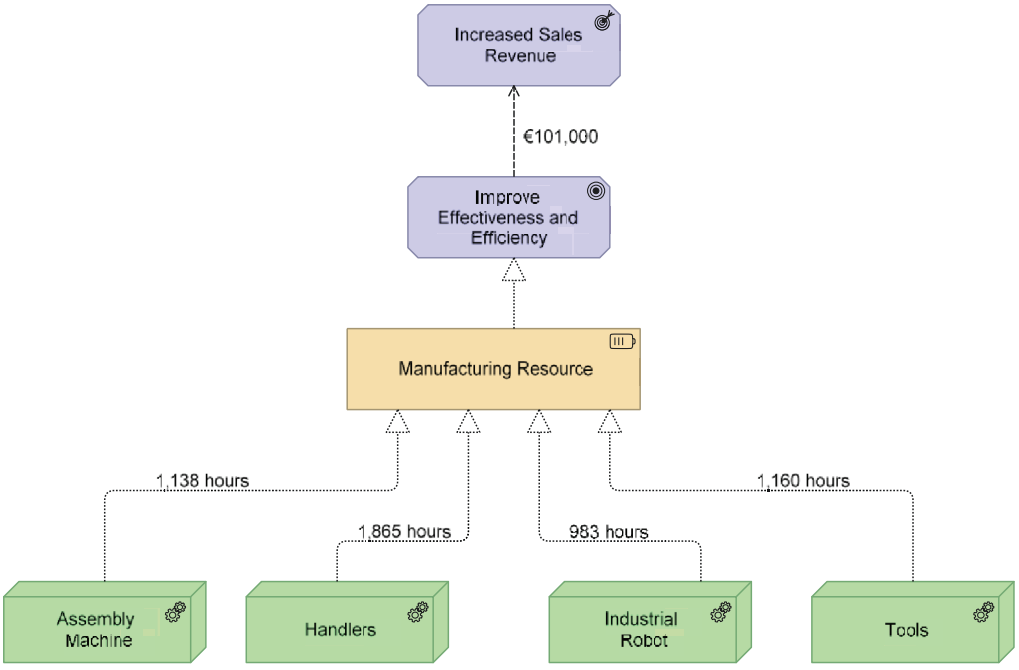


Figure 24 Resource Optimization Analysis - Maximize the Revenue

Besides computing the maximum possible income, the company should also take the costs into consideration. Thus, additional computation regarding the cost will be provided in the next step.

Step 2 – Decrease Cost

After finding the most optimal quantity for producing the car in order to get the maximum revenue, the next step is to find the minimum possible production costs in order to reduce the cost as much as possible.

In assessing the costs, there are some additional constraints should be considered, including the maximum capacity of each equipment as well as manufacturing cost based on different types of equipment. In addition, each equipment provided by different companies also has a variety of maximum capacity of production. The detailed information can be found in Appendix H.

After applying linear programming (LP) method based on the information provided, it is found that minimum possible cost for the car manufacturing is € 87,750, with the allocation of resources scattered amongst the ecosystem members. Below is the result of linear programming calculation to find out the minimum production cost, with the purpose maximize the profit.

Table 12 Resource Allocation among the Ecosystem Member

Company	Equipment	Operational Time			
		Assembly Machine	Handlers	Industrial Robot	Tools
	Company A	750	0	183	0
	Company B	0	1000	0	285
	Company C	0	865	800	0
	Company D	388	0	0	875
	Total	1138	1865	983	1160

Based on the table, it can be concluded that to maximize the production cost, 1,138 hours of assembly machine should be utilized, which can be provided by Company A and Company D. The same calculation is also applicable to other equipment, such as handlers, industrial robot, and tools.

As an addition, the result of implementing the linear programming method can also be transformed into a single model, as provided in *Figure 25*. In the figure, a type of equipment may be possessed by different companies. This is possible as the collaboration between companies within an ecosystem is expected to occur. Thus, the resource allocation analysis not only shows the type of the equipment to be focused on but also which partner could provide the required equipment.

To sum up, after having the maximum sales revenue along with the minimum cost for manufacturing the car as the result of conducting two steps resource optimization analysis, the maximum profit for the production can be calculated. To compute the profit, the economic principle of net income is referred, where the profit is obtained from the revenue subtracted by the cost incurred. Thus, the maximum profit can be received by the enterprise as the result of cooperating with other companies in producing the cars is €13,250 (Profit = €101,000 - €87,750).

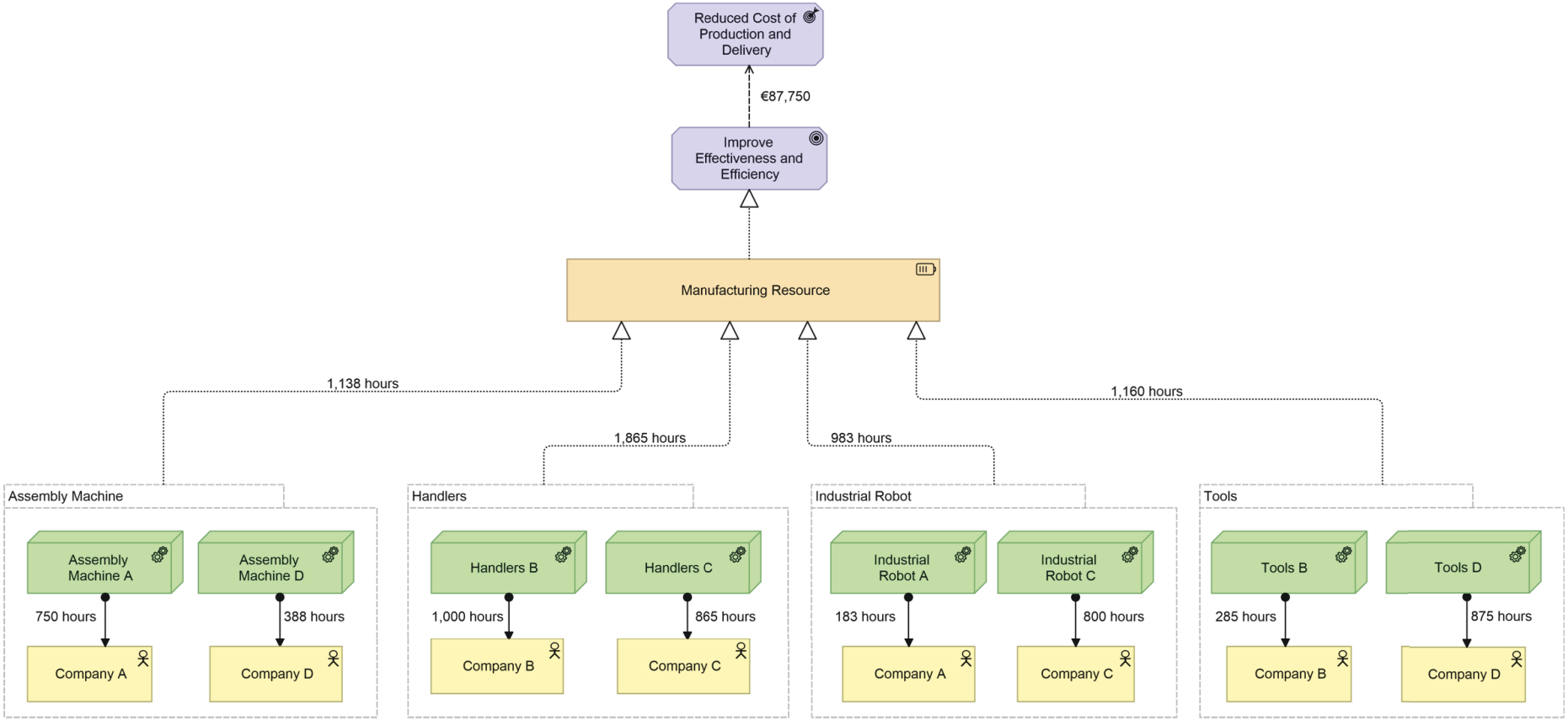


Figure 25 Resource Optimization Analysis - Minimize the Production Costs

3.4. Value Measurement

After having more knowledge regarding the modeling and analysis, some essential values within a digital business ecosystem can be extracted. The purpose of having a deep understanding regarding these elements is to find out the situation of a digital business ecosystem.

However, currently there is no standard indicator which is able to evaluate each element of a digital business ecosystem. In addition, it is a bit unclear what kind of elements should be used as the benchmark for measuring the quality of an ecosystem. To answer the situation, this study is also expected to contribute to the field by establishing a new measurement instrument which can support value appraisal of an ecosystem.

One of the well-known tools available for measuring the performance, which is also discussed in the previous section, is the balanced scorecard by Kaplan and Norton (1996). This evaluation instrument is considered to be quite comprehensive as it is related to other corresponding assessments, such as the strategy map by Kaplan and Norton (2000). Therefore, the proposed method for assessing digital business ecosystems will be established with the reference of the balanced scorecard as one of the theoretical frameworks used in this thesis.

Before evaluating the performance of the enterprise in terms of putting the number in the balanced scorecard based on the key performance indicators, the preceding step is to create a strategy map, with the purpose of linking enterprise assets to shareholder value creation through interrelated perspectives (Kaplan & Norton, 2000).

However, during the measurement process of the digital business ecosystem, some elements within the strategy map, as well as the balanced scorecard by Kaplan and Norton (2000), may be adjusted. In addition, there might be other factors found in an ecosystem which are not included in the balanced scorecard model. Thus, the proposed method is expected to incorporate the essential aspects as well as to remove unnecessary elements from the map and the scorecard.

The factors to be measured will be referred to the dimensions presented in the v^4 ontological framework, as it considered to be quite comprehensive in covering the value elements of a digital business ecosystem. Moreover, the value constructs the proposed strategy map will be linked to the relevant analysis, as discussed in the previous section. Thus, it is expected that the suggested solution could support the decision making of appropriate stakeholders involved during the business operation of an enterprise.

As the purpose of the balanced scorecard is to support performance measurement which will be assessed by the business executives, it is necessary to understand the stakeholders involved for every business perspective. Therefore, the provided scorecard also contains the information about stakeholder interests with the purpose to aid the measurement process.

As previously stated, the elements of a digital business ecosystem are not the same as the aspects of a standalone business. Thus, the scorecard is modified based on the requirements of the ecosystem. In order to avoid the ambiguity and to distinguish between the original balanced scorecard with the modified one, the proposed instrument will be renamed into the value scorecard. However, the purpose of the tool is still the

same, disregards its different name. To be more specific, the values assessed by the instruments are the elements based on the underlying theory used during the study, namely the v^4 ontological framework of the business model.

Provided below is the proposed value scorecard for assessing digital business ecosystems.

Table 13 The Value Scorecard for the Digital Business Ecosystems Measurement

Perspective	V4 Ontology (Dimension – Value)	Relevant Analysis	Stakeholders Involved	Architecture Viewpoints
Financial	Value finance – total cost of ownership	Profitability analysis	CFO	Value Network Viewpoint
	Value finance – pricing method	Profitability analysis	CFO	Value Network Viewpoint
	Value finance – revenue structure	Profitability analysis	CFO, Business Analysts	Value Network Viewpoint
Customer	Value proposition – products/services	Goal analysis	CIO, CFO, COO, Business Analysts	Goal Analysis Viewpoint
	Value proposition – intended value element	Goal analysis, resource prioritization analysis	CIO, CFO, COO, Business Analysts	Goal Realization Viewpoint, Resource Prioritization Viewpoint
	Value proposition – target segments	Goal analysis, resource prioritization analysis	CIO, COO, Business Analysts	Goal Realization Viewpoint, Resource Prioritization Viewpoint
Internal	Value architecture – value configuration	Resource allocation analysis	CIO, COO, Business Analysts	Resource Allocation Viewpoint
	Value architecture – core competency	Goal analysis, resource prioritization analysis	CIO, COO, Business Analysts	Goal Analysis Viewpoint, Resource Prioritization Viewpoint
External	Value architecture – core resource	Resource allocation analysis	CIO, CFO, COO, Enterprise and ICT Architect	Resource Allocation Viewpoint
	Value network – actor	Resource prioritization analysis, resource allocation analysis	CIO, CEO, Business Analysts, Enterprise and ICT Architect	Value Network Viewpoint, Resource Prioritization Viewpoint, Resource Allocation Viewpoint

	Value network – role	Resource allocation analysis	CIO, CEO, Business Analysts, Enterprise and ICT Architect	Resource Allocation Viewpoint
	Value network – relationship	Profitability analysis, resource allocation analysis	CIO, CEO, Business Analysts, Enterprise and ICT Architect	Value Network Viewpoint, Resource Allocation Viewpoint
		Profitability analysis, resource allocation analysis	CIO, CEO, Enterprise and ICT Architect	Value Network Viewpoint, Resource Allocation Viewpoint
	Value network – flow communication	Resource allocation analysis	CIO, CEO, Enterprise and ICT Architect	Resource Allocation Viewpoint
	Value network – channel	Resource allocation analysis	CIO, CEO, Business Analysts, Enterprise and ICT Architect	Resource Allocation Viewpoint
	Value network – governance	Profitability analysis	CIO, CEO, Enterprise and ICT Architect	Value Network Viewpoint
	Value network – network mode	Profitability analysis	CIO, CEO, Enterprise and ICT Architect	Value Network Viewpoint

The proposed value scorecard is provided with the purpose to understand what kind of value and analysis should be evaluated by particular stakeholder. In addition, the scorecard is also expected to show the relevant viewpoint, which is considered to be useful for enterprise architecture modeling. To sum up, the purpose of providing the scorecard is to give a summary, that can also be used as a guideline, for the stakeholders within the organization to model and analyze digital business ecosystems.

4. Demonstration

This chapter will discuss the implementation of the proposed modeling and analysis in an e-commerce case. The objective of the case study is to show that the proposed approach, as mentioned in *Chapter 3*, is suitable for real businesses. In addition, it is expected that thorough guidance in implementing the approach can be demonstrated by executing step-by-step analysis in a business case.

To represent a real e-commerce company, Shopify is chosen. The proposed approach presented in the previous chapter will be implemented to Shopify with the purpose to show the modeling and analysis of digital business ecosystems in a real business. As an additional information, the data about the company is generated from online sources, such as blogs and company website. As not all information regarding the company is available, some assumptions will be used during the case study.

4.1. Case Description

Shopify Inc. (Shopify) is an e-commerce company that offers a cloud-based, multi-channel commerce platform for small and medium-sized businesses. This Canadian based startup company was established as the result of the strong desire of the founders to have their own brand and build relationships with customers in selling the goods, instead of listing their products on some marketplaces available. At that time, adequate tools to build retail business platform were not available, which leads the founders to provide them, and that is how Shopify was born.

By providing a hassle-free platform as well as experts support, the owner of the business can focus on building and selling their product, instead of wasting a lot of time and resources in building an e-commerce website. The software offered by Shopify can be used by the merchants, which in this case is the primary customer of the company, to run their business across all channels, including the web and mobile storefronts, physical retail locations, social media storefronts, and other marketplaces, such as Amazon.

Besides providing e-commerce service for online store, Shopify also takes care of other types of merchant, such as Point-of-Sale (POS) Retail merchant and big enterprise merchant. Some of the well-known online stores that use Shopify service are Good as Gold (www.goodasgold.co.nz), Tattly (https://tattly.com), Pipsnacks (https://www.pipsnacks.com). Shopify also does rebranding of some big enterprises, such as Wikipedia[9] (https://en.wikipedia.org), and Google[10], specifically for Zagat (https://www.zagat.com).

Realizing that Shopify is a keep growing company, the company should also keep improving in serving their clients. In order to come up with better services, Shopify is partnering up with a lot of companies to bring more features to merchants. One of the methods is by cooperating with Stripe to provide a built-in payment method, which is known as Shopify Payments. In addition, Shopify also supports external payment

[9] https://www.shopify.com/plus/customers/wikipedia
[10] https://www.shopify.com/plus/customers/google

gateways by collaborating with other companies, such as Amazon Pay by Amazon and PayPal, which is owned by eBay. Besides payment methods, shipping and fulfillment are considered as crucial steps in owning a retail business. Thus, Shopify works together with third-party companies, such as *Amazon, Rakuten*, and *Shipwire*, which are responsible for the inventory management as well as the logistics of merchants' goods. More detailed information regarding Shopify partners will be described later in the next section.

Realizing that the company has a lot of business partners, it can be concluded that Shopify is expected to keep growing in the future, which is also corroborated by the forecasts that Shopify will get revenue above estimates in 2017[11]. In order to maintain the growth rate as well as to expand the business, it will be better to explore the room for improvements that could be done by the company. Thus, a brief recommendation as the result of conducting the analyses will be provided as well.

4.1.1. Shopify Features

As previously stated, Shopify has big numbers of business partners, which indirectly support the development of the company. In order to give more understanding of each business partner and its functions, as well as to see potential improvements for Shopify, brief explanations of some Shopify features along with the associated partners are provided.

- **Fulfillment Services**

  Shopify provides a third-party warehouse run by Shopify business partners, which are responsible for preparing and shipping the orders of merchants' store. This feature is suitable for the merchant that does not want to deal with shipping, or if the business has grown to a point where the items cannot be shipped manually, or it goes beyond capabilities of the existing warehouse. As for default fulfillment provider, Shopify appoints three main partners to deal with merchant inventory and shipping process, as mentioned below.

  - Fulfillment by Amazon (FBA)

  Fulfillment by Amazon lets the merchant to store the inventory and fulfill the orders from an Amazon.com fulfillment center. Although *Amazon* fulfillment for Shopify provides competitive pricing and more benefits, it only available in the United States, where it can be considered as the limitation of *Fulfillment by Amazon*.

  - Rakuten Super Logistic

  Rakuten fulfillment service deals not only with the inventory and delivery services of the merchant store, but also with the product inventory management of the store. In addition, *Rakuten* provides several options of delivery services run by well-known delivery providers, such as *UPS*, *FedEx*, and *USPS*.

[11] http://www.reuters.com/article/us-shopify-results-idUSKBN15U1FP?type=companyNews

- Shipwire

Same as mentioned above, *Shipwire* is also a company that could support the merchant in fulfilling and shipping the goods. What makes it different is *Shipwire* has more warehouses throughout the world, along with top-notch integration technology for the merchant store. However, the handling fees of *Shipwire* is considered quite high if compared to other providers.

- **Payment**[12]

As payment is considered as the most crucial step in running a store, Shopify ensures reliable and integrated payment methods for its merchant are supported. Beside providing standard payment method like credit card payment, other third-party gateways are integrated with Shopify. Up-to-date online payment method without using credit card, such as *PayPal*, *Amazon Pay*, and *Apple Pay* can be found in Shopify payment gateway. Another additional alternative supported by Shopify is *BitCoin*. Detailed explanation about the payment gateways of Shopify can be found below.

- Shopify Payments powered by Stripe

Shopify Payments is the internal payment gateway of Shopify which accepts payments online. *Shopify Payments* comes fully integrated with merchant store and includes a wide variety of functions to manage entire business and financials in one place. Although it is provided by Shopify, the service is managed by third-party company, specifically Stripe. Thus, it can also be said that the Shopify still needs a third-party provider in order to bring the service to the merchants.

Although it seems promising, the service is currently available only for the stores in the United States, Puerto Rico, Canada, the United Kingdom, Ireland, and Australia. Therefore, the merchants located outside the listed area have to find other payment methods provided by third-party companies, which will be mentioned later.

- PayPal

Paypal is one of Shopify's default payment gateways, where the feature of *PayPal* will be integrated automatically once merchant builds the store using Shopify. However, it is necessary to set up *PayPal* account first before the merchant can collect payments based on the orders. Because of its global availability, *PayPal* is currently considered as the most commonly used payment gateways on Shopify platform.

- Amazon Pay

Beside providing fulfillment and delivery services, *Amazon* also offered another feature for e-commerce platform, specifically to provide payment solution for business, which also known as *Amazon Pay*. *Amazon Pay* is a fast, easy, and trusted

[12] https://help.shopify.com/manual/payments/understanding

way for buyers to make purchases on online store using payment and shipping information, as already stored in their *Amazon* accounts. By using *Amazon Pay*, merchants can keep full control of the customer relationship, while keeps product-level data private. Like *Shopify Payments*, *Amazon Pay* also supported selected countries only, which limits the buyers of merchant's store.

- Apple Pay

With *Apple Pay*, buyers will be able to check out from merchant online store using Safari on the iPhone, iPad, and Mac. When a buyer pays for their order using *Apple Pay*, they do not need to manually enter the credit card details or shipping address. They only need to tap the *Apple Pay* button and scan their fingerprint, and *Apple Pay* will gather necessary information required for the payment process.

- BitCoin

Bitcoin is a type of digital currency, which means *Bitcoin* is not controlled by any particular financial institution and can be used by buyers in any country. *Bitcoins* are transferred directly from person to person over the internet without going through a bank or another financial institution. If compared to credit card payments, *Bitcoin* charges lower transaction fees and do not carry the risk of chargebacks.

- **Retail Point-of-Sale (POS) Hardware Support**

Shopify supports not only online transactions but also selling in person through Shopify POS (Point-of-Sale) application and retail hardware. Shopify POS accepts different payment types, which keeps synced to track the orders and inventory across different retail locations, online store, and other sales channels.

Beside providing an integrated application, Shopify also provides various hardware required for running a physical store, such as credit card reader, cash drawer, receipt printer, and much more. In order to provide the hardware, Shopify cooperates with several device manufacturers, such as Hecklerdesign, which provides various types of cash drawer required for retail payment.

- **Shopify Application Store**

As an addition to providing the tools needed for running an e-commerce store, Shopify has their own application marketplace to provide the applications and add-ons required for the merchants in managing their online store. Shopify App Store allows the exchange of applications between the developers and the users. Therefore, not all applications have to be developed by Shopify, which leads to lower operation cost.

- **Shopify Experts**

Shopify realized that managing a business is not a simple task. Therefore, they also provide business experts which could support business management, especially during the launching period of a business. Shopify does not possess internal business experts for their merchants, but they acquire third-party experts instead. Thus, it can be said that Shopify also run a human resource marketplace.

4.1.2. Possible Improvements

Based on the explanations above, it can be seen that Shopify possesses a comprehensive list of features to support merchant business operation. Thus, to improve its overall business, as well as to gain more financial benefits, the company can seek for improvement to expand the business by learning from the predecessor in e-commerce industry, which is also one of their current partners, specifically Amazon.

Back in 1994, Amazon is popular as an online bookstore, which later expanding their business by selling DVDs, Blu-rays, apparel, furniture, food, and many more. Currently, Amazon offers not only the service in e-commerce industry, but also in cloud infrastructure services, such as IaaS and PaaS. In addition, back then Amazon had to cooperate with other companies in order to provide payment gateway, delivery service, and other related services in order to deliver the services to their customers. Now, they are able to provide all of those services by themselves. Even, Amazon is considered to have a better service in particular sector, if compared to them who already run the business in the same industry for a longer time than Amazon. One of the services offered by Amazon is logistics service, where some of the practitioners considered it as the future of logistics[13].

Based on the history of Amazon, it is better for Shopify to learn from them in order to enhance their business as both of them are in the same industry. What brings Amazon to a success is to have their own ecosystem, which is made of a lot of companies[14]. Before, Amazon acquired a lot of services from various companies in the ecosystem, with the purpose to serve the customers in their own platform. However, currently they provide all services by themselves. Some examples include Amazon Pay as the payment gateway solution, and Fulfillment by Amazon (FBA) in order to provide the service in fulfillment and delivery. By having their own services, Amazon is able to remove ineffective partners, as well as offers their services to other companies. Therefore, it can be said that currently Amazon is highly independent, in terms of delivering value to the customers.

Short saying, collaborating in a digital business ecosystem sounds very promising, as it is already proven by Amazon as a giant e-commerce company in the world. However, it is also recommended to find out whether leaving the ecosystem is even more beneficial for Shopify. Thus, the analyses of Shopify digital business ecosystem are conducted with the purpose to assess Shopify ecosystem, as well as to seek new opportunities. To be more specific, the result of the analyses is expected to show

[13] http://www.supplychain247.com/article/amazon_logistics_services_the_future_of_logistics
[14] https://www.forbes.com/sites/haydnshaughnessy/2012/04/29/why-amazon-succeeds/#3940a38c385a

whether Shopify is ready to leave the ecosystem and provide all services by themselves, like Amazon does, or to stay in the current ecosystem as it is more profitable.

Following is the detailed implementation of proposed modeling and analyses to an e-commerce company, specifically Shopify.

4.2. Applying Digital Business Ecosystem Modeling and Analysis Approach to the Case of Shopify e-commerce

As previously mentioned, it is necessary to implement the proposed approach into a real case study. The purpose of the application is to find out whether the approach applies to real business situation, which in this case is Shopify.

Meanwhile, the purpose of conducting the analyses of Shopify is to evaluate the situation of its ecosystem, as well as to find more opportunities for the future. To do the improvements, the first step is to find out whether Shopify is ready to become independent and provide all services by themselves, as refers to Amazon key success factor. To find out this situation, a profitability analysis is conducted as the first step of assessing a digital business ecosystem.

If it turns out that leaving the ecosystem will bring Shopify to losses, then Shopify has to stay within the ecosystem and find the best way to reach their enterprise goal by optimizing the capabilities, as well as by reducing inefficiency partners in order to achieve the objective. Thus, a goal analysis, as conducted as the second step is provided.

After understanding the enterprise goal, the profit maximization can be done by the company by optimizing the resource allocation, which can be done by performing resource prioritization and resource optimization analysis, as shown in the third and the last steps of ecosystem assessment.

Following is the step-by-step analysis of Shopify ecosystem, which is provided with the purpose to give clearer picture regarding the modeling and analysis of digital business ecosystems.

4.2.1. Analysis 1: Profitability Analysis (Value Network Viewpoint)

As mentioned previously, profitability analysis is closely related to the financial analysis. Thus, the case study will refer to the information on Consolidated Statements of Operations and Comprehensive Loss of Shopify (*Figure 26)* in order to give an overview of the financial situation of the company, as well as for the assessment purpose.

Shopify Inc.

Consolidated Statements of Operations and Comprehensive Loss

(Expressed in US $000's, except share and per share amounts, unaudited)

	Three months ended		Years ended	
	December 31, 2016 $	December 31, 2015 $	December 31, 2016 $	December 31, 2015 $
Revenues				
Subscription solutions	56,387	34,608	188,606	111,979
Merchant solutions	73,996	35,565	200,724	93,254
	130,383	70,173	389,330	205,233
Cost of revenues				
Subscription solutions	11,593	7,662	39,478	24,531
Merchant solutions	50,655	26,044	140,357	67,447
	62,248	33,706	179,835	91,978
Gross profit	68,135	36,467	209,495	113,255

Figure 26 Shopify Financial Statement

Based on the figure, it can be seen that the revenues and costs obtained not only because of the internal business operation, but also as the result of cooperating with business partners. Therefore, to give an overview of Shopify partners and their roles, a table to show the role of each partner is provided below:

Table 14 Partners Role in Shopify Ecosystem

Partner	**Role**	**Products/Service**
Shopify	Keystone	
Stripe, Amazon Pay, PayPal, Apple Pay, Bitcoins	Payment Solution Provider	Payment Solution
Amazon FBA, Shipwire, Rakuten Super Logistics	Fulfillment Provider	Fulfillment & Logistics service
Fastly CDN	Cloud Service Provider	Cloud Service
External hardware manufacturer	Supplier	Hardware
Application Developers	Supplier	3rd party apps
Experts	Supplier	Service

The list above enables the design of the company and its ecosystem in order to give a comprehensive overview about how the company collaborates with other parties within the ecosystem. In addition, some values are flow within the members in the ecosystem during the cooperation with other business partners, including product or service, money, subscription fee, and much more. Those values are associated with the revenues and costs generated by the company. Hence, to provide more understanding regarding the revenues and costs emerge as the result of partnering with other in the ecosystem, a detail list of the sources is provided in *Table 15*.

Table 15 Shopify Sources of Revenue and Cost of Revenue

Source of Revenue	**Ecosystem Member**	**Description**
Subscription solutions	Customer (Merchant)	Website fee (including additional features)

Merchant solutions	Customer (Merchant)	Point-of-sale (POS) and payment gateway solutions for customer
Cost of Revenue Source (COGS)	**Ecosystem Member**	**Description**
Subscription solutions	Amazon Pay, PayPal, Apple Pay, Bitcoins	Payment Solution Fee
	Amazon FBA, Shipwire, Rakuten Super Logistics	Fulfillment Service Fee
	Fastly CDN	Cloud Service Fee
Merchant Solutions	Application Developers	Application Cost
	Experts	Revenue share
	Hardware Manufacturers	Hardware Costs

Based on provided information above, a modeling of Shopify digital business ecosystem can also be provided, as shown in *Figure 27*.

After understanding the list of the value flow based on the model as well as the lists provided, a profitability assessment can be conducted in order to see whether the ecosystem supports Shopify to be more profitable, if compared to the company when provides all the services by themselves. In *Table 16*, a comparison to show whether it is more beneficial for the company to leave the ecosystem or to stay within the current ecosystem. As an additional information, the numbers provided in the table are based on assumptions, except for the ones with the footnotes.

Table 16 Shopify Current and Possible Future Profit

	Current Situation (with ecosystem)	**Possible Future Situation (without ecosystem)**
Revenue	$389.330[15]	$389.330
Cost of Revenue		
Payment Solution Fee	$38.725	$49.892
Fulfillment Service Fee	$27,414	$35,199
Cloud Service Fee	$19,497	$24,157
Application Cost	$22.562	$48.785
Revenue share	$32.843	$41.251
Hardware costs	$38.794	$55.224
Total Cost of Revenue	$179.835[16]	$254.508
Gross Profit	**$209.495[17]**	**$134.822**

[15] Refers to Shopify revenues on December 31, 2016, as shown in *Figure 26*
[16] Refers to Shopify cost of revenues on December 31, 2016, as shown in *Figure 26*
[17] Refers to Shopify gross profit on December 31, as shown in *Figure 26*

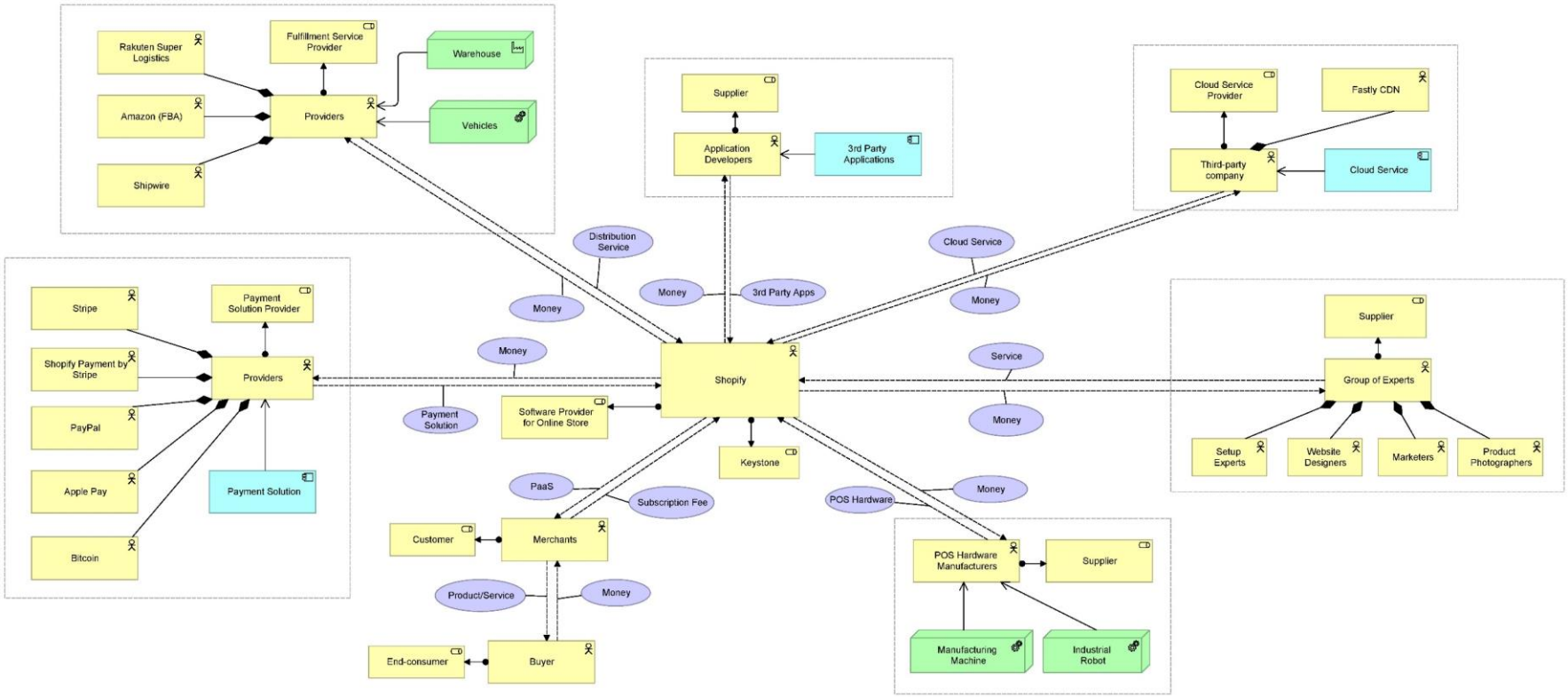


Figure 27 Modeling Shopify Ecosystem

Table 16 leads to the conclusion that becoming a part of an ecosystem will result in the company to be more profitable. To be more precise, providing all services in-house without partners are costlier as it may require more resources, including financial resources, human resources, time, and so on.

Take an example, if all payment solutions are provided only by Shopify, they have to consider the scalability of the solutions by keep expanding the system, as well as to focus more on the system development, which requires more costs. In addition, if Shopify only provides their own payment solution, there is a possibility of losing more customers, if the merchant does not like the payment system provided by the company. Thus, to deal with the situation, partnering with well-known payment solution providers, like PayPal and Amazon Pay, are considered to bring more advantages for Shopify.

As for the fulfillment and logistics, currently Shopify has neither their own inventory warehouses nor vehicles required for delivering the goods. Thus, if now Shopify is considering to do all logistics process by themselves, it will cost more because the company has to acquire the vehicles and warehouses to store and ship the goods, as well as additional staffs to manage the logistics. Thus, it can be said that keep partnering with other third-party providers which could support the fulfillment process is much more beneficial for Shopify, if compared to invest in the assets required to run the fulfillment and logistics on their own.

In order to support the software platform, some additional features, as well as integrated add-ons, are required to attract new customers. Therefore, developing the applications is considered crucial for the company. However, to provide more knowledge workers to work on additional applications will cost a lot of money, as the company has to spend more money on their salaries. The same case applies to providing the experts to fulfill the customer needs, such as in providing business consultation, website design, and so on. Therefore, it will be better if the company facilitates the external experts to make contact with the merchant, compares to providing their own experts, because it may lead to additional costs, including training costs and monthly salary.

Besides providing intangible products, Shopify also offers hardware required for running point-of-sale retail stores, as previously mentioned. Thus, Shopify also needs to consider whether it will be more profitable to produce all hardware by themselves, or to ask other manufacturers to produce it for the company. If they decided to their own production, the costs of manufacturing include the cost of providing the factory and its machinery, as well as salary for the workers. Meanwhile, if the company decides to buy the hardware from external companies, it will only cost them the margin of production, which can be considered as a smaller loss.

Based on the given information, it can be concluded that being in the current situation, specifically to stay within their own digital business ecosystem, will be more beneficial for Shopify. To be more specific, their ecosystem support the reduction in costs, which lead to higher profit of the company, as shown in the comparison provided in *Figure 28* and *Figure 29*. Therefore, for now, leaving the ecosystem is considered to be costlier for Shopify, which can lead to the loss, instead of creating more profits. Thus, it is better for Shopify to remain in the ecosystem, and look for other opportunities to be improved within the ecosystem itself.

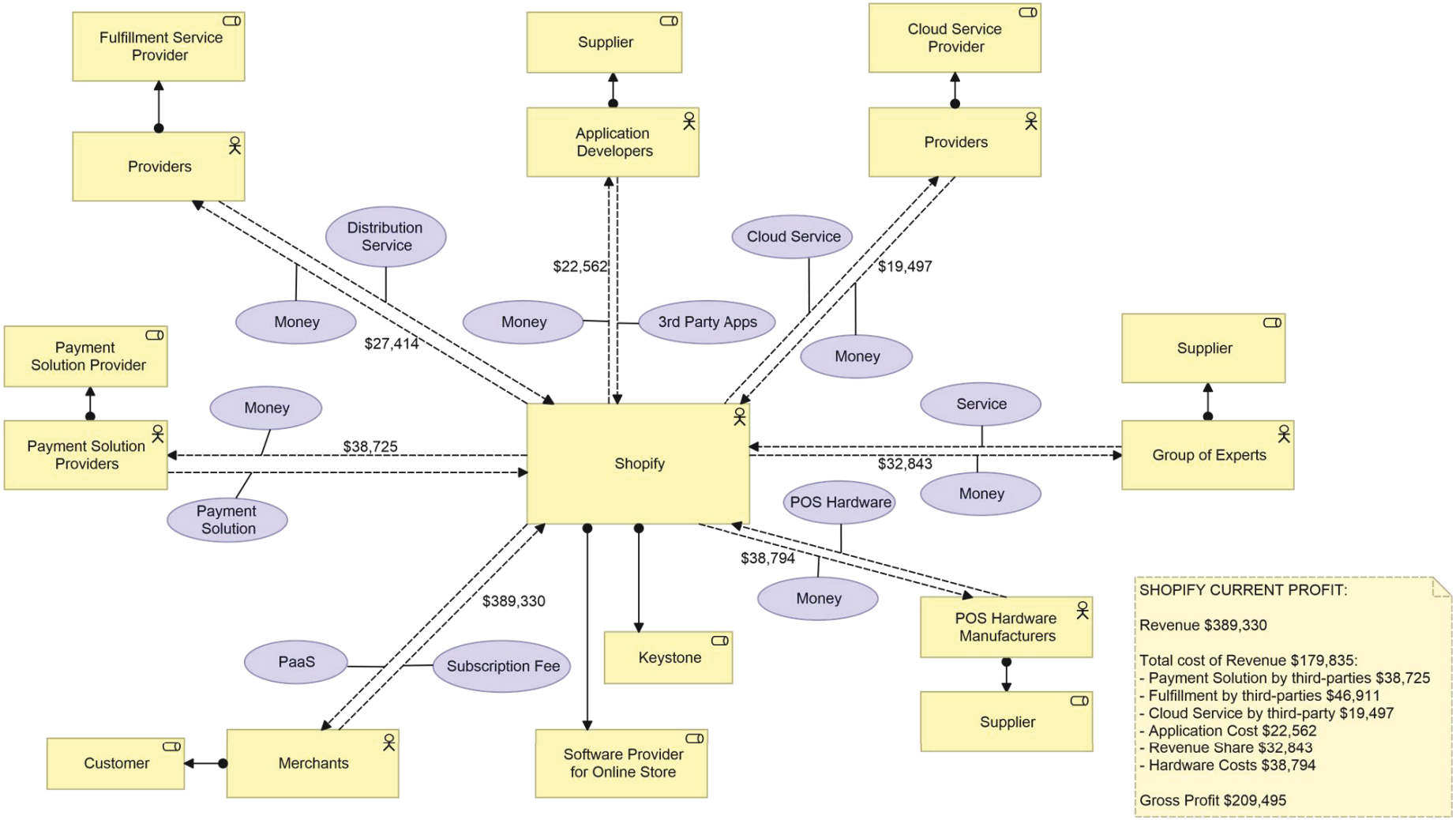


Figure 28 Shopify Current Profit

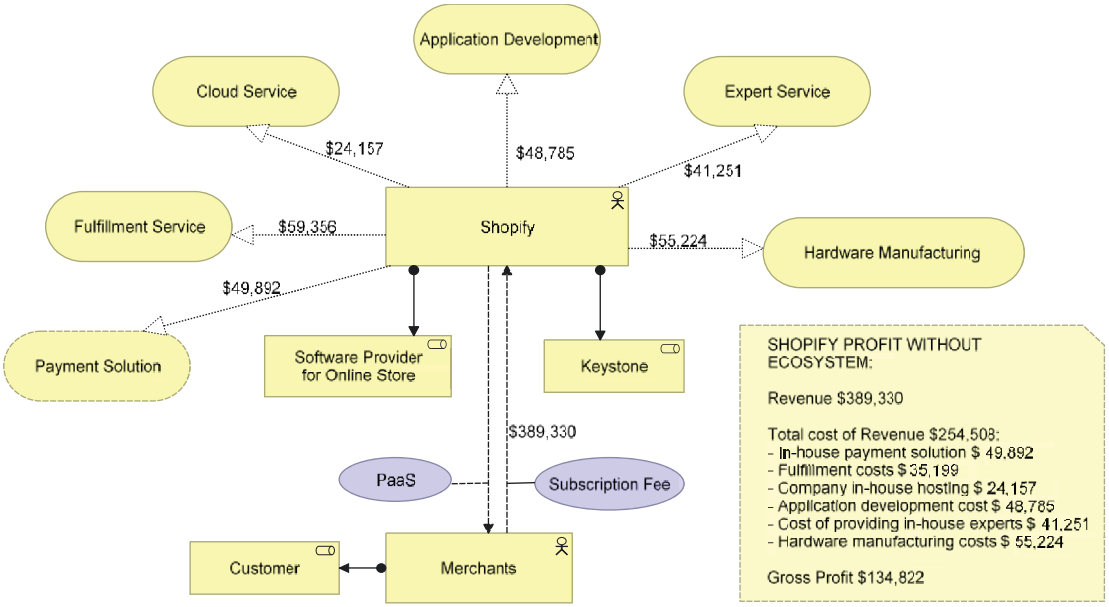


Figure 29 Shopify (Possible) Future Profit

To sum up, the profitability analysis applied to the case study is expected to bring more understanding regarding the purpose of conducting the analysis to the business ecosystem, which is to show whether the ecosystem is advantageous or not. In addition, the analysis leads to the conclusion that the digital business ecosystem brings added value to the company, which in this case is financial added value. The analysis also shows another benefit of being a part of the ecosystem, which is to lower costs, by comparing with the situation if the company decides to leave the ecosystem. To be more specific, the benefits stated above can be achieved by collaborating with partners within the ecosystem, as partners may support operational efficiency and productivity, which indirectly leads to the financial profit.

The benefits of the digital business ecosystem mentioned as the result of the analysis also corroborate some of the advantages stated in Chapter 2, which is presented as the result of performing a systematic literature review. Thus, applying the analysis to a case study helps to validate the statement that the digital business ecosystem brings advantages to the enterprises.

4.2.2. Analysis 2: Goal Analysis (Goal Realization and Goal Analysis Viewpoint)

Profitability analysis, as explained in Section 4.1.1., brings to the conclusion that for now it is better for Shopify to stay within the ecosystem. After knowing that ecosystem is more beneficial for Shopify, the next step is to figure out how to achieve the major outcome by completing several goals. Therefore, defining influencing factors that can lead to the main objective is necessary in order to ensure that all processes are aiming at the same end result. In order to give a deeper understanding regarding the enterprise goal and how to achieve it, a goal analysis, which is shown by goal realization and goal analysis viewpoint will be provided in this section.

Not only Shopify, but also other companies want to have a higher profit, which is also considered as the main goal of a company. In order to maximize the profits, the company also has to deal with the factors that can impact the achievement of the goal as well. Therefore, an integrated picture to show the mapping of companies' objectives towards the enterprise goal is modeled, as shown in *Figure 30*.

Based on the figure, it can be concluded that to reach high customer satisfaction in order to increase the revenue, several things that can be done by the company are to reduce the delivery time, to provide an excellent payment solution, and to have an integrative and reliable service. With the purpose to fulfill the requirements, it is necessary to seek for the ecosystem member that could provide the best based on each function. Thus, a goal analysis is conducted in order to find the best company that possesses the best factors to achieve each objective, which aiming at the main goal.

The first step in conducting the goal analysis is to understand the capabilities possessed by each ecosystem member. Since there is no exact measurement result regarding the capability, an assumption for the level or number of each capability will be provided, which came up based on the information available from online sources, such as blogs or company website.

As previously mentioned, currently Shopify does not offer only their own payment service, but also by cooperating with other companies to bring more payment options to the merchants. However, the company still needs to find out whether it is better to focus on their own payment solution or to focus on a particular partner that could bring more profits for their merchants, which can lead to customer satisfaction.

Currently, the payment solutions supported by Shopify are Shopify Payments by Stripe, Amazon Pay, PayPal, Apple Pay, and Bitcoins[18]. As Bitcoins is considered as an alternative payment method and how it works is a bit different than other payment gateway, Bitcoins will not be included in this analysis. As an additional information, in this case study, some drivers that can affect the excellence of payment solutions are security, accessibility, compatibility, and easiness.

To be more specific, security refers to how secure is your payment can be made through the appointed payment gateway. Meanwhile, accessibility describes the availability of payment gateway in particular countries, and which countries are supported by the gateway. Compatibility shows whether the payment gateway is compatible in various devices with different operating system. The easiness demonstrates how easy for the end-customer to use the payment gateway, which often refers to the special feature provided by the solution provider.

After having required information for the analysis, a calculation to find out which company has the best capabilities to achieve excellent payment solution can be done. The detailed calculation is provided in *Appendix I*.

[18] https://help.shopify.com/manual/payments

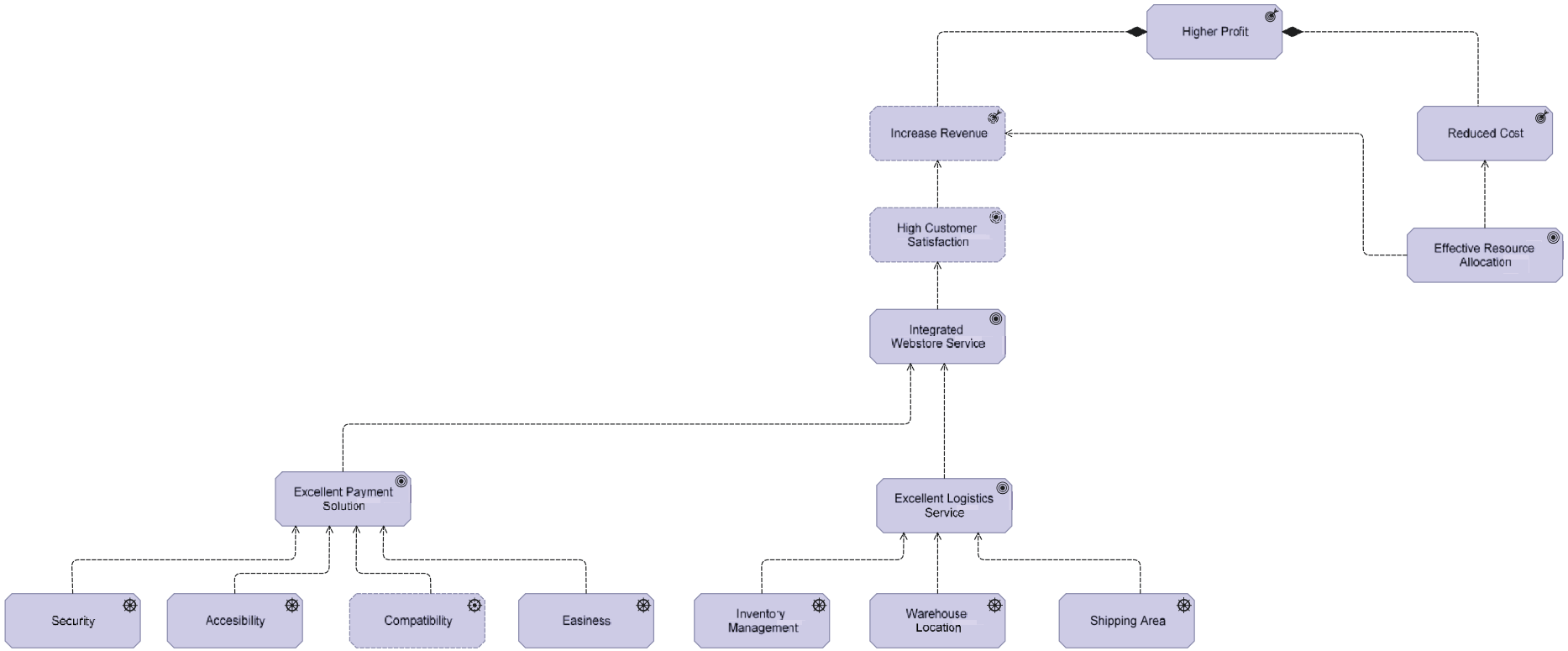


Figure 30 Towards Goal Realization - Shopify

Later on, the result of applying the calculation can be illustrated in a decision-tree diagram, which is shown in *Figure 31*. Based on the figure, it can be concluded that it is recommended to focus on Amazon Pay as the primary payment gateway solution provider, as it provides the most capabilities for the merchant, which is also shown by the biggest weighted average value. Furthermore, the information within the decision tree diagram can be used to transform the analysis into the final model of goal analysis, as shown in *Figure 32*.

In *Figure 32*, another objective of Shopify that can be found is to provide excellent logistics service. The same method is implemented in order to provide the result, where the detailed explanation and calculation regarding the analysis can be found in *Appendix I*.

To sum up, the purpose of conducting the goal analysis is to find out which partner that is able to support Shopify towards the goal achievement. In addition, this analysis is also expected to help Shopify optimizing the ecosystem by removing the inefficient partners from the ecosystem, that Shopify can focus more on maximizing its revenue. Thus, the chosen companies, as also shown in *Figure 32*, are considered as the most suitable ecosystem members that can aid Shopify in achieving their enterprise goal.

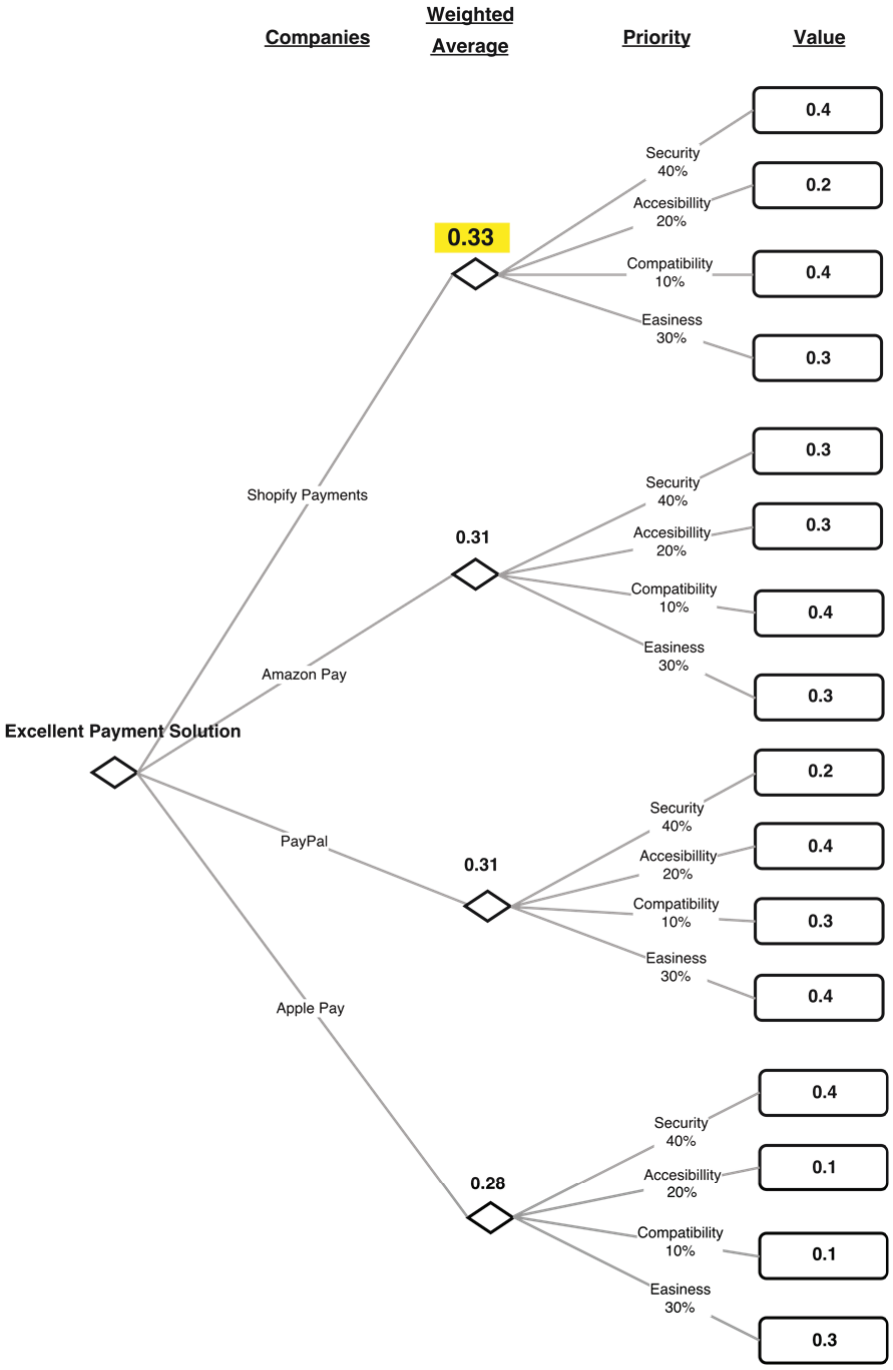


Figure 31 Decision Tree Diagram towards Excellent Payment Solution

Although the model and analysis presented in this section brings the overview of the members to be partner with, this analysis does not show the steps towards maximizing its revenue. Thus, additional analysis, specifically a resource analysis is provided in the next section.

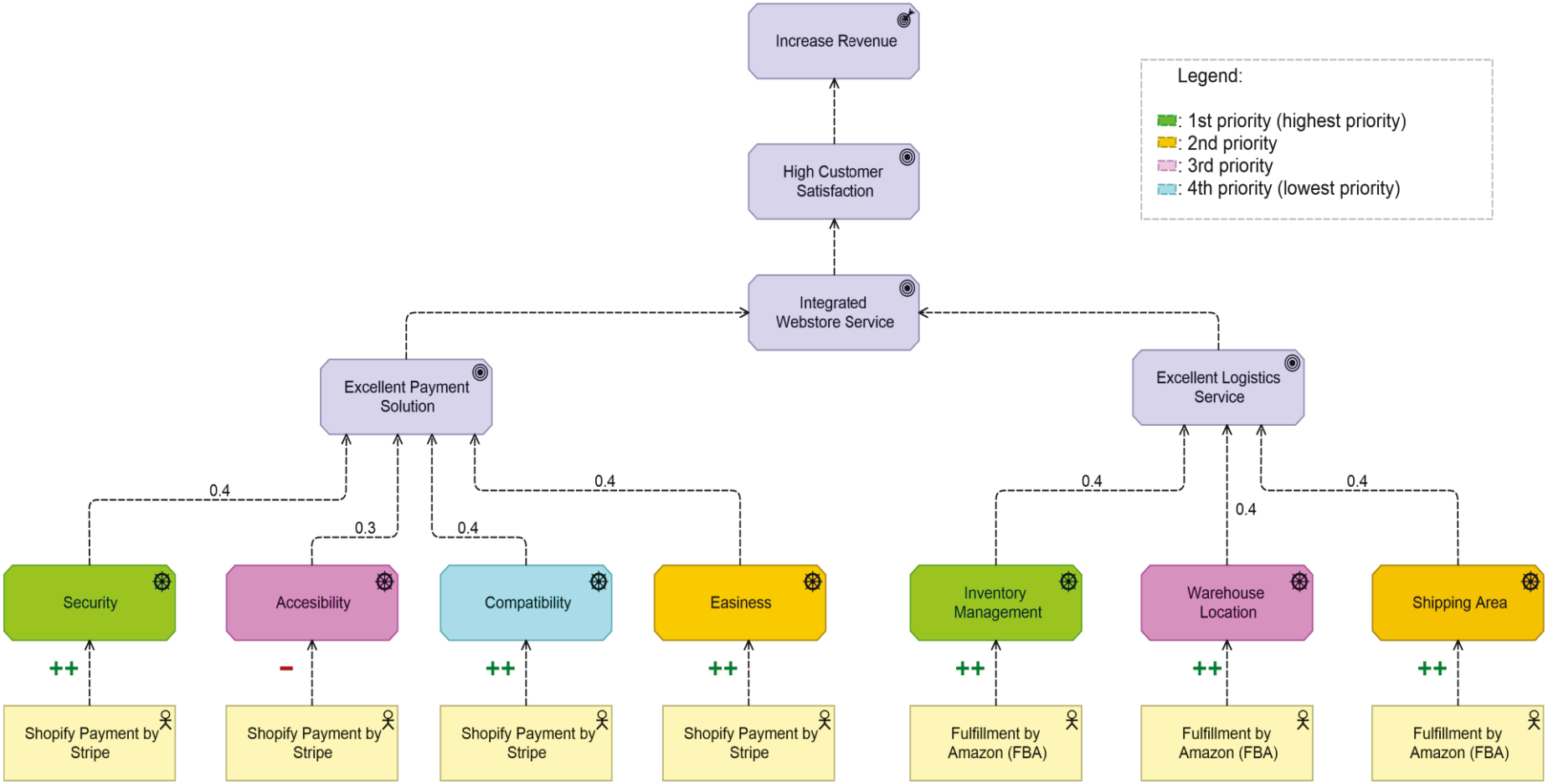


Figure 32 Modeling Goal Analysis Viewpoint Shopify

4.2.3. Analysis 3: Resource Prioritization Analysis (Resource Prioritization Viewpoint)

The goal analysis, as provided in the previous section, shows which companies should be chosen by Shopify to be their partners. The next step after having more understanding regarding the partners is to conduct resource analyses.

The purpose these analyses are to find out which company possesses the best resource required to support the business operation, with the intention to maximize revenue by prioritizing the currently available resource. As learnt from Amazon case, Shopify should consider to be more independent by less dependent on its partners. Since leaving the ecosystem is considered costlier, as also shown in profitability analysis, the only thing that Shopify can do is to reduce the number of partners and to maximize on that partner resources. To maximize these resources, two resources analyses are provided in this study, specifically resource prioritization analysis and resource optimization analysis. Following is the resource prioritization analysis for Shopify case study.

As a provider of Software as a Service (Saas), Shopify has its own value proposition: "Shopify is everything you need to sell anywhere". To provide an excellent service, Shopify has to consider various resources involved in providing the service. Some of the resources required are human resource, intangible resource, financial resource, and technological resource.

In this case, human resource is the experts and developers who maintain and provide the system of Shopify. Moreover, the products created by them are considered as intangible resource. Financial resource of Shopify is the money and other financial instruments. Lastly, technological resource in providing the service is the computing hardware, such as server, processor, and much more.

Shopify provides a cloud software service, where the cloud service itself is acquired from a third-party company. In this case study, it is assumed that Shopify focuses on improving their technological resources that are provided by the cloud service provider. Thus, the analysis provided in this section aims to find out the best partner that can give the required resource needed for Shopify to provide the service.

There are a lot of cloud providers that offer the cloud service, specifically in content delivery networks (CDN), such as Amazon Cloud Front, Google Cloud CDN, IBN CDN, and many more. Based on the information above, a figure to show the relationship between Shopify and the potential partners, as well as resources possessed, is provided in *Figure 33*.

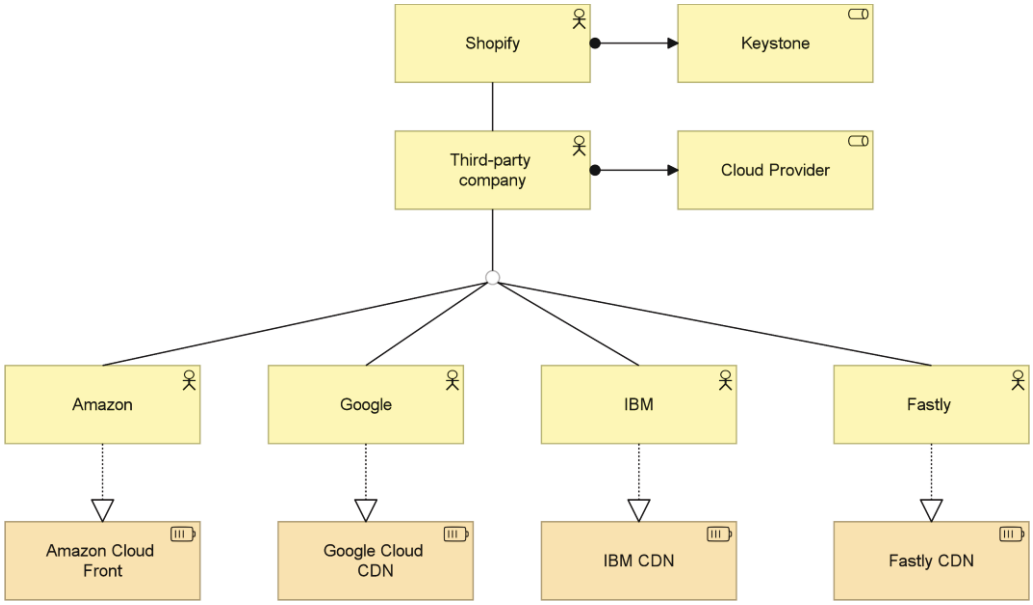


Figure 33 Shopify Potential Partners

Currently, Shopify cooperates with Fastly in bringing the web hosting to the merchants. Although they already acquired the service from Fastly, it should be assessed whether Shopify should continue cooperating with them, or it is better for Shopify to find a new partner that can provide a better service. Therefore, a resource prioritization analysis is required.

After having the information required for the analytical purpose, a resource prioritization analysis can be conducted. The analytical hierarchy process (AHP), which is also explained in the previous chapter, will be used in order to find the best company to become a partner within the ecosystem. Detailed calculation of the AHP method can be found in *Appendix J*, and the result of the calculation is provided as follows.

Table 17 Result of AHP Method

Determining company with the best cloud service resources	
	Score
Fastly CDN	0.22
Google Cloud CDN	0.22
IBM CDN	0.27
Amazon Cloud Front	**0.29**

Based on the table, it can be concluded that if Shopify wants to focus on providing their service to the merchants, the best company to partner with is Amazon Cloud Front, as they can provide the best cloud service. It can also be said that it is better for Shopify to consider adding Amazon to the ecosystem as a new member, with the intention to replace Fastly CDN in providing the cloud service. By choosing Amazon Cloud Front as the provider, Shopify is considered to choose the best option available, which also allows them to expand the business, specifically by optimizing the resource allocation regarding this technological resource. Detailed explanation regarding the resource optimization analysis will be provided in *Section 4.2.4*.

To sum up, the resource prioritization analysis is useful for the organization, as it is not only aid the company in assessing the current ecosystem, but also to seek a new opportunity for the ecosystem, which in this case is by adding a new member to be a partner with in order to replace the inefficient partner. However, the company should also take care of the allocation of the resource, which can be done by optimizing the resource itself. Thus, an additional analysis to support the optimization of the resource has to be performed by the company as well.

4.2.4. Analysis 4: Resource Optimization Analysis (Resource Allocation Viewpoint)

The resource prioritization analysis helps the allocation of the resources. By understanding the main concern, which is determined by resource prioritization analysis, additional analysis to provide an effective resource allocation can be provided. Moreover, the optimization of the resources is expected to affect the revenue, as well as the cost, which indirectly leads to the higher profit, as shown in *Figure 30*. Based on the statement, it can be said that Shopify also has to evaluate the resource provided by Amazon Cloud Front, which plays the role as the cloud service provider of Shopify. To be more specific, the resource to be assessed is related to the technological resources, as also discussed previously. Following is the detailed explanation of the resource allocation analysis for Shopify case study.

Step 1 – Increase Revenue

As previously stated, it is assumed that Shopify wants to focus on its technological resources provided by a third-party company, specifically the cloud provider. However, there are various types of technological resources involved in providing a content delivery network (CDN) service. Thus, an optimization in resource allocation, which can lead to the increased revenue should be done. Therefore, a resource analysis to increase the revenue is provided.

In conducting this analysis, a linear programming method, which is explained in the previous chapter, will be implemented. The detailed calculation of the linear programming method for conducting a resource allocation analysis can be found in *Appendix K*.

The analysis brings to the result as can be seen in the following table:

Table 18 Linear Programming Result

	Online Store	**POS**	**Enterprise**	**Maximum Revenue:**
Decision Variable	500 merchants	175 merchants	243 merchants	**$1,454,750**
Service Revenue	$1,500.00	$1,250.00	$2,000.00	

Based on the table, it can be concluded that Shopify has to serve 500 online store merchants, 175 POS merchants, and 245 enterprise merchants in order to reach the maximum revenue of $1,454,750. Furthermore, the result of the analysis can be modeled in order to show the effective allocation of the resource, as provided in the figure below.

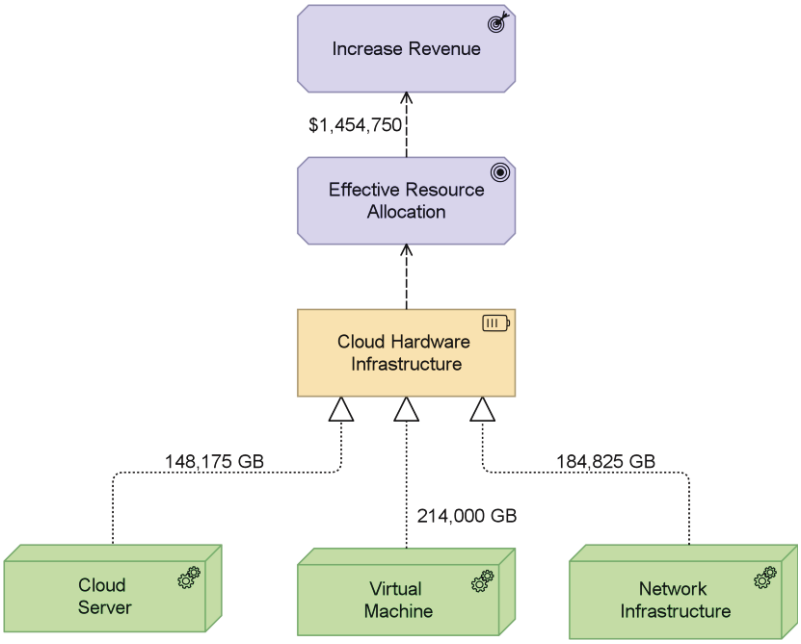


Figure 34 Modeling Resource Allocation Viewpoint

Besides computing the maximum possible revenue, the company should also take the cost required into a consideration. Thus, an additional computation with the purpose to find the minimum cost will be provided in the next step.

Step 2 – Decrease Cost

After finding the most optimal number of the merchants to be served in order to get the higher revenue, the next step is to find out the minimum possible cost in order to reduce the cost as possible.

In this case study, it is assumed that the cloud provider uses different hardware in providing the service for different types of Shopify merchant. Therefore, different hardware with various pricings should be considered in order to minimize the cost. In addition, not all hardware possesses same capacity. Thus, maximum bandwidth of each hardware should be taken into consideration as well.

After having the information regarding the hardware cost for each provider, as well as the maximum capacity, the next step is to analyze the resource in order to find the most optimum allocation. A linear programming method calculation is implemented in order to analyze the resource allocation. The detailed calculation regarding the analysis can be found in *Appendix K*, and the result is provided as follows:

Table 19 Bandwidth Allocation for each Hardware (in GB)

Merchants / Hardware	Online Store	POS	Enterprise
Cloud Server	49,625	80,000	4,750
Virtual Machine	49,625	85,000	95,000
Network Infrastructure	49,625	50,000	85,000
Total Bandwidth	148,875	215,000	184,750
Required Bandwidth to be Used	148,875	215,000	184,750
Minimum Cost	**$697,588**		

The table shows the distribution of the bandwidth for different hardware in order to fulfill the demand of the merchants. Based on the allocation of the resources, an additional figure to shows an overview of the distribution is provided, as shown in *Figure 35*. Considering bandwidth in providing cloud service is important, because it also shows whether the application can survive in the competition[19]. Thus, it is believed that conducting this step is also necessary for Shopify.

The two steps analysis as explained previously enable Shopify to find the maximum profit can be generated by the company. In the first step, it is stated that the maximum revenue can be gained as the result of providing service to the merchants is $1,454,750. With the purpose to achieve that amount of revenue, the minimum possible cost is $697,588, as also stated in the second step of the analysis.

By referring to the economic principle of net income, the profit can be generated by deducting the cost of the revenue. The result of the calculation shows that the maximum profit that can be achieved by Shopify is $757,163 ($1,454,750 - $697,588).

Based on the example, it can be said that the analysis is useful for the company to find new opportunities for the ecosystem, which in this case is to maximize the allocation of the resource, specifically in the hardware bandwidth distribution. In this step, the hardware distribution refers to the demand of the market, which is shown in the first step of resource optimization. Thus, this assessment provides an overview of the number of the merchants should be reached by the company in order to get a higher revenue, as well as the number of the cost should spend by the company in order to minimize the costs. By having this knowledge, it is expected that the information could aid Shopify to create future goals.

In addition, the result of the analysis itself brings to the several conclusions related to the ecosystem advantages. First, the members of the ecosystem can support deliver the value. Second, added value for both the stakeholders and the customers can be created. As for the stakeholders, the value provided is related to the financial value. Meanwhile, the value given to the customer is a better service provided by Shopify.

The benefits as mentioned above corroborate the advantages as stated in Chapter 2. Therefore, it can be said that the analysis can be used as a guideline in achieving the benefits comes from implementing the digital business ecosystem.

[19] http://www.computerworld.com/article/2500888/cloud-computing/bandwidth-bottlenecks-loom-large-in-the-cloud.html

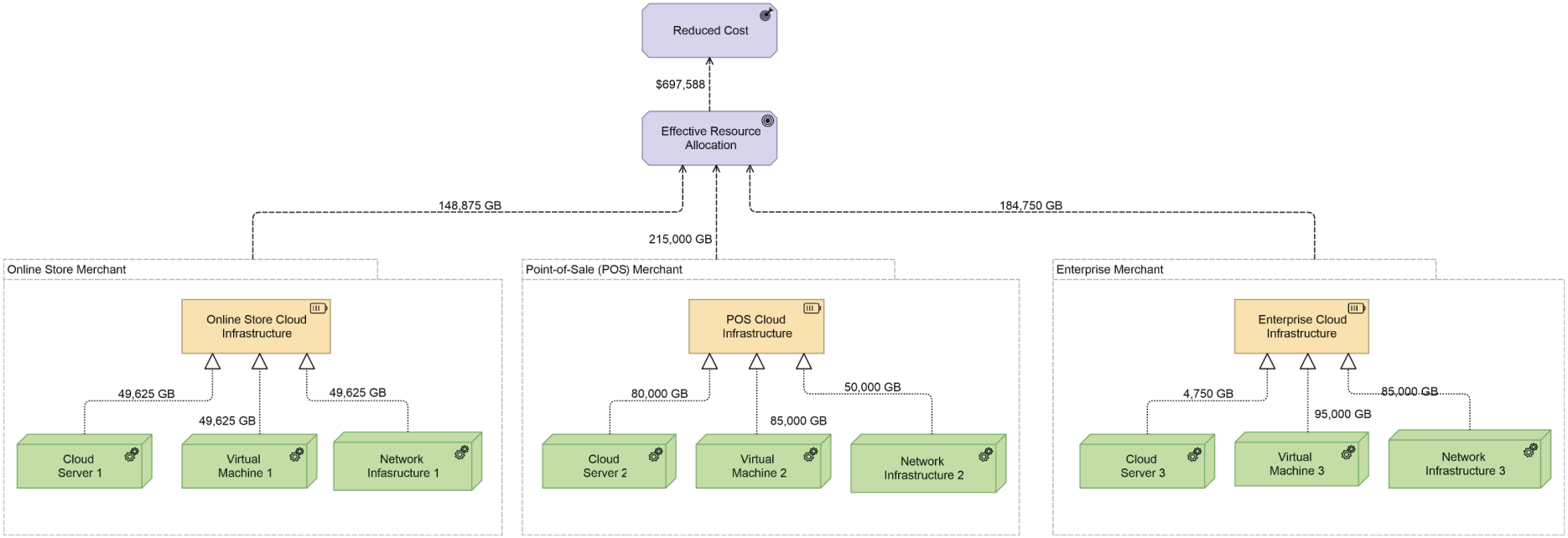


Figure 35 Modeling Resource Allocation Viewpoint

5. Evaluation

The purpose of this chapter is to describe the evaluation process regarding the implementation of the proposed approach in the demonstration process, as discussed in the previous chapter. As this study refers to the design science research methodology (DSRM), to conduct the evaluation is considered essential as it is one of the required steps in DSRM. The evaluation process is expected to measure the quality of the proposed approach towards supporting specific objective. To be more specific, the measurement will be done by finding out whether the implementation of the approach creates the desired outcomes.

In order to do the measurement, the evaluation process will be done by performing a workshop, which is attended by the practitioners in the area. In this workshop, the use of the proposed approach into the case study will be presented by the researcher of this study. In the end of the workshop, the participants will be asked to fill in the survey with the purpose to get some feedback regarding the approach. Afterwards, the results of the survey will be summarized, as can be found in this section.

5.1. Survey

To evaluate the result of the study, a survey is carried out in order to receive some feedback regarding the proposed approach. This survey is considered as a quantitative analysis, as it aims to collect the opinions from the experts, which in this case are the practitioners of a company.

In order to formulate the statements of the survey, we adapt the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, Morris, Davis, and Davis (2003). UTAUT is considered suitable in this study as it explains the distinct aspects towards user behavior and acceptance of the information technology. To be more specific, it can be said that the survey in this study is conducted in order to find out the user acceptance of using the proposed approach as the guideline for modeling and analyzing digital business ecosystems.

UTAUT consists of several constructs that have significant role in determining user acceptance and usage behavior. Those constructs are performance expectancy, effort expectancy, social influence, and facilitating conditions, as can be found in *Figure 36*. This figure also shows additional factors that play the role as moderators towards user acceptance, such as gender, age, experience, and voluntariness of use. As these constructs are considered as indirect determinants of intention, these aspects will not be included in this study.

Furthermore, Venkatesh et al. (2003) also breaks down the overall items that are previously mentioned into more detail. These items can be considered as the factors that influence the constructs towards achievement of usage behavior, as shown in *Figure 36*. *Table 20* presents the detailed items in formulating the statement for the questionnaire based on UTAUT concept. A complete list of UTAUT items can be found in *Appendix L*.

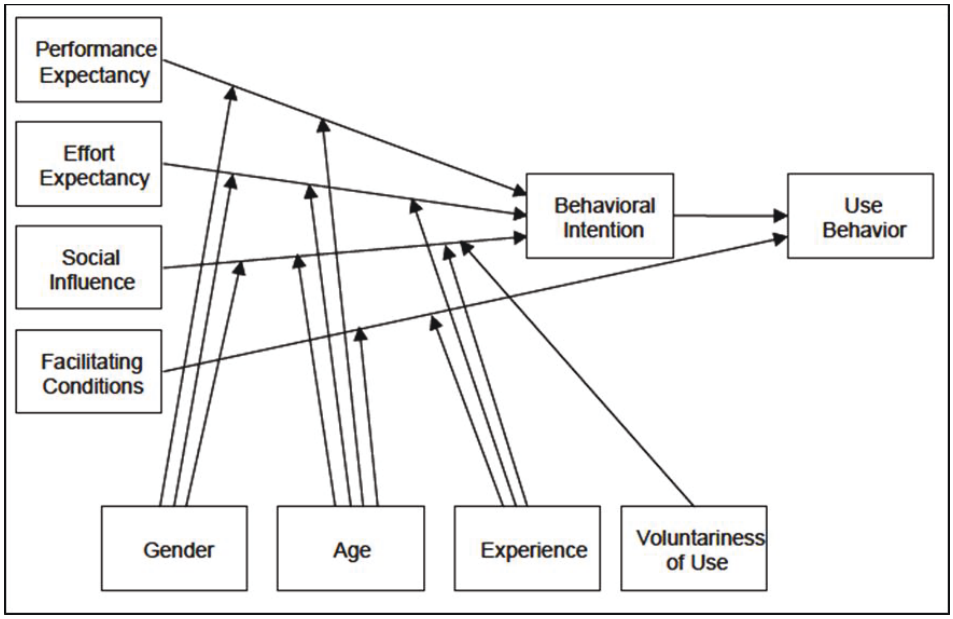


Figure 36 UTAUT Research Model

After having more understanding regarding the items of UTAUT, the next step is to formulate the statement. The complete list of statements based on UTAUT can be found in *Appendix M*. Afterwards, the statements are put in the questionnaire (*Appendix N*), which will be filled in by the participants during the workshop.

5.2. Workshop Result

The workshop was conducted in BiZZdesign, with four experts as the participant. The participants consist of one technical writer, two research consultants, and one research and development team leader. The workshop starts with the presentation about the proposed approach. After the presentation, the participants were asked to fill in the questionnaire in order to find out their opinion regarding the proposed approach. Afterwards, the survey results will be reviewed, as explained in this section.

5.2.1. Background Information

The questionnaire starts with asking the participants about their background information regarding their working experiences, including their position in the company, their experiences in using business analysis, and so on. Afterwards, the results are summed up, as can be found below:

1. Position in the company

The questionnaire shows that the participants have a various role in the organization, includes technical writer, research consultant, and leader of research and development (R&D) team. As this research is conducted under the supervision of the R&D department in BiZZdesign, most of the participants of the survey also come from this

department. The figure below shows an illustration of the number of participants, as well as their role in the company.

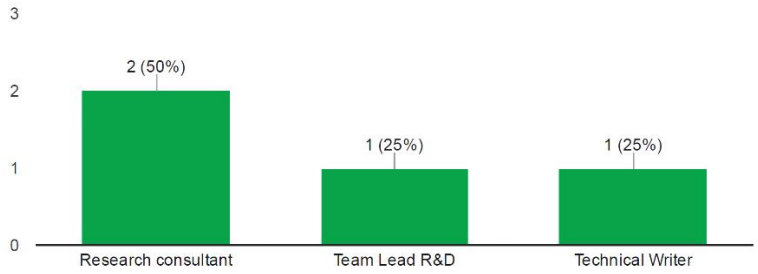


Figure 37 Role of Participants

2. Frequency of using business analysis

Figure 38 shows how often the participants use business analysis in daily work. It can be seen that most of the participants only use the business analysis sometimes, while the rest rarely or never use that analysis at all.

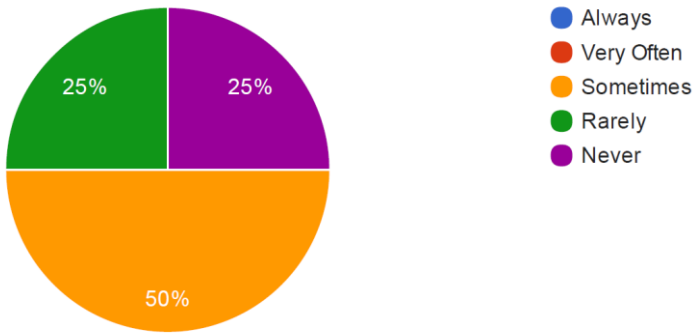


Figure 38 Participants Frequency in Using Business Analysis

If we take a look at the role, the participants that sometimes use the analysis are the leader of R&D team and the research consultant, which is in the same department. The participants in the research department have to find out a new way to improve the business, which brings them to deal with the business analysis in some occasions. Meanwhile, the person who never uses the business analysis is the technical writer. It is reasonable because, in daily work, the technical writer only deals with the technical documentation, so it is not necessary for them to take care of business analysis.

3. Familiarity with particular type of business analysis and method

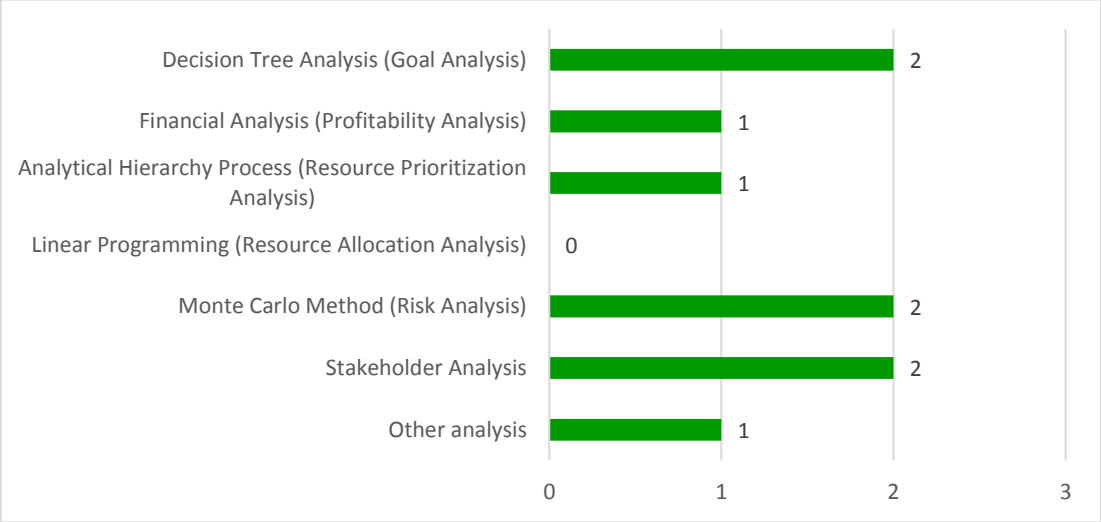


Figure 39 Participants Familiarity of Different Type of Business Analyses

The types of analysis mentioned in the questionnaire are decision tree analysis (J. Ross Quinlan, 1987), financial analysis, analytical hierarchy process (Thomas L Saaty, 2008), linear programming method (Kantorovich, 1939), Monte Carlo method (Metropolis & Ulam, 1949), stakeholder analysis, and other analysis. The analyses mentioned in the proposed approach of the study are decision tree analysis, financial analysis, analytical hierarchy process, and linear programming. Meanwhile, other types of possible analyses for assessing digital business ecosystems are mentioned in order to give more insights regarding possible analysis that can also be implemented for analyzing digital business ecosystems.

Based on the figure above, it can be concluded that the participants mostly familiar with decision tree analysis, Monte Carlo method, and stakeholder analysis. The participants that are familiar with decision tree analysis and Monte Carlo method are the experts from R&D department. This happens because they have to deal with clients and businesses indirectly, and those analyses are related to the decision-making process that should be done with the companies as customers of BiZZdesign. Meanwhile, the participants that are familiar with stakeholder analysis have the role as a technical writer and the R&D team leader. The technical writer has to produce the technical document based on the request, while the R&D team leader has to understand the stakeholder interests, in order to create the result based on the needs of the stakeholder. Therefore, they are more familiar with stakeholder analysis if compared to other participants with different roles.

As an addition, only one participant acknowledged being familiar with other analysis, such as performance analysis and cost analysis. Also, none of the participants are familiar with the linear programming method for resource prioritization. This happens

because none of them have to deal with any resources in the organization, which make them unfamiliar with this type of analysis.

5.2.2. Acceptance of the Proposed Approach

After having the result of the questionnaire, the next step is to analyze the result to find out the user acceptance towards the proposed approach provided in this study. This evaluation consists of five constructs, that are performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC), self-efficacy (SE), and behavioral intention to use (BI). In the questionnaire, there are seventeen questions in total, which are related to the user acceptance aspects based on UTAUT concepts. The responses are recorded in Likert scale, with the score from 1 to 5. Afterwards, the descriptive statistic result is provided in *Table 21*. in order to show the overview of the survey result. The detailed calculation based on the response from the participants can be found in *Appendix O*. As for an additional information, the questions in table are divided based on the constructs as mentioned above.

Table 20 Descriptive Statistic of Result

Question	N	Min	Max	Sum	Mean	SDEV
PE1	4	3	4	14	3.5	0.577
PE2	4	3	3	12	3	0
PE3	4	3	3	12	3	0
EE4	4	3	4	15	3.75	0.5
EE5	4	3	5	15	3.75	0.957
EE6	4	3	4	15	3.75	0.5
FC7	4	1	4	12	3	1.414
FC8	4	1	4	12	3	1.414
FC9	4	1	5	14	3.5	1.732
SE10	4	3	4	14	3.5	0.577
SE11	4	3	5	16	4	0.816
BI12	4	2	4	13	3.25	0.957
BI13	4	2	4	12	3	0.816
BI14	4	3	4	13	3.25	0.5
Average PE	-	3	3.333	12.667	3.167	0.192
Average EE	-	3	4.333	15	3.75	0.652
Average FC	-	1	4.333	12.667	3.167	1.520
Average SE	-	3	4.5	15	3.75	0.697
Average BI	-	2.333	4	12.667	3.167	0.758

The aspects in *Table 21* can be explained as follows:

- N refers to the total number of participants
- Min refers to the highest score based on the response of participants for each statement
- Max refers to the lowest score based on the response of participants for each statement
- Sum refers to the total score from all participants for each statement
- Mean refers to the average of total score from all participants

- SDEV refers to the standard deviation, which is used to quantify the amount of dispersion of the scores, which explains the spread of the values around the central tendency. The Higher score of standard deviation means the result is highly dispersed, and vice versa.

As the scoring refers to the Likert scale, the format is divided into the five-level Likert item, that are strongly disagree, disagree, neutral, agree, and strongly agree. Strongly disagree and agree mean negative response to a statement with the score of 1 and 2, while agree and strongly agree represent a positive response to a statement, with the score of 4 and 5 respectively. Meanwhile, neutral means neither agree nor disagree, which has the score of 3.
The focus of this analysis is mean and standard deviation of the result. In order to show an overview of the overall mean and standard deviation based on the result, a figure is provided as follows:

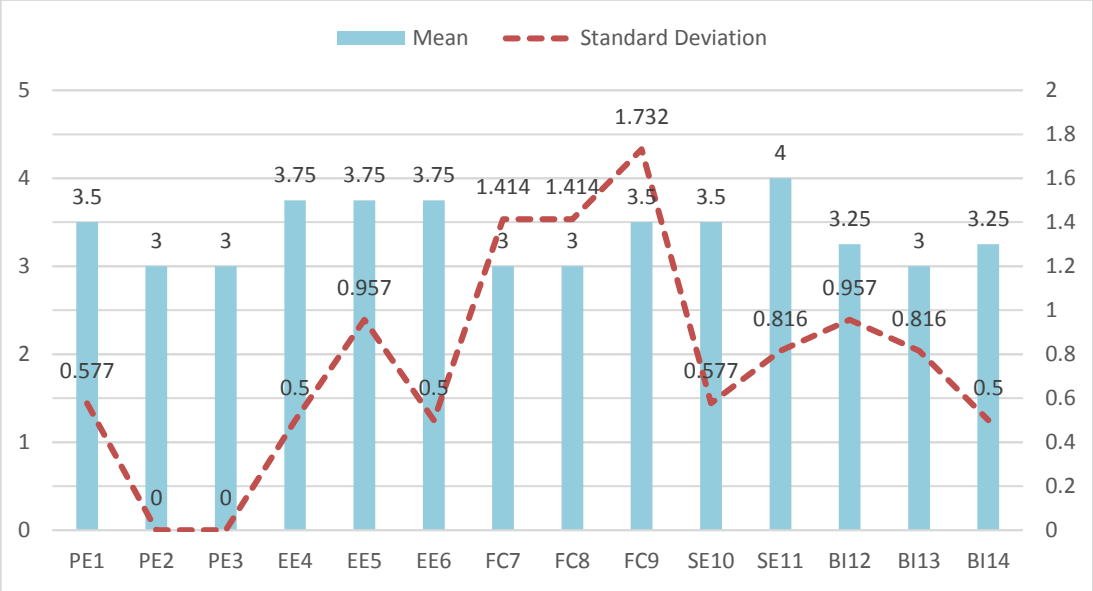


Figure 40 Mean and Standard Deviation of the Result

Based on the figure above, it can be seen that the average for most of the responses are between 3 and 4, which means that overall the proposed approach has either a positive response or neutral response from the participants. This score also means that generally participants have positive acceptance and attitude towards the proposed approach.

Within all questions, SE11 is the one with the highest score. All participants show positive responses that they want to use the proposed approach if there is a built-in assistance provided for helping them in using the proposed approach. It also means that they can use the proposed approach without help from others, as long as there is a guideline provided. In contrast, there are several questions with the lowest mean score, such as PE2, PE3, FC7, FC8, and BI13. As PE2 and PE3 are related to the performance expectancy, it can be said that the participants do not expect that the proposed approach would significantly improve their performance. Meanwhile, FC7 and FC8 are related to the prerequisites before using the proposed approach, such as the availability of knowledge and resource. It can also be said that the participants suggest that these requirements should be taken care of before implementing the proposed approach. Although some questions with low mean score can be found, it should be kept in mind

that the lowest score is 3. This also means that overall, the participants neither agree nor disagree towards the proposed approach.

Despite the fact that the participants have a positive attitude towards the proposed method, additional analysis of the result is required as some of the questions have a very dispersed score, as can be seen in *Figure 40*. Therefore, each statement of the questionnaire, which is grouped into several constructs will be assessed in order to find out more detail explanation regarding the result.

- **Performance Expectancy**

Table 21 Performance Expectancy Survey Result

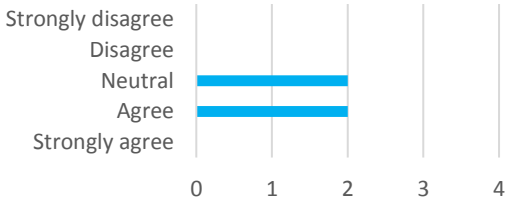
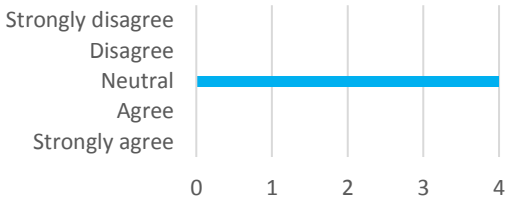
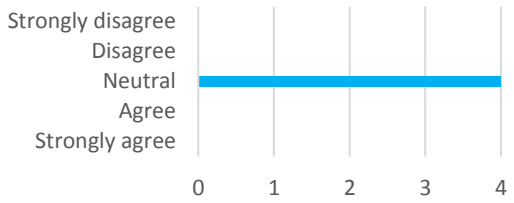
Construct	Question	Result
Performance Expectancy	Using the proposed approach would improve my job performance	
	Using the proposed approach enables me to accomplish tasks more quickly	
	Using the proposed approach increases my productivity	

Table 22 shows that most of the participants neither agree nor disagree towards the expected performance if they use the proposed approach. As regards for the job performance, some participants agree that the proposed approach would help them in improving their job performance, while the rest are neutral. Meanwhile, all participants have unbiased opinion that the proposed approach would assist them in accomplishing tasks more quickly or increasing the productivity.

Based on the result, it can be concluded that most of the participants have a neutral point of view regarding the performance expectancy. This happens because the role of most participants does not directly relate to business consultancy. However, some participants still have an indirect relationship with business consultancy, especially the research consultant because they have to investigate the needs of clients although they are not directly deal with them. Still, the result is considered as a positive response, and there is no negative response towards the proposed method as regards to performance expectancy.

- **Effort Expectancy**

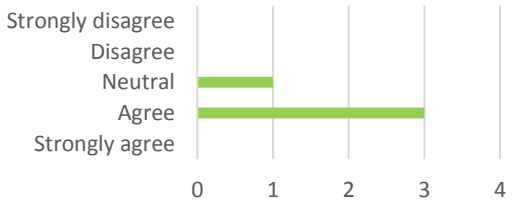
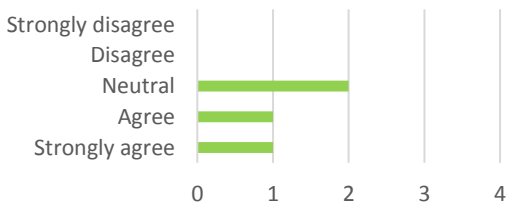
The survey result towards effort expectancy in using the proposed approach can be seen in *Table 23*. Based on the table, it can be seen that most of the result are above neutral. Even, a participant gives a very positive response towards the proposed approach. Following are the explanations for each item of the construct.

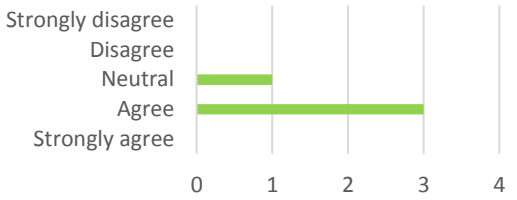
Three participants agree that it would be easy for them to become skillful at using the proposed approach, while another expert neither agrees nor disagree with the statement. The participant that has a different opinion has the role as the technical writer. It is reasonable because this expert never uses business analysis in daily work, as stated previously.

Meanwhile, the participants have a quite dispersed opinion of the easiness of use in using the proposed approach. One research consultant agrees that the proposed approach is easy to use, while another research consultant strongly agree to the statement. Based on the response, it can be said it is feasible to use this proposed approach since the practitioners acknowledge that it is not difficult to use the proposed approach.

After knowing that the participants believe that the proposed approach is easy to use, we should also consider how easy it is to use the proposed approach. Three participants agree that it will be easy for them to learn to use the proposed approach, while another expert only gives a neutral opinion, which is the one as the technical writer in BiZZdesign. It is reasonable because of this expert is not too familiar with business analysis, as mentioned in the previous section. Thus, all participants under research department agree that learning to use this proposed method will be easy. To conclude, using the proposed approach requires not too much effort, as the participants believe that it is easy to learn to use the proposed approach.

Table 22 Effort Expectancy Survey Result

Construct	Question	Result
Effort Expectancy	It would be easy for me to become skillful at using the proposed approach	
	Overall, I believe that the proposed approach is easy to use	

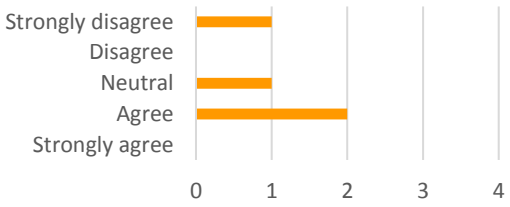
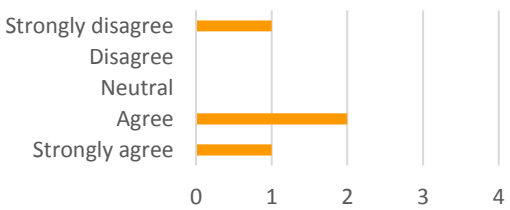
	Learning to use the proposed approach is easy for me	

- **Facilitating Conditions**

Table 24 shows the response of the participants towards the facilitating conditions in using the proposed approach. Based on the table, it can be seen that the responses are very dispersed. For all items of the construct, one participant gives a very negative response regarding the facilitating conditions. The participant that strongly disagree towards the statements is the expert that has a role as a technical writer in BiZZdesign. This is reasonable because, in daily work, this expert does not have to deal with business analysis, which makes this expert lack required knowledge and resource necessary for using the proposed approach.

As for other participants that are under the research department, they either agree or has a neutral opinion towards the facilitating conditions for using the proposed approach. Based on the responses, it can be concluded that it is feasible to use the proposed approach as long as the user possess the skills related to the proposed approach. Otherwise, it will be hard to use the proposed approach since it consists of various business method and analysis, which requires the user to have the knowledge in the area.

Table 23 Facilitating Conditions Survey Result

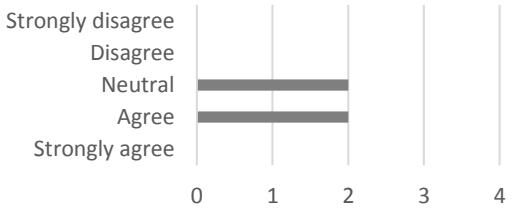
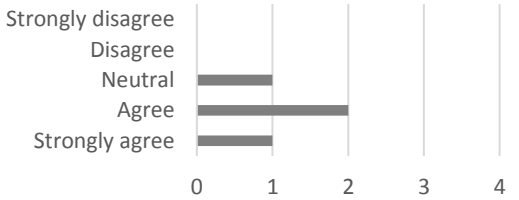
Construct	Question	Result
Facilitating Conditions	I have the knowledge necessary to use the proposed approach	
	I have the resource necessary to use the proposed approach	
	I think that using the proposed approach fits well with the way I like to work	

- **Self-efficacy**

For this construct, we are trying to find out the willingness of the user in using the proposed approach if they pose any difficulties in using the approach. As regards to self-efficacy, there are two questions were asked to the participants, as can be seen in *Table 25*.

Based on the table, it can be seen that most of the participants have either neutral opinion or positive response towards the self-efficacy in using the proposed approach. It can also be concluded that they are willing to use the proposed method as long as they can get the help either from someone or from the guidance from built-in assistance. Thus, it is considered necessary to provide a guideline for using the proposed method, as it can encourage the user to use the proposed approach.

Table 24 Self-efficacy Survey Results

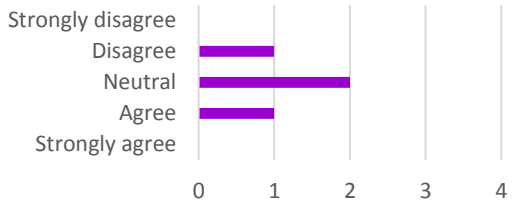
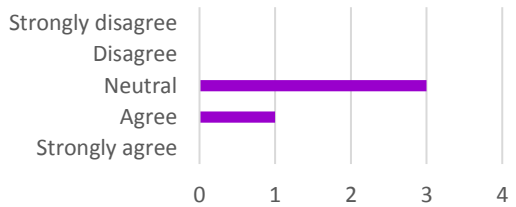
Construct	Question	Result
Self-efficacy	I would use the proposed approach if could get a help from someone if I got stuck	
	I would use the proposed approach if there is built-in guide for assistance	

- **Behavioral Intention to Use**

The purpose of this construct is to see whether the participants are going to use this proposed approach in the future. The survey result regarding this construct is provided in *Table 26*.

The responses toward this question are quite dispersed. On *Table 26*, it can be seen that one participant is not going to use the proposed approach in the future, while others are planning to use it. To be more specific, one research consultant disagrees on using this propose approach to complete the job in dealing with clients, while another agree that the approach can help in dealing with clients.The same reason applies in the prediction of using the proposed approach in the future. It is reasonable because although they are in the same position in the company, the specialization of they work may be different. Therefore, they have a different interest in using the proposed approach.

Table 25 Behavioral Intention to Use Survey Result

Construct	Question	Result
Behavioral Intention to Use	I intend to use the proposed approach in the future to help me completing my job in dealing with clients	
	I predict that I would use the proposed approach in the future to help me completing my job in dealing with clients	
	I plan to use the proposed approach in the future for helping me in dealing with the clients	

After conducting an evaluation, it can be concluded that the proposed approach is received user acceptance, as shown by the positive responses from the participants in general. Also, some of the participants are planning to use the proposed approach in helping them to complete their tasks in the future. Therefore, it can be said that the proposed approach is believed to give a contribution in practice, specifically for the practitioners in the company.

6. Conclusion

This chapter describes various aspects regarding the studies, which is presented in this thesis. In the beginning, the results of conducting a systematic literature review, as well as a case study will be discussed in the first section. Then, the contributions presented as the result of this study will be provided in the second section. The last part of this chapter describes the limitations of the research, along with possible improvements and recommendations for further studies.

6.1. Discussion & Summary

The purpose of this thesis is to provide an approach to aid modeling and assessing digital business ecosystems, which is also provided as the answer to the main research question of this study: *How to support digital business ecosystems modeling and analysis by using an architecture-driven modeling approach?* The proposed approach provided in this study is expected to be used as the guideline for the companies to model and analyze, not only the prospective ecosystem but also to the current ecosystem. To be more specific, if a company is not a part of an ecosystem, then the proposed approach could aid the company in finding out whether to join an ecosystem will be more profitable or not. Meanwhile, if an enterprise is already a member of an ecosystem, then the approach is expected to bring more insight into the current situation of the ecosystem. If the result shows that the ecosystem is considered as unfavorable, then it is better for the company to leave the ecosystem, and vice versa. In order to gather more understanding regarding the topic, as well as to find out the state of the art of the research, a systematic literature review is conducted in this study.

The systematic literature review, as presented in *Chapter 2*, provides the knowledge required for developing the proposed approach. The result of doing the literature review can be used to answer the first sub-research question: *What is the current situation of the digital business ecosystem research?* The literature review also shows that the digital business ecosystem is beneficial for the companies, which is considered as the background of conducting the research, as presented in this thesis. Although the digital business ecosystem is considered useful for the companies, the literature review also presents that there is only a few number of research in this topic. One of the examples is currently available framework for exploring digital business ecosystems is the modified Zachman framework only. As for the modeling language, the currently available standards cannot support all elements found in a digital business ecosystem.

Furthermore, the theoretical frameworks referred in this study comes up as the result of doing the literature review, including architecture modeling standards and the business model ontologies. Besides providing the theoretical framework, in this chapter, several possible quantitative analyses for ecosystems are also described, as the answer to the second sub-research question: *What kind of quantitative analysis is relevant for the digital business ecosystem assessment?* Those analyses include profitability analysis, goal analysis, and resource analysis. To be more specific, the methods used for conducting the analyses in this study are financial analysis, decision tree analysis, analytical hierarchy process (AHP) method, and linear programming method.

After having more understanding of the topic, the proposed approach is developed, as described in Chapter 3. The architecture-driven approach suggested in this study, which is also the answer to the third sub-research question (*How to model and analyze business ecosystems?*), is represented by the use of ArchiMate standards to model and analyze digital business ecosystems. Meanwhile, to understand the elements of the digital business ecosystem itself, the v^4 ontological framework of business model is referred, as the framework is able to show the aspects within the ecosystem. The purpose of proposing the approach is to provide a guideline for the companies in modeling and analyzing the digital business ecosystem. The end result presented in this study comes up as the result of combining those theoretical frameworks into one single approach.

In order to provide an overview of how to use the proposed approach in real business, as well as to answer the last sub-research question (*How to validate the proposed method in practice?*), a case study as explained in *Chapter 4* is provided. Afterwards, the case study is used for the evaluation, which is done by performing a small workshop attended by four participants, which are practitioners in a company. The result of the evaluation shows that overall the proposed method is easy to use, which leads to the willingness to use the proposed method in the future. It can also be said that the proposed method receives positive responses from the practitioners, which means it is feasible to implement the proposed approach in practice. The result also brings to the conclusion that the proposed method gives a contribution in practice, as already mentioned in *Chapter 1*.

6.2. Contributions

In this part, the contributions provided by this study will be discussed. The contributions of this study refer to the contributions of the current research, as well as for practical use. The detailed explanation is provided as follows.

6.2.1. Contributions to the Research Area

The objective of this section is to explain the contributions provided by this study. Below is the list of theoretical contributions to the state of the art of the research:

1. This study provides a guideline for modeling and analysis of digital business ecosystems, as currently only limited approach available to support modeling and analysis of the ecosystems, particularly for the digital business ecosystem
2. Currently, ArchiMate language is only used to model a single company. Therefore, this study also contributes to the application of the language, which is done by using the language to model a business ecosystem, which consists of more than one enterprise.
3. The systematic literature review provided in this study shows that there are several limitations of current research in the field. One of the examples is a lack of adequate indicator to assess a business ecosystem. Therefore, the proposed approach provided in this study is expected to give a contribution in the area, which is to aid the company in modeling and assessing digital business ecosystems.

To sum up, it can be said that the result of this study provides an update on the existing research. Moreover, this study also presents possible further improvement, as the topic is considered as still young and not too many research is conducted in the area. Hence, those contributions are expected to provide more insights for the future researchers in the field.

6.2.2. Contributions to Practice

As previously mentioned, this study is expected to give contributions not only to the academic area but also in practice. Therefore, in this section, the contributions provided as the result of this study will be described.

Hereunder the list of main contributions in practice given by this study:

1. The proposed approach can be used by a company as a guideline to model and analyze their relationship with other companies. To be more specific, by using the proposed approach, organizations will be able to assess whether a business ecosystem can support the company in aiming the enterprise goal, or whether a member of an ecosystem can bring more benefit to the company.
2. The proposed approach is considered as a new way to deal with business partners because it enables the organizations to seek for benefit from the partners by collaborating with them in an ecosystem.
3. The proposed approach supports the organization to look for the room for improvements of their business, e.g. to remove inefficiency or to find out more effective resource allocation by acquiring the capabilities or resources from the company that can provide the best capabilities or resources in particular area. Another example is the company can decrease the investment cost by collaborating with other members in an ecosystem, instead of acquiring all the required assets by themselves.

To conclude, the proposed approach is expected to guide the organization in achieving the enterprise goal, which can be done by collaborating with other companies within the ecosystem. To be more specific, this approach also gives additional required information regarding their ecosystem, such as the relationship between members, the value flows between the members and so on.

6.3. Research Limitations and Recommendations

In this section, the limitations of this study, as well the recommendations for the future works are discussed. This section is divided into two parts. The first part shows the limitations of this study (*Section 6.3.1*). The second part explains the possible further research in the area, as well as the recommendation for future work (*Section 6.3.2)*.

6.3.1. Research Limitations

This section explains several limitations regarding this research. To be more specific, the limitations can be considered either as research limitation, limitation related to suitability, or limitation of evaluation.

During this study, several research limitations are found, which described as follows:

1. As there are not too many research regarding modeling and analysis of digital business ecosystems, a standard in creating the approach cannot be found. Therefore, the suitability of the approach may differ depending on the needs. In order to fill in the gap, the proposed approach is developed by referring to the concepts of other disciplines, such as supply chain management and system sciences.
2. Because of the limited number of the scientific literature, gray literature such as blogs and white paper are also referred during the study. However, gray literature only reflects the particular business situation as it usually comes from the experience of the practitioners in the field. Thus, the information gathered from the gray literature cannot be generalized and may not be applied to some cases. Still, gray literature is considerably important as it explains the real business situation because the business professional provides them, and it is possible that some information provided in gray literature cannot be found in scientific literature.

As regards to the proposed approach, there are some limitations related to suitability, such as:

1. The research only refers to some types of quantitative business analyses, while in practice, the various analysis may be required in making a decision for a different situation. Therefore, the type of analysis on the proposed approach cannot be generalized and should be adjusted based on particular circumstances.
2. Currently, a lot of companies with traditional business model wants to migrate to e-business or e-commerce type business model, and creating their digital business ecosystem. In this kind of case, the proposed approach is not too suitable, as the main purpose of modeling and analysis mentioned in this study is only to assess the e-commerce based business.

In this study, the proposed approach is presented in a case study, which later is validated by an evaluation. However, several limitations of evaluation are found during this study, including:

1. In this research, the proposed approach has only been applied to one case study. Therefore, the result of the implementation cannot be generalized, since the effects may be different if implemented into a different type of organizations or ecosystems. Therefore, a further study regarding the implementation of the proposed approach is considered necessary.
2. The validation using evaluation method only attended by several participants with the quite similar working background. Therefore, the result of user acceptance towards the proposed method may be different if the number of participants is higher and if the experience of the participants is more varies.

To conclude, the limitations found in this study lead to the room for improvements, which aims at a better result. Therefore, further research should be conducted with the purpose to extend the approach provided in this study.

6.3.2. Possible Further Research and Recommendations

As previously mentioned, there is some possible further research can be done in order to improve the current research, as well as to fill in the gap as stated in the limitations section. Following is the list of possible future research and the recommendations for future work:

1. As mentioned in the limitation part, the proposed approach is developed by adopting the concepts from other disciplines. Therefore, it is also expected that other disciplines can conduct some research by referring to this study, as the topic of this thesis can be considered as an interdisciplinary study.
2. As gray literature only represents a particular situation, adjustment in the proposed approach is considered required in order to fulfill the needs based on the circumstances. Therefore, additional studies focus on a particular business situation are required.
3. In the future, more types of analyses can be added to the approach in order to provide a complete approach required to support the decision-making process.
4. Currently, the proposed approach is supposed to be used for supporting the e-business type organizations. Therefore, it is expected that further research in the area is conducted so the proposed approach can be implemented not only for e-commerce based organizations but also for the traditional industries that want to expand their business into e-business industry.
5. As the proposed method has only been validated in a case study in the e-commerce industry, it is expected that additional case studies in a different type of industries or ecosystems can be done in order to see whether the effects of the proposed method will be the same if it is implemented into another kind of business.
6. With the purpose to improve the proposed method, additional evaluation can be conducted with the participants from more varied backgrounds. To be more specific, the acceptance of the primary user, which is the business consultant who deals with the customers, should be seen as well. It is important to see their response because the proposed approach provided in this study is expected to help them in dealing with clients. Furthermore, as the research related to modeling of ecosystems, having opinions from them who will model the business is considered necessary as well. Thus, in the future, it should be investigated whether the proposed method is well-accepted by the ICT architect.
7. As the research related to the stakeholder interest, which is also mentioned in Chapter 3, further research can be done by dividing the analyses based on stakeholder needs, as well as to provide a deeper analysis based on the interest of each stakeholder.
8. A more in-depth investigation regarding the limitation of ArchiMate standards for an ecosystem can be done in the future, such as to include governance and network

mode into the ecosystem modeling, as currently ArchiMate does not have the required notation to represent them.

9. In the future, the usage of the proposed method within an organization can be considered, by assuming the individual parts of the organizations as the actors of the ecosystem. The implementation of the proposed method for the internal part of organization is suitable for the company which has a lot of departments and branches so that it is necessary for them to create their own ecosystem.

It is expected that the list of possible further research as mentioned above could provide some directions for other researchers in the field. In addition, the further study conducted in the future is expected to bring improvement not only in the academic area, but also in practice.

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Appendix

Appendix A: List of Literature Selected for This Study

Table 26 Selected Publications for This Study

#	Title	Author(s) & Year of Publication	Publication Type
1.	Business models for digital business ecosystems: the case of the Open Negotiation Environment (ONE) platform.	Hoyer and Stanoevska-Slabeva (2009)	Conference Proceedings
2.	A framework for exploring digital business ecosystems	Korpela, Kuusiholma, et al. (2013)	Conference Proceedings
3.	From business ecosystems towards digital business ecosystems	Razavi, Krause, and Strømmen-Bakhtiar (2010)	Conference Proceedings
4.	Ecosystem Advantage: How to Successfully Harness the Power of Partners	Peter James and Arnoud De (2012)	Journal Article
5.	Research commentary—seeking the configurations of digital ecodynamics: It takes three to tango	El Sawy, Malhotra, Park, and Pavlou (2010)	Journal Article
6.	The business model: A theoretically anchored robust construct for strategic analysis	Zott and Amit (2013)	Journal Article
7.	A Business Modelling Language (BML) For Digital Business Ecosystem: the DBE project case	Ferronato (2006)	Conference Proceedings
8.	The emperor's new clothes: Redressing digital business ecosystem design	Cheah (2007)	Conference Proceedings
9.	Current state and research trends on business ecosystem	J. Zhang and Fan (2010)	Conference Proceedings
10.	Performance indicators for collaborative business ecosystems—Literature review and trends	Graça and Camarinha-Matos (2016)	Conference Proceedings
11.	Methodology of business ecosystems network analysis: A case study in Telecom Italia Future Centre	Battistella, Colucci, De Toni, and Nonino (2013)	Journal Article
12.	How to capture value from innovation: Shaping intellectual property and industry architecture	Pisano and Teece (2007)	Journal Article
13.	Conceptual and business models for customer-centric business ecosystems	Fragidis, Tarabanis, and Koumpis (2007)	Conference Proceedings
14.	Understanding business ecosystem using a 6C framework in Internet-of-Things-based sectors	Rong, Hu, Lin, Shi, and Guo (2015)	Journal Article
15.	Innovation ecosystems: A critical examination	Oh, Phillips, Park, and Lee (2016)	Journal Article
16.	The need of performance indicators for collaborative business ecosystems	Graça and Camarinha-Matos (2015)	Conference Proceedings
17.	The collaborative enterprise	Tencati and Zsolnai (2009)	Journal Article

18.	Ecosystem-inspired enterprise modelling framework for collaborative and networked manufacturing systems	Fayoumi (2016)	Journal Article
19.	Collaborative networked organizations–Concepts and practice in manufacturing enterprises	Camarinha-Matos, Afsarmanesh, Galeano, and Molina (2009)	Journal Article
20.	Collaborative networked organizations: Status and trends in manufacturing	Camarinha-Matos (2009)	Journal Article
21.	Open innovation and strategy	Chesbrough and Appleyard (2007)	Journal Article
22.	Towards formalizing virtual enterprise architecture	Goel et al. (2009)	Conference Proceedings
23.	A management and orchestration model for integrating Digital Business Ecosystems	Korpela, Ritala, Vilko, and Hallikas (2013)	Journal Article
24.	Leveraging digital business ecosystems for enterprise agility: The tri-logic development strategy of Alibaba.com	Tan, Pan, Lu, and Huang (2009)	Journal Article
25.	Toward an open network business approach	Ndou, Schina, Passiante, Del Vecchio, and De Maggio (2010)	Conference Proceedings
26.	Comparison of different ecosystem analogies: The main economic determinants and levels of impact	Pilinkienė and Mačiulis (2014)	Journal Article
27.	Aligning IT with firm business strategies using the balance scorecard system	Hu and Huang (2005)	Conference Proceedings
28.	Connecting business value and strategy: using balanced scorecard	Chen (2005)	Conference Proceedings
29.	Competency based balanced scorecard model: An integrative perspective	Agrawal (2008)	Journal Article
30.	Management indicators model to evaluate performance of IT organizations	Bianchi (2001)	Conference Proceedings
31.	The dynamic information technology capability and firm performance: a resource-based perspective	Fang, Wu, and Wu (2006)	Conference Proceedings
32.	Alignment is not enough: integrating business and information technology management with the balanced business scorecard	Van Der Zee and De Jong (1999)	Journal Article
33.	A goal-oriented requirement modelling language for enterprise architecture	Quartel et al. (2009)	Conference Proceedings
34.	Extending enterprise architecture modelling with business goals and requirements	Engelsman, Quartel, Jonkers, and van Sinderen (2011)	Journal Article

Appendix B: Comparison of Business Model Approaches (El Sawy & Pereira, 2013)

Source	Components	Number of components	Eco-system	Digital platform
Horowitz (1996)	Price, product, distribution, organizational characteristics and technology	5	No	Some
Viscio and Pasternak (1996)	Global core, governance, business units, services and linkages	5	No	No
Timmers (1998)	Product/service/information flow architecture, business actors and roles, actor benefits, revenue sources, and marketing strategy	5	No	Some
Markides (1999)	Product innovation, customer relationship, infrastructure management, and financial aspects	4	No	No
Donath (1999)	Customer understanding, marketing tactics, corporate governance and intranet/ extranet capabilities	4	No	No
Mahadevan (2000)	Value stream, revenue stream, logistical stream	3	No	No
Gordijn et al. (2001)	Actors, market segments, value offering, value activity, stakeholder network, value interfaces, value ports and value exchanges	8	No	No
Linder and Cantrell (2001)	Pricing model, revenue model, channel model, commerce process model, internet-enabled commerce relationship, organizational form and Value proposition	8	No	Some
Chesbrough and Rosenbaum (2000)	Value proposition, target markets, internal value chain structure, cost structure and profit model, value network and competitive strategy	6	No	No
Gartner (2003)	Market offerings, competencies, core technology investments, and bottom line	4	No	Some
Hamel (2001)	Core strategy, strategic resources, value network and customer interface	4	No	No
Petrovic et al. (2001)	Value model, resource model, production model, customer relations model, revenue model, capital model, and market model	7	No	No

(continued)

Source	Components	Number of components	Eco-system	Digital platform
Dubosson-Torbay et al.	Products, customer relationship, infrastructure and network of partners, and financial aspects	4	No	Some
Afuah and Tucci (2001)	Customer value, scope, price, revenue, connected activities, implementation, capabilities and sustainability	8	No	Some
Weill and Vitale (2001)	Strategic objectives, value proposition, resource sources, success factors, channels, core competencies, customer segments, and IT infrastructure	8	No	No
Applegate (2001)	Concept, capabilities and value	3	No	No
Amit and Zott (2001)	Transaction content, transaction structure and transaction governance	4	No	No
Alt and Zimmerman (2001)	Mission, structure, process, revenues, legalities and technology	6	No	No
Rayport and Jaworski (2001)	Value cluster, market space offering, resource system, and financial model	4	No	No
Bertz (2002)	Resources, sales, profits and capital	4	No	No
Hedman and Kalling (2003)	Value network, resources, capabilities, revenue and pricing, competitors, output, management	7	Some	No
Chesbrough (2003)	Customer, value network, capabilities, revenue and pricing, cost, strategy	6	Some	No
Rappa (2004)	Types: Brokerage, advertising, infomediary, merchant, manufacturer (direct), affiliate, community, subscription, utility	9	Some	No
Stanoevska-Slabeva and Hoyer (2005)	Features of specific product, features of specific medium, customers, value chain, financial flow, goods and services, societal environment	7	No	No
Osterwalder and Pignuer (2009)	Customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, cost structures	9	Some	No
Al-Debei and Avison (2010)	Value proposition, value architecture, value finance, value network (integrated approach)	4	Yes	No

Figure 41 Comparison of Business Model Approach

Appendix C: Stakeholder Interests

CIO

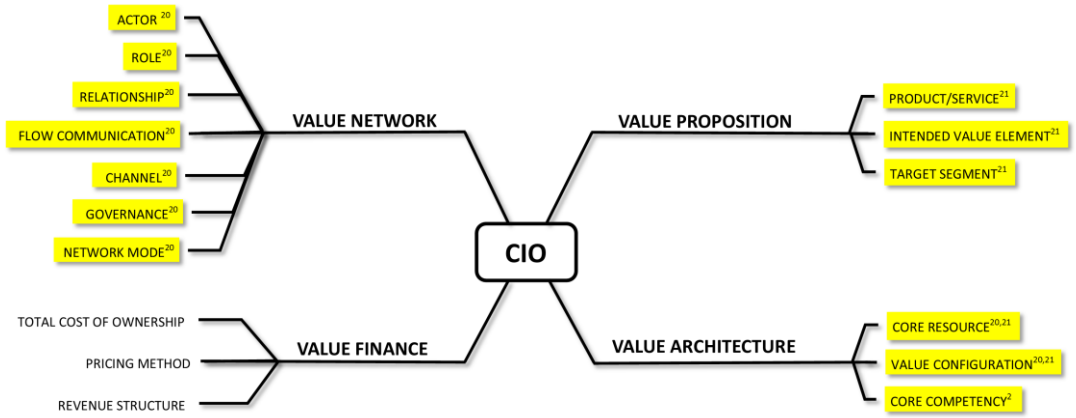

Figure 42 CIO Interests

CEO

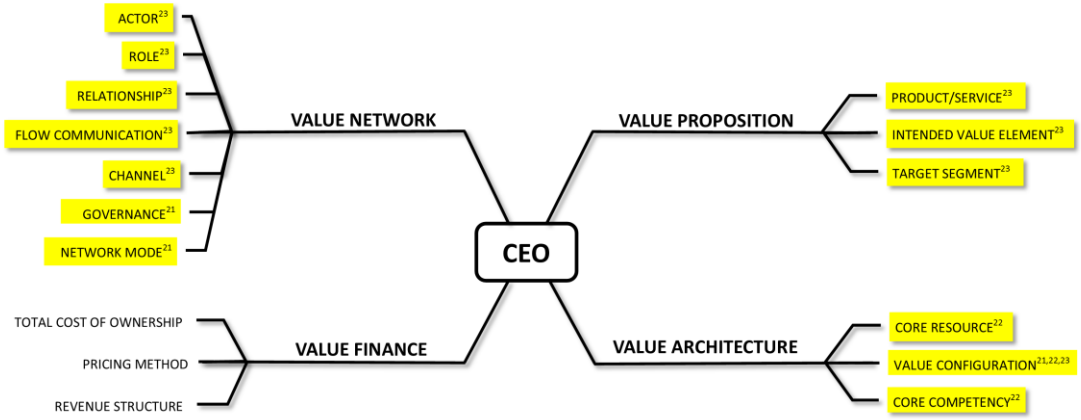

Figure 43 CEO Interests

[20] http://www.gartner.com/smarterwithgartner/every-organization-needs-a-digital-platform-strategy/
[21] http://www.slideshare.net/AccentureNL/accenture-digital-business
[22] http://www.pwc.com/gx/en/technology/publications/assets/pwc-the-new-digital-ecosystem-reality-nine- trends-rewriting-the-rules-of-business.pdf
[23] http://www.cgma.org/magazine/news/pages/how-cfos-can-support-digital-business-model-201513323.aspx?TestCookiesEnabled=redirect

COO

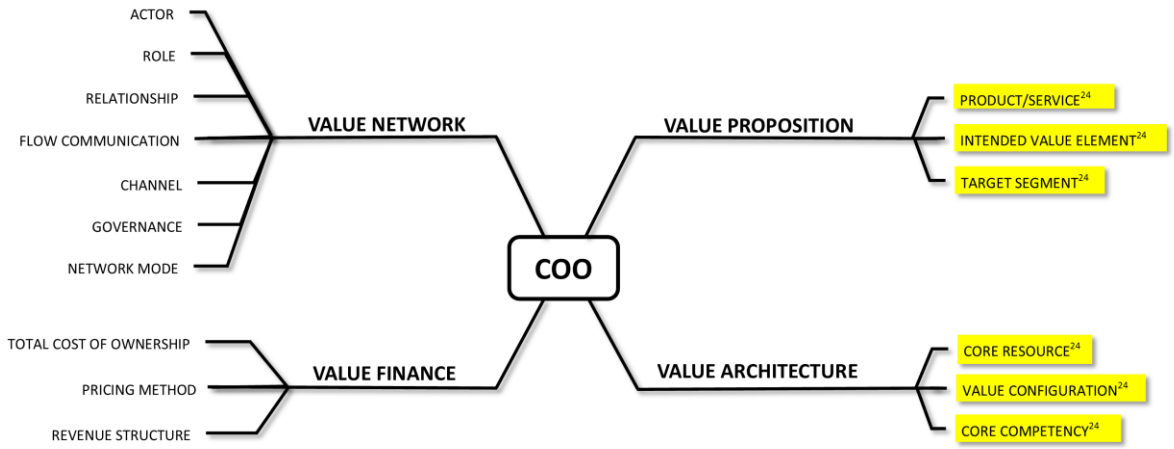

Figure 44 COO Interests

Business Analysts

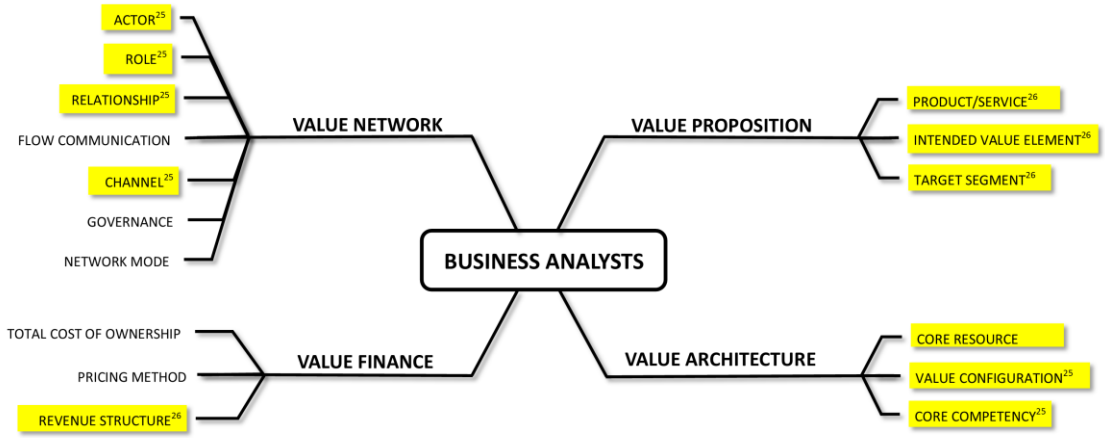

Figure 45 Business Managers Interests

As for Chief Operational Officer (COO), they have to deal with value proposition and value architecture in the digital business ecosystem. The value architecture is required as COO has to determine the best way to create value, which is a part of the value proposition (Figure 38).

[24] http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=XB&infotype=PM&htmlfid=GBE03737USEN&attachment=GBE03737USEN.PDF

[25]https://www.google.nl/url?sa=t&rct=j&q=&esrc=s&source=web&cd=12&cad=rja&uact=8&ved=0ahUKEwiNsrP32YzSAhVJVxQKHdDtC784ChAWCEcwAQ&url=http%3A%2F%2Fwww.mckinsey.com%2F~%2Fmedia%2Fmckinsey%2Fdotcom%2Fclient_service%2Fbto%2Fpdf%2Fmcbt_compendium_perspectives_on_digital_business.ashx&usg=AFQjCNEsqi8IhCoA4R_eKj9O64VDbMEXYQ

[26] https://dupress.deloitte.com/dup-us-en/topics/emerging-technologies/new-digital-ecosystem-technology-media-telecom-industry.html

Enterprise and ICT Architect

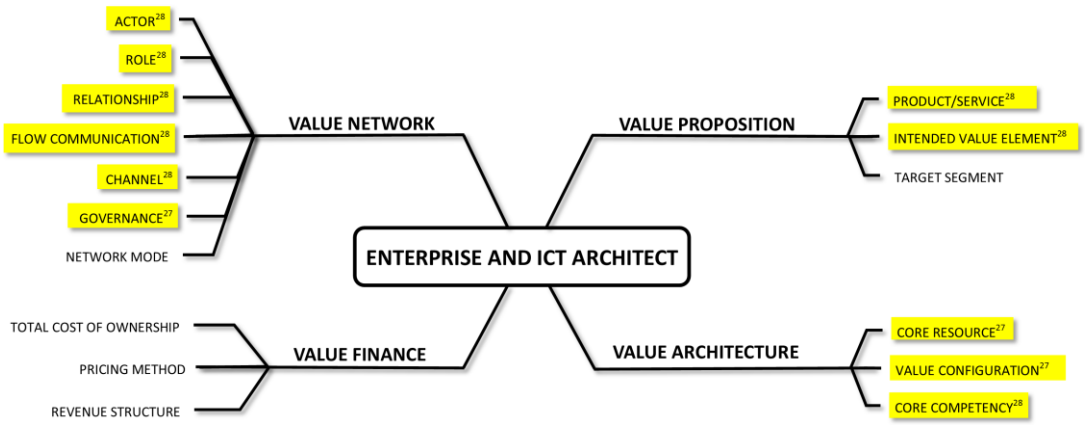

Figure 46 Enterprise and ICT Architect

[27] http://www.infoworld.com/article/2935141/enterprise-architecture/what-will-enterprise-architecture-look-like-in-5-years.html
[28] http://www.sparxsystems.com/enterprise-architect/keys-to-ea-success.html

Appendix D: Viewpoints

Value Network Viewpoint

Table 27 Value Network Viewpoint

Value Network Viewpoint	
Stakeholders	Stakeholders, business analysts, enterprise and ICT architects, CIO, CEO, CFO
Concerns	Dependencies between stakeholders, identification of competencies and responsibilities, (financial) value offered by each actor, (financial) value gained from business operations
Purpose	Designing, analyzing, deciding
Scope	Multiple layer/Multiple aspect
Elements • Business Actor • Business Role • Facility • Equipment • Material • Distribution Network	

Goal Realization Viewpoint

Table 28 Goal Realization Viewpoint

Goal Realization Viewpoint	
Stakeholders	Stakeholders, business managers, enterprise and ICT architects, business analysts, CEO, CIO, requirements manager
Concerns	Architecture mission, strategy and tactics, motivation
Purpose	Designing, deciding
Scope	Motivation
Elements • Driver • Goal • Outcome	

Goal Analysis Viewpoint

Table 29 Goal Analysis Viewpoint

Goal Analysis Viewpoint	
Stakeholders	Enterprise and ICT architects, business analysts, external stakeholders, CEO, COO, CIO
Concerns	Strategy, supporting drivers, motivation
Purpose	Designing, analyzing
Scope	Multiple layer/Multiple aspect
Elements • Driver • Goal • Business actor	

Resource Prioritization Viewpoint

Table 30 Resource Prioritization Viewpoint

Resource Prioritization Viewpoint	
Stakeholders	Business analysts, external stakeholders, COO, CEO, CIO
Concerns	Strategy, supporting drivers, motivation, optimal resource priority
Purpose	Designing, analyzing, deciding
Scope	Multiple layer/Multiple aspect
Elements • Goal • Capability • Business actor	

Resource Allocation Viewpoint

Table 31 Resource Allocation Viewpoint

Resource Allocation Viewpoint	
Stakeholders	Business analysts, external stakeholders, CFO, CEO, COO, CIO
Concerns	Strategy, supporting drivers, motivation, optimal resource allocation
Purpose	Designing, analyzing, deciding
Scope	Multiple layer/Multiple aspect
Elements • Business Actor • Resource • Driver • Goal • Facility • Equipment • Distribution Network	

Appendix E: Profitability Analysis Calculation (Sample Case)

Company A is a car manufacturer which conducts in-house production for all parts of the car. Below is the financial information of the companies regarding the manufacturing costs:

Table 32 Ecosystem Members

Company	Role	Relationship (Role)	Personnel costs
Company A	Keystone	Final Product Manufacturer (OEM)	€ 10/man hour
Company B	Brake system manufacturer	Tier 1	€ 10 /man hour
Company C	Chassis system manufacturer	Tier 1	€ 10/man hour
Company D	Aluminium supplier	Tier 2	€ 10/man hour

Table 33 Manufacturing Time and Costs of Aluminium

Company	Time to process raw aluminum into aluminum block (per 30 blocks)	Total personnel cost
Company A	6 hours/block	€ 60
Company D	3 hours/block	€ 30

(It is assumed that company D is the specialist in the field, so the manufacturing time is shorter)

Table 34 Manufacturing Time and Costs of Brake System

Company	Time to process aluminum block into brake system	Total personnel cost
Company A	20 hours/block	€ 200
Company B	10 hours/block	€ 100

(It is assumed that company B is the specialist in the field, so the manufacturing time is shorter)

Table 35 Manufacturing Time and Costs of Chassis System

Company	Time to process aluminum block into chassis system	Total personnel cost
Company A	15 hours/block	€ 150
Company B	7,5 hours/block	€ 75

(It is assumed that company C is the specialist in the field, so the manufacturing time is shorter)

In manufacturing a car, 30 blocks of aluminum are needed, where 15 are used for producing the brake system, and the rest are for producing the chassis system. The price of raw aluminum, with the assumption that it can produce 15 blocks of aluminum is €50. Meanwhile, the price of 15 blocks of aluminum is €75.

Based on the available information, company A has to pay certain amount of costs in producing a car, as shown in *Table 38* and *Table 39*.

It is assumed that the sales revenue from selling a car is €750. A comparison to show which situation is more profitable can be seen in *Table 37*.

Table 36 Comparing the Profit (Income)

	In-house Production	Collaborating in the Ecosystem
Sales Revenue	€750	€750
Total Costs	€560 –	€505 –
Income	**€190**	**€245**

Table 37 Total In-house Production Costs

Company	Overhead Costs						Total Cost
	Material		Personnel Costs				
	Raw Aluminium	Aluminium Block	Aluminium manufacturing	Brake manufacturing	Chassis manufacturing	Final Assembly	
Company A	€ 50		€ 60	€ 200	€ 150	€ 100	**€ 560**

The table above shows the total manufacturing cost if the Company A does in-house manufacturing for producing a car. However, if the Company A enter the ecosystem and cooperate with other members in producing a car, the costs can be reduced. The cost comparison, as well as the detailed calculation of the costs, can be found in the table below:

Table 38 Comparing In-house Production Costs and Production Costs within the Ecosystem

Company	Overhead Costs						Total Cost	
	Material		Personnel Cost					
	Raw Aluminium	Aluminium Block	Aluminium manufacturing	Brake manufacturing	Chassis manufacturing	Final Assembly	In-house Production (Company A)	Cooperating in the Ecosystem (Company A+B+C+D)
Company A	€ 50		€ 60	€ 200	€ 150	€ 100	€ 560	€ 100
Company B		€ 75		€ 100				€ 175
Company C		€ 75			€ 75			€ 150
Company D	€ 50		€ 30					€ 80
Total							**€ 560**	**€ 505**

If the Company A decided to do the production by themselves, then the manufacturing costs must be spent by the company is €560. Meanwhile, if the Company A wants to collaborate with other partners in the ecosystem, the overall production costs are €505, which is €55 lower than in-house product.

Appendix F: Goal Analysis Calculation (Sample Case)

Table 39 Capabilities Needed towards Better Information Quality

Capability / Company	Security	Integrity	Reliability
Company A	+	++	-
Company B	++	++	--
Company C	-	--	++
Priority	0.3	0.5	0.2

Note:
++: 0.4 : 1st priority (highest)
+ : 0.3 : 2nd priority
- : 0.2 : 3rd priority (lowest)
-- : 0.1

Table 40 Capabilities Needed towards Better Information Quality

Capability / Company	**Security**	**Integrity**	**Reliability**	**Weighted Average**
Company A	0.3	0.4	0.2	0.33
Company B	0.4	0.4	0.1	0.34
Company C	0.2	0.1	0.4	0.19
Priority	0.3	0.5	0.2	

Table 40 shows the capabilities necessary to improve the information quality. In addition, from the table, it can be seen that integrity is the highest priority amongst the capabilities required. After converting the plus and minus signs into numeric, the weighted average can be computed. The end calculation shows that Company B has the biggest number of weighted average, and we can conclude that it is better for the keystone company to collaborate with company B in attaining better information quality towards the achievement of the main objective. Afterwards, another decision tree diagram can be created to visualize the best option among the alternatives, which is shown in *Figure 47*.

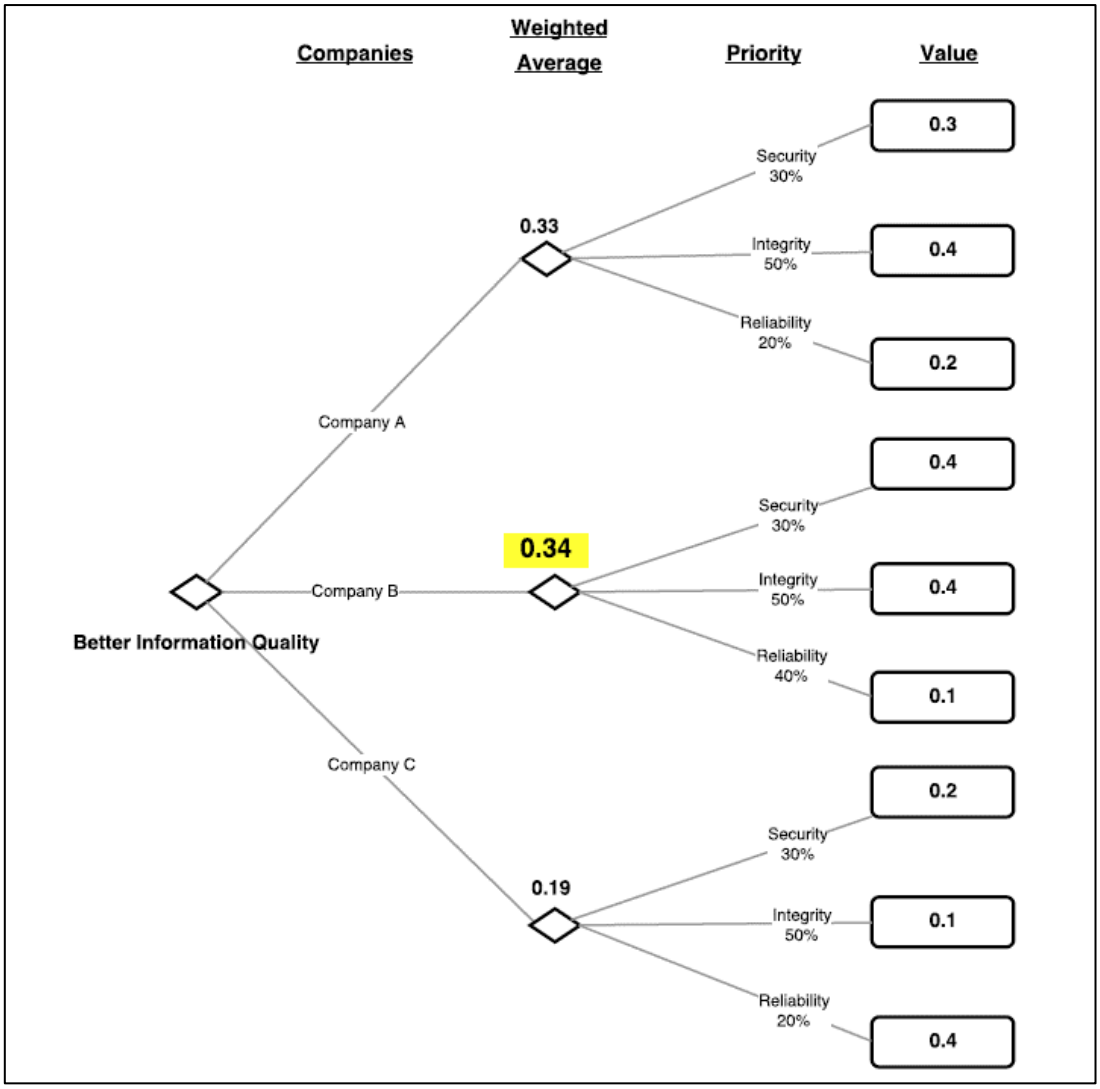

Figure 47 Decision Tree Diagram of Capabilities Needed to Achieve Better Information Quality

Appendix G: Resource Prioritization Analysis Calculation (Sample Case)

It is assumed that Company A wants to find the partner which provide the best resource. However, currently the company does not know the resource should be prioritized on. Thus, in order to find the resource to be focused on, analytical hierarchy process (AHP) method is implemented. Following are the data provided to calculate the resource prioritization analysis using AHP method.

Table 41 Importance of Criteria of the Resources

Importance of Criteria				
	Inventory	Human	Manufacturing	Logistics
Inventory	1,00	0,20	0,50	0,33
Human	5,00	2,60	0,29	0,71
Manufacturing	2,00	3,50	1,00	0,83
Logistics	3,00	1,40	1,20	1,00
Sum	11,00	7,70	2,99	2,88

The data of the priority of each resource can be used to create the normalized matrix, in order to calculate the weight of each resource. The result is shown in the following table:

Table 42 Normalized Matrix of the Criteria

Normalized Matrix					**Weights**
Inventory	0,09	0,03	0,17	0,12	0,10
Human	0,45	0,34	0,10	0,25	0,28
Manufacturing	0,18	0,45	0,33	0,29	0,32
Logistics	0,27	0,18	0,40	0,35	0,30
Checksum	1	1	1	1	1

Based on the data regarding the weight of the criteria, as well as the normalized matrix based on the criteria, we can see that manufacturing resource is the most important, which is shown by the value of 0.32. After having an understanding regarding the most important resource, the next step is to find out the partner that can provide the best manufacturing resource. In this sample, the potential partners are Company B, Company C, Company D, and Company E. Provided below is the table shows the evaluation of choices, with the highest score signifies the most desirable option.

Table 43 Evaluation of Choices

Evaluation of Choices (Scale 1-10)				
Company B	2,50	3,50	2,50	3,00
Company C	1,50	2,50	1,50	1,00
Company D	4,00	1,00	4,00	2,50
Company E	2,00	1,50	2,00	2,50
Sum	10,00	8,50	10,00	9,00

Afterwards, the normalized matrix is calculated to provide the values needed for the next step.

Table 44 Normalized Matrix of the Choices

Evaluation of Choices (Scale 1-10)				
Company B	0,25	0,41	0,25	0,33
Company C	0,15	0,29	0,15	0,11
Company D	0,40	0,12	0,40	0,28
Company E	0,20	0,18	0,20	0,28
Checksum	1,00	1,00	1,00	1,00

The last step is to find the company with the biggest score based on the provided information above. To find out the score, AHP method can be applied, which can be done by doing the matrix multiplication. The result of the calculation is shown in the table below:

Table 45 AHP Method Result

Determining company with the best manufacturing resource	
	Score
Company B	**0,32**
Company C	0,18
Company D	0,28
Company E	0,22
Checksum	1

Therefore, it can be concluded company B should be picked out amongst the options if the keystone company wants to focus on the manufacturing resource, because company B possesses the highest score, with the number of 0.32.

Appendix H: Resource Optimization Analysis Calculation (Sample Case)

Step 1 – Increase Revenue

As refer to the previous example, it is assumed that Company A as the keystone company is going to focus on the manufacturing resource, which constructs of various kinds of equipment. As an additional information, each equipment has different time available, which is described in the following table.

Table 46 List of Equipment

Equipment	Available Operational Time
Assembly Machine	2,000 hours
Handlers	2,500 hours
Industrial Robot	1,000 hours
Tools	1,800 hours

Three types of cars, which are Car A, Car B, and Car C, are going to be produced by the company. The revenue from the sales of Car A, Car B, and Car C is €2,000, €2,300, and €1,750 respectively. Production time required to make one car is varied depend on the vehicle type, as mentioned below.

Table 47 Time Required in Manufacturing a Car (in hours)

Equipment	Car A	Car B	Car C
Assembly Machine	25.5	15	20
Handlers	42.5	41.5	30
Industrial Robot	14	18.5	20
Tools	23.5	25.5	20

With the purpose of responding to the demand in the market, there are some constraints about the numbers in producing the car. First, Car A should be manufactured less than 15 units. Second, production of Car B should be exact of 5 units. Lastly, a least one unit of Car C should be provided. Still, at least 5 units of each car type should be produced in order to meet the customer needs as well as maximize the revenue.

In order to optimize the resource allocation based on the criteria as mentioned earlier, linear programming method is used to find out the best arrangements of the resource.

Table 48 Manufacturing Constraints

	Equipment	Car A	Car B	Car C	Capacity Used (in hour)	Maximum Capacity	Number of Cars Produced
CONSTRAINTS	Assembly Machine	25,5	15	20	1138	2000	
	Handlers	42,5	41,5	30	1865	2500	
	Industrial Robot	14	18,5	20	983	1000	
	Tools	23,5	25,5	20	1160	1800	
	Minimum car A	1			15	≤	15
	Minimum car B		1		5	=	5
	Minimum car B			1	34	≥	1

Based on the table above, the suggested amount of Car A, Car B, and Car C to be manufactured is 15 units, 5 units, and 34 units respectively. As regards to seeking the maximum revenue, the table below shows the detailed of the optimum revenue could be gained by the company based on the number of produced cars and sales revenue per unit.

Table 49 Linear Programming Result

	Car A	Car B	Car C	Maximum Revenue
Decision Variable	15 units	5 units	34 units	**€ 101,000**
Sales Revenue per unit	€2,000	€2,300	€1,750	

To sum up, the company should make 15 units of Car A, 5 units of Car B, and 34 units of Car C to achieve the maximum sales revenue of €101,000.

Step 2 – Decrease Costs

After finding the most optimal quantity for producing the car in order to get the maximum revenue, the next step is to find the minimum possible production costs in order to reduce the cost as much as possible.

In assessing the costs, there are some additional constraints should be considered, including the maximum capacity of each equipment as well as manufacturing cost based on different types of equipment. The detailed information is provided below.

Table 50 Manufacturing Cost per Hour to Produce the Car

Company	Equipment	Manufacturing Cost			
		Assembly Machine	Handlers	Industrial Robot	Tools
	Company A	€ 15	€ 25	€ 20	€ 25
	Company B	€ 25	€ 13	€ 28	€ 22
	Company C	€ 21	€ 17	€ 18	€ 27
	Company D	€ 18	€ 23	€ 25	€ 20
	Required Capacity	1138	1865	983	1160

Meanwhile, each equipment provided by different companies has a variety of maximum capacity of production, which can be seen in *Table 52*.

Table 51 Maximum Equipment Capacity of Each Company

Company	Equipment	Capacity (in Hours)			
		Assembly Machine	Handlers	Industrial Robot	Tools
	Company A	750	575	215	300
	Company B	275	1000	250	575
	Company C	375	885	800	415
	Company D	555	875	175	875
	Required Capacity	1955	3335	1440	2165

After applying linear programming (LP) method, it is found that minimum possible cost for the car manufacturing is € 87,750, with the allocation of resources scattered amongst the ecosystem members. Below is the detailed linear programming calculation to find out the minimum production cost in order to maximize the profit.

Table 52 Resource Allocation among the Ecosystem Member

Company	Equipment	Operational Time			
		Assembly Machine	Handlers	Industrial Robot	Tools
	Company A	750	0	183	0
	Company B	0	1000	0	285
	Company C	0	865	800	0
	Company D	388	0	0	875
	Total	1138	1865	983	1160
	Required Capacity	1138	1865	983	1160

In this case, the maximum capacity of each equipment as shown in *Table 52*, as well as the total capacity required as found in the bottom of *Table 53*, are the constraints of the computation. The allocation of the equipment is required in order to fulfill the amount of the expected capacity, which at the same time to decrease the total production costs.

Appendix I: Goal Analysis Shopify

Current level of the capabilities possessed by each company in providing payment solutions is shown below:

Table 53 Capabilities of each Payment Solution Provider[29]

Capabilities / Providers	Security	Accessibility	Compatibility	Easiness
Shopify Payments[30]	++	-	++	+
Amazon Pay[31]	+	+	++	+
PayPal[32]	-	++	+	++
Apple Pay[33]	++	--	--	+
Priority	1	3	4	2

Note:
++: 0.4 : 1st priority (highest)
+ : 0.3 : 2nd priority
- : 0.2 : 3rd priority
-- : 0.1 : 4th priority (lowest)

The value provided in the given table presented based on the information gathered from online sources, which are also mentioned in the footnotes.

Security is related to how secure can be made through particular payment gateway. As the security is the most important factor in the transactions, it is assumed that security is the highest priority to be considered of a payment gateway provider. Stripe, which is the company who runs the service for Shopify Payments, has the feature not to send the credit card data to the server, which makes the payment process much secure. Apple Pay uses mobile payment method so the retailer cannot retrieve any credit card information, which should prevent fraud. Therefore, those payment gateways are considered as the best ones in terms of security. Although a lot of people think that PayPal is a safe payment method, several sources [34] claimed that it is quite easy to steal PayPal credentials, which makes it is considered not too secured. Meanwhile, Amazon Pay is considered quite secure, but the company has to consider that there might be a crucial security flaw in its SDK. This security flaw lead to the losses for some web store owners, because a lot of malicious shoppers can shop for free[35]. Although they already fix the problem, it should be noted that Amazon Pay might have security issue. Based on the facts, the scores regarding the security of each payment provider is provided, as shown in *Table 54*.

For the accessibility, which regards to the countries available for their service, Shopify Payments by Stripe has a quite low score. This happens because currently Stripe is only available in around 20 countries. In contrast, PayPal is supported in more than 200 countries, which explains why PayPal is considered as the most common payment gateway to be used, and followed by Amazon Pay which supports payment in around 60 countries. As for Apple

[29] https://payment-gateway.financesonline.com/
[30] https://reviews.financesonline.com/p/stripe/; https://memberful.com/blog/stripe-vs-paypal/
[31] https://reviews.financesonline.com/p/amazon-payments/#features; https://talkroute.com/google-vs-amazon-vs-paypal-which-online-payment-solution-is-right-for-you/
[32] https://reviews.financesonline.com/p/paypal-payments-pro/#features;
[33] https://www.reddit.com/r/Bitcoin/comments/2psmrk/can_someone_compare_bitcoin_vs_apple_pay/; http://time.com/money/4068133/apple-samsung-android/
[34] http://bgr.com/2016/01/04/paypal-account-security-hackers/; http://tech.newstatesman.com/security/paypal-breach-highlights-dependence
[35] https://www.microsoft.com/en-us/research/publication/how-to-shop-for-free-online-security-analysis-of-cashier-as-a-service-based-web-stores/?from=http%3A%2F%2Fresearch.microsoft.com%2Fapps%2Fpubs%2Fdefault.aspx%3Fid%3D145858

Pay, it is currently only available in less than 20 countries, which makes it as the least desirable payment method in terms of its accessibility.

As for the compatibility, it shows whether the payment gateway is compatible to be used in various devices with different operating system. In *Table 54*, it can be seen that Apple Pay has the lowest score, because it can only be used in Apple devices with certain version of operating system. Meanwhile, Amazon Pay can be considered as a quite comprehensive payment method that supports various devices. Even, they provide special feature for different devices which makes it as the best one, in terms of compatibility. As previously mentioned, PayPal is the most common payment gateway that support all kinds of online vendors. However, their mobile application is not fully optimized for in-stores transactions. Stripe, as the Shopify payment gateway is compatible with various kinds of device, with much more features available than PayPal, which makes it better in terms of compatibility.

In this case, the easiness is related to the easiness of use of the payment gateway for the buyers of a web store. Basically, the easiness of use for all payment gateways are quite similar, except for PayPal. A lot of buyers mentioned that PayPal is the easiest one if compared to other payment methods. Therefore, *Table 54* shows that PayPal has the highest score of easiness.

As an additional information, the priority mentioned in the table is only an assumption. Moreover, each notation in the table shows different value, which refers to the note provided besides the table. Afterwards, the priority will also be converted into the numbers, where the biggest value means the highest priority. After converting the notation into the given value, weighted average between the options can be computed. The table below shows the value of each capability, as well as the result of applying the weighted average calculation, with the purpose to find the right company to provide the best payment gateway solution.

Table 54 Capabilities of Each Payment Solution Provider

Capabilities / Providers	**Security**	**Accessibility**	**Compatibility**	**Easiness**	**Weighted Average**
Shopify Payments	0,4	0,2	0,4	0,3	0,33
Amazon Pay	0,3	0,3	0,4	0,3	0,31
PayPal	0,2	0,4	0,3	0,4	0,31
Apple Pay	0,4	0,1	0,1	0,3	0,28
Priority	0.4	0.2	0.1	0.3	

The table shows that Shopify Payments by Stripe has the biggest weighted average value, which means the current situation is the most desirable. Thus, it is recommended for Shopify to keep acquiring the service from Stripe as the partner for providing the payment gateway solution. The results of the analysis can also be modeled into a single image, as shown in figure below.

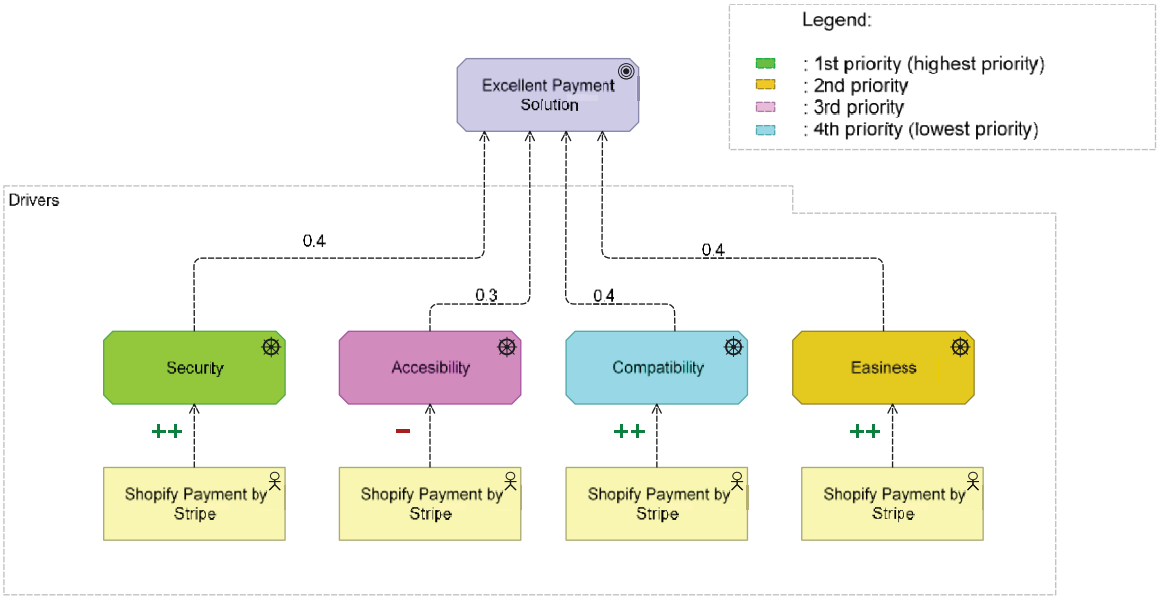

Figure 48 Modeling Goal Analysis towards Excellent Payment Solution

Another analysis is also needed to find out which company can support Shopify to achieve customer satisfaction by providing the best logistics service required for the webstore. The capabilities required to provide an excellent logistics service includes availability of inventory management, warehouse locations, and the coverage area for shipping.

Inventory management is important in managing the inventory, as it shows the flow of the goods. Warehouse is also considered needed for the merchant, as it can indirectly reduce the delivery time, as well as enable the merchant to store the goods remotely. Logistic is closely related to shipping. Therefore, merchants will take into consideration whether the logistics partner provided support international shipping or domestic area only.

After having more understanding regarding the capabilities required, more information about the quality of the services provided by each logistics provider is needed. As an additional information, the quality level provided in the following table is only an assumption, based on the information found on the online sources. Below is the information regarding the logistics and fulfillment services provided by Shopify partners:

Table 55 Capabilities of Each Fulfillment Service Provider

Capabilities / Providers	Shipping Area	Warehouse Location	Inventory Management
Amazon (FBA)[36]	++	++	++
Rakuten[37]	++	-	+
Shipwire	++	+	-
Priority	2	3	1

Note:
++: 0.4
+ : 0.3
- : 0.2
-- : 0.1
: 1st priority (highest)
: 2nd priority
: 3rd priority (lowest)

For shipping area, it is considered that the score is high for all providers, because all of them provide international shipping throughout the world. As for the warehouse location, Amazon FBA is considered as the best as they have a lot of warehouses in the USA, Europe, Asia, and

[36] https://services.amazon.com/global-selling/fulfillment-overview.html#
[37] https://www.nchannel.com/blog/3rd-party-fulfillment-services-fulfillment-by-amazon-fba-alternatives/

even Africa. Meanwhile, Shipwire only have several warehouses in the USA, two warehouses in Europe, one in Asia, and one in Australia. Followed by Rakuten that possessed the warehouses only in the USA, which also explains why it scores the lowest compared to other providers. As for inventory management, Amazon has the most features required for analyze the metrics to understand the sales trends, which is also support store integrations. Meanwhile, Shipwire Inventory Manager displays only inventory counts and status in tabular format. Although it is much simpler than inventory management of Amazon FBA, Shipwire Inventory Manager is considered not to provide too many features for managing the inventory. Thus, it has the lowest score if compared to other providers.

Afterwards, having more understanding regarding the scoring of each aspect, the information in the given table above can be transformed into numerical values, which are required to calculate the weighted average of each company. The result of the analysis to find out which provider provides the best capabilities is shown in the following table.

Table 56 Capabilities of Each Fulfillment Service Provider

Capabilities / Providers	Shipping Area	Warehouse Location	Inventory Management	Weighted Average
Amazon (FBA)	0.4	0.4	0.4	0.4
Rakuten	0.4	0.2	0.3	0.31
Shipwire	0.4	0.3	0.2	0.28
Priority	0.3	0.2	0.5	

The provided table leads to the conclusion that Fulfillment by Amazon (FBA) can provide the best logistics service, which is also shown by the biggest weighted average value. Therefore, it is better to focus on partnering with Amazon as the logistics provider, in order to bring better service to the merchant, which can lead to customer satisfaction.

To provide an overview, the result in the table can also be illustrated into a model, which is shown in *Figure 49*. Afterwards, another model to illustrate the result of the analysis is presented, as can be found in *Figure 50*.

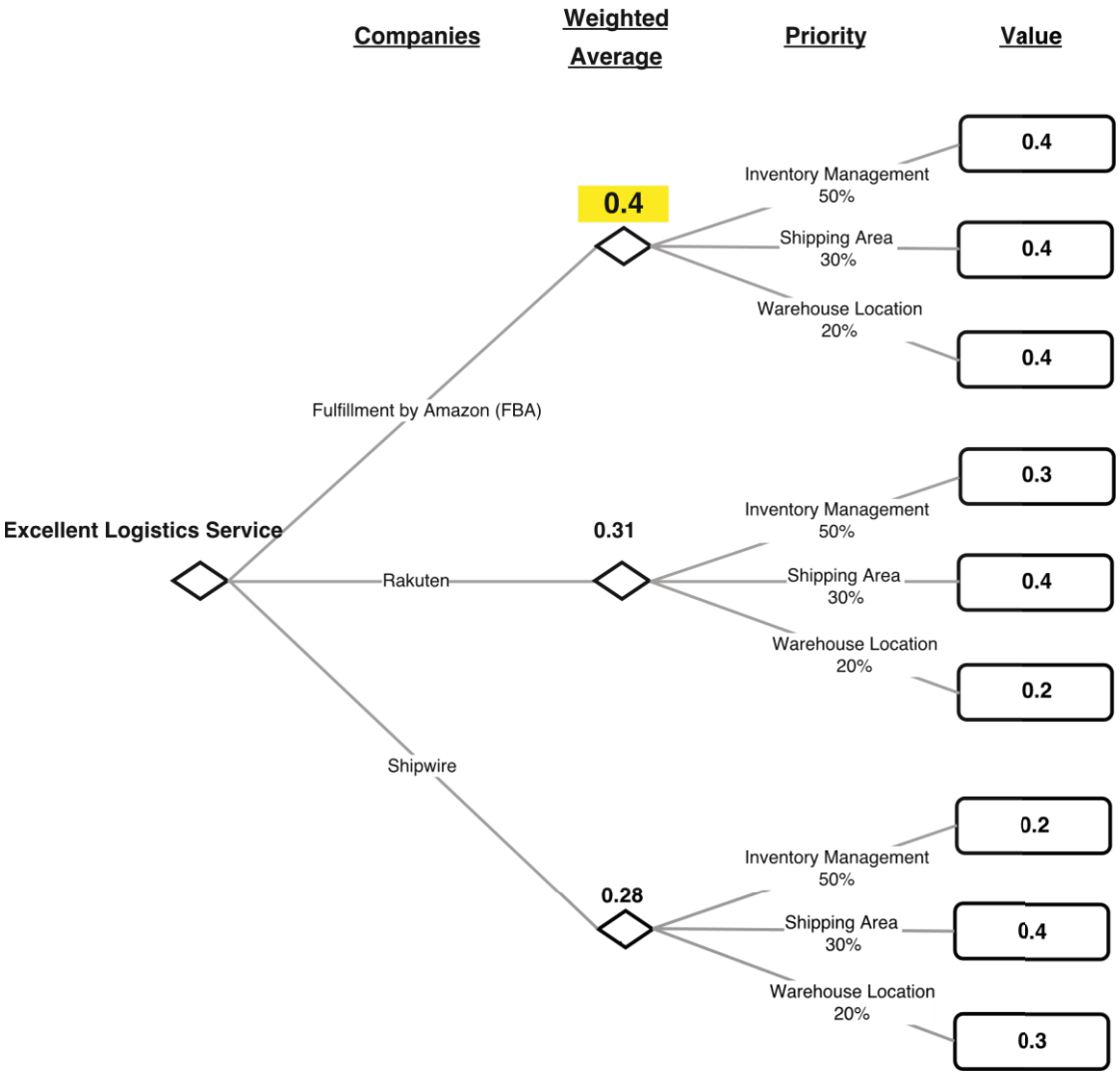

Figure 49 Decision Tree Diagram towards Excellent Logistics Service

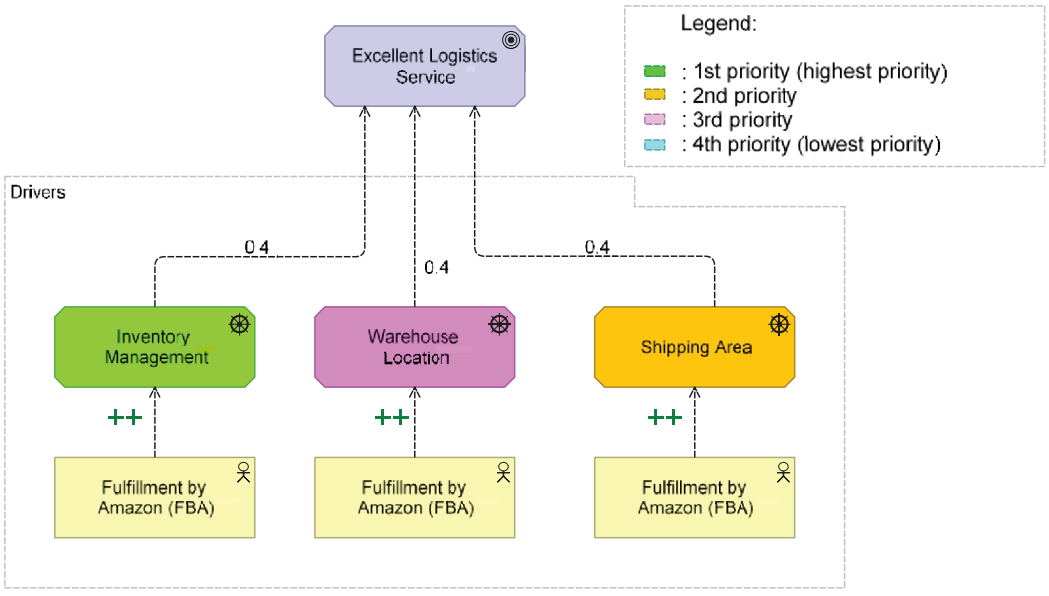

Figure 50 Modeling Goal Analysis towards Excellent Logistics Service

Appendix J: Resource Prioritization Analysis Shopify

It is assumed that Shopify wants to find the partner which provide the best resource. However, the company does not have an understanding regarding the particular resource to be prioritized on. Thus, in order to find the resource to be focused on, a calculation which refers to the analytical hierarchy process (AHP) method will be implemented. Below is the data about the level of criteria possessed by each company:

Table 57 Importance of Criteria of the Resources

Importance of Criteria				
	Knowledge	**Service**	**Pricing**	**Cloud infrastructure**
Knowledge	1,00	0,40	0,13	0,23
Service	2,50	1,00	0,11	0,13
Pricing	7,98	8,84	1,00	0,19
Cloud infrastructure	4,44	7,75	5,36	1,00
Sum	15,92	17,99	6,60	1,54

After having the data, the next step is to find out the normalized matrix. Below is the result of calculating the normalized matrix:

Table 58 Normalized Matrix of the Criteria

Normalized Matrix					**Weights**
Knowledge	0,06	0,02	0,02	0,15	0,06
Service	0,16	0,06	0,02	0,08	0,08
Pricing	0,50	0,49	0,15	0,12	0,32
Cloud infrastructure	0,28	0,43	0,81	0,65	0,54
Checksum	1	1	1	1	1

Based on the table above, cloud infrastructure is considered as the resource to be prioritized on, as it has the biggest weight of 0.54. Thus, it is recommended for Shopify to focus on the cloud infrastructure of partner in order to provide a better service to the merchants.

Currently, there are a lot of cloud providers that offer content delivery network (CDN), such as Amazon Cloud Front, Google Cloud CDN, IBN CDN, and many more. As for now, Shopify cooperates with Fastly in bringing the web hosting to the merchants. Even though Shopify already acquired the service from Fastly, it still should be assessed whether Shopify should continue cooperating with them, or it is better for Shopify to find a new partner that can provide a better cloud service. Therefore, the analysis conducted in this step is not only to assess the current members, but also to look for new opportunity of cooperating with a new member that can provide the best cloud infrastructure for Shopify.

Following is the data of the providers, along with the scale of choices. Afterwards, the data is used to calculate the normalized matrix, which later will be used to determine the company with the best marketing tools.

Table 59 Evaluation of Choices

Evaluation of Choices (Scale 1-10)				
Fastly CDN	1,00	3,00	2,00	1,50
Google Cloud CDN	1,80	2,50	1,50	2,00
IBM CDN	2,50	3,00	2,50	1,50
Amazon Cloud Front	3,00	2,50	2,00	2,50
Sum	8,30	11,00	8,00	7,50

Table 60 Normalized Matrix of Choices

Normalized Matrix				
Fastly CDN	0,12	0,27	0,25	0,20
Google Cloud CDN	0,22	0,23	0,19	0,27
IBM CDN	0,30	0,27	0,31	0,20
Amazon Cloud Front	0,36	0,23	0,25	0,33
Sum	1	1	1	1

Below is the end result of applying AHP method in conducting resource prioritization analysis:

Table 61 AHP Method Result

Determining company with the best cloud service resources	
	Score
Fastly CDN	0,22
Google Cloud CDN	0,24
IBM CDN	0,25
Amazon Cloud Front	0,30

The table shows the result of applying AHP method, cooperating with Amazon Cloud Front is the most desirable, which is shown by the biggest score of 0.29. Therefore, it is recommended for Shopify to cooperating with Amazon Cloud Front, instead of cooperating with Fastly CDN in acquiring the intangible resources, especially as regards to the cloud services. Hence, it is recommended that Shopify add Amazon Cloud Front in the ecosystem and remove Fastly CDN as the cloud provider, in order to provide better services to the merchants, which can lead to customer satisfaction.

Appendix K: Resource Optimization Analysis Shopify

It is assumed that Shopify wants to focus on technological resource in order to provide a better cloud software service. As the service is provided in cloud, Shopify has to acquire a cloud service, specifically content delivery network (CDN) service, which is run by a third-party company.

In running a CDN service, there are a lot of technological resources involved, especially related to the computing hardware, such as cloud server, virtual machine, network infrastructure, and so on. All of the services are available in different service cost.

In order to give a better service to the customer, Shopify has to assess the best cloud provider that can provide the best CDN service in the minimum cost. Thus, a resource optimization analysis is conducted, as explained below.

Step 1 – Increase Revenue

First, in order to increase the revenue, Shopify has to get the most optimal numbers of the merchants to be served. In addition, Shopify also has to ensure, whether the cloud provider is able to provide the capacity required for Shopify to give a cloud software service to their customers. Therefore, a linear programming calculation to find the number of merchants should be served in order to get the most optimal revenue is provided below:

It is assumed that there is a maximum capacity for the cloud provider in providing the bandwidth for each hardware. Detailed information about the bandwidth capacity can be found in the following table:

Table 62 Bandwidth Capacity of Each Hardware

Computing Hardware	Bandwidth capacity (in GB)
Cloud Server	195,950
Virtual Machine	245,000
Network Infrastructure	185,000

Meanwhile, Shopify provides the service to the various types of merchant, including online store, Point-of-Sale (POS) Retail, and enterprise. Each type of merchant consumes different amount of bandwidth in acquiring the service from Shopify. Therefore, an additional information regarding the number of bandwidth consumed for providing the service to different types of merchant is provided as follows:

Table 63 Total Bandwidth Consumed by Various Merchants

Computing Hardware	Online Store	POS	Enterprise
Cloud Server	100	75	350
Virtual Machine	150	100	500
Network Infrastructure	135	115	400

After having the required information, the analysis to find out the most optimal revenue can be provided. However, it should be taken into consideration that several constraints may apply.

As to answer the market demand, it is better for Shopify to provide the service to less than 500 online store merchants, exact 175 merchants of POS, and more than 150 enterprise merchants. As an additional information, revenue from providing service for online store merchant, POS merchant, and enterprise merchant are $1,500, $1,250, and $2,000 respectively. With the objective to find the maximum revenue can be generated by Shopify, a linear programming calculation is done, as described below:

Table 64 Constraints

	Hardware	Online Store	POS	Enterprise	Total Bandwidth used (GB)	Maximum Bandwidth	Number of Merchant
CONSTRAINTS	Cloud Server	100	75	350	148,175	195,950	
	Virtual Machine	150	100	500	214,000	245,000	
	Network Infrastructure	135	115	400	184,825	185,000	
	Online Store	1			500	<	500
	POS		1		175	=	175
	Enterprise			1	243	>	150

The table shows the constraints required in implementing the calculation. The end result, which also shows the numbers of the merchants should be served by Shopify is provided below:

Table 65 Linear Programming Result

	Online Store	POS	Enterprise	Maximum Revenue:
Decision Variable	500 merchants	175 merchants	243 merchants	**$1,454,750**
Service Revenue	$1,500.00	$1,250.00	$2,000.00	

Based on the table, it can be concluded that Shopify has to served 500 online store merchants, 175 POS merchants, and 245 enterprise merchants in order to reach the maximum revenue of $1,454,750.

Step 2 – Decrease Cost

After finding the most optimal number of the merchants to be served in order to get the higher revenue, the next step is to find the minimum possible cost in order to reduce the cost as possible.

Provided below is the cost of providing cloud service for each type of cloud hardware:

Table 66 Cost of Providing Cloud Service (per GB)

		Online Store	POS	Enterprise
Providers	**Cloud Server**	$1,3	$1,1	$1,8
	Virtual Machine	$1,3	$0,9	$1,6
	Network Infrastructure	$1,3	$1,2	$1,4

In assessing the cost, there is an additional constraint that should be considered, specifically the maximum capacity can be provided by each hardware. As different cloud providers may offer different capacity for each hardware, it should be analyzed which of the company can provide the most beneficial service for Shopify. The capacity of each hardware provided by different providers is shown in the following table:

Table 67 Maximum Bandwidth Provided by Each Company (in GB)

Providers		Online Store	POS	Enterprise
	Cloud Server	85,000	80,000	90,000
	Virtual Machine	80,000	85,000	95,000
	Network Infrastructure	83,000	80,000	85,000

After having the information regarding the hardware cost for each provider, as well as the maximum capacity, the next step is to analyze the resource in order to find the most optimum allocation. A linear programming method calculation is implemented in order to analyze the resource allocation. The detailed calculation regarding the analysis is provided below:

Table 68 Allocation of Bandwidth for each Hardware (in GB)

Merchants / **Hardware**	**Cloud Server**	**Virtual Machine**	**Network Infrastructure**
Fastly CDN	49,625	80,000	4,750
Amazon Cloud Front	49,625	85,000	95,000
IBM CDN	49,625	50,000	85,000
Total Bandwidth	148,875	215,000	184,750
Required Bandwidth to be Used	148,875	215,000	184,750
Minimum Cost	**$697,588**		

Based on the example, it can be said that the analysis is useful for the company to find new opportunities for the ecosystem, which in this case is to maximize the allocation of the resource, specifically in the hardware bandwidth distribution. In this step, the hardware distribution refers to the demand of the market, which is shown in the first step of resource optimization. Thus, this assessment provides an overview of the number of the merchants should be reached by the company in order to get a higher revenue, as well as the number of the cost should spend by the company in order to minimize the costs. By having this knowledge, it is expected that the information could aid Shopify to create future goals.

Appendix L: Items of UTAUT

Table 69 Items Used in Estimating UTAUT (*Venkatesh et al., 2003*)

Construct	Definition	Items	Root Constructs
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	U6: I would find the system useful in my job. RA1: Using the system enables me to accomplish tasks more quickly. RA5: Using the system increases my productivity. OE7: If I use the system, I will increase my chances of getting a raise.	Perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT)
Effort Expectancy	The degree of ease associated with the use of the system	EOU3: My interaction with the system would be clear and understandable. EOU5: It would be easy for me to become skillful at using the system. EOU6: I would find the system easy to use. EU4: Learning to operate the system is easy for me.	Perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT).
Attitude towards Using Technology	An individual's overall affective reaction to using a system	A1: Using the system is a bad/good idea. AF1: The system makes work more interesting. AF2: Working with the system is fun.	Attitude toward behavior (TRA, TPB/DTPB, C-TAMTPB), Intrinsic motivation (MM), Affect toward use (MPCU), and Affect (SCT)
Social Influence	The degree to which an individual perceives that important others believe he or she should use the new system	SN1: People who influence my behavior think that I should use the system. SN2: People who are important to me think that I should use the system. SF2: The senior management of this business has been helpful in the use of the system. SF4: In general, the organization has supported the use of the system	Subjective norm (TRA, TAM2, TPB/DTPB, and C-TAM-TPB), Social factors (MPCU), and Image (IDT)
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system	PBC2: I have the resources necessary to use the system. PBC3: I have the knowledge necessary to use the system. PBC5: The system is not compatible with other systems I use. FC3: A specific person (or group) is available for	Perceived behavioral control (TPB/ DTPB, C-TAM-TPB), facilitating conditions (MPCU), and compatibility (IDT)

		assistance with system difficulties.	
Self-efficacy	Judgment of one's ability to use a technology (e.g., computer) to accomplish a particular job or task	I could complete a job or task using the system… SE1: If there was no one around to tell me what to do as I go. SE4: If I could call someone for help if I got stuck. SE6: If I had a lot of time to complete the job for which the software was provided. SE7: If I had just the built-in help facility for assistance.	Self-efficacy (SCT)
Anxiety	Evoking anxious or emotional reactions when it comes to performing a behavior (e.g., using a computer)	ANX1: I feel apprehensive about using the system. ANX2: It scares me to think that I could lose a lot of information using the system by hitting the wrong key. ANX3: I hesitate to use the system for fear of making mistakes I cannot correct. ANX4: The system is somewhat intimidating to me.	Anxiety (SCT)
Behavioral Intention to Use	A person's perceived likelihood or subjective probability that he or she will engage in a given behavior	BI1: I intend to use the system in the next <n> months. BI2: I predict I would use the system in the next <n> months. BI3: I plan to use the system in the next <n> months.	Attitude Toward Behavior (TRA, TPB/DTPB, C-TAMTPB), Perceived behavioral control (TPB/ DTPB, CTAM- TPB), Intrinsic motivation (MM)

Appendix M: Formulating Questionnaire Statements

Table 70 Items for Estimating UTAUT That Are Used in Formulating Questionnaire Statements

Construct	Definition	Items	Root Constructs
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.	U6: I would find the system useful in my job (PE1) RA1: Using the system enables me to accomplish tasks more quickly (PE2) RA5: Using the system increases my productivity (PE3)	Perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT)
Effort Expectancy	The degree of ease associated with the use of the system	EOU5: It would be easy for me to become skillful at using the system (EE4) EOU6: I would find the system easy to use (EE5) EU4: Learning to operate the system is easy for me (EE6)	Perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT).
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system	PBC2: I have the resources necessary to use the system (FC8) PBC3: I have the knowledge necessary to use the system (FC7) PBC5: The system is not compatible with other systems I use (FC9)	Perceived behavioral control (TPB/ DTPB, C-TAM-TPB), facilitating conditions (MPCU), and compatibility (IDT)
Self-efficacy	Judgment of one's ability to use a technology (e.g., computer) to accomplish a particular job or task	I could complete a job or task using the system… SE4: If I could call someone for help if I got stuck (SE10) SE7: If I had just the built-in help facility for assistance (SE11)	Self-efficacy (SCT)
Behavioral Intention to Use	A person's perceived likelihood or subjective probability that he or she will engage in a given behavior	BI1: I intend to use the system in the next <n> months (BI12) BI2: I predict I would use the system in the next <n> months (BI13) BI3: I plan to use the system in the next <n> months (BI14)	Attitude Toward Behavior (TRA, TPB/DTPB, C-TAMTPB), Perceived behavioral control (TPB/ DTPB, CTAM-TPB), Intrinsic motivation (MM)

Appendix N: Workshop Questionnaire

Modeling and Analyzing Digital Business Ecosystems Questionnaire

Thank you for participating in the Modeling and Analyzing Digital Business Ecosystems Survey. The purpose of this survey is to validate the proposed approach for modeling and analyzing digital business ecosystems, and to get a better understanding of the acceptance of the proposed approach. It will take approximately 10 minutes to complete this survey.

The main objective of modeling and analyzing digital business ecosystems is to support value co-creation for organizations and customers. The approach provided in this study is expected to help organizations in finding the potential opportunities in an ecosystem or to optimize an ecosystem. The modeling in this approach refers to ArchiMate standards, while the analyses consist of profitability analysis, goal analysis, and resource analysis. Several techniques used for the analyses are financial analysis, decision-tree analysis, linear programming method, and analytical hierarchy process method.

The responses to this survey are anonymous, and the collection and usage of the responses are done while keeping your privacy in mind.

The survey starts with some general questions regarding your background, which is followed by the questions regarding the proposed approach. To be more specific, the survey consists of five parts, and each section discuss:
- The usefulness of using the proposed approach
- The easiness in using the proposed approach
- Additional helps required in using the proposed approach
- Ability to use the proposed approach
- Intention to use the proposed approach in a future work

*Required

Background

1. **What is your position in the company?** *

2. **How often do you use business analysis?** *
   Mark only one oval.
   - ◯ Always
   - ◯ Very Often
   - ◯ Sometimes
   - ◯ Rarely
   - ◯ Never

3. **Which of the following method and analysis are you familiar with?** *
   Tick all that apply.
   - ☐ Decision Tree Analysis (Goal Analysis)
   - ☐ Financial Analysis (Profitability Analysis)
   - ☐ Linear Programming method (Resource Prioritization Analysis)
   - ☐ Analytical Hierarchy Process (Resource Allocation Analysis)
   - ☐ Monte Carlo method (Risk Analysis)
   - ☐ Stakeholder Analysis
   - ☐ Other:

Performance Expectancy

4. **Using the proposed approach would improve my job performance** *
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

5. **Using the proposed approach enables me to accomplish tasks more quickly** *
Mark only one oval.

	1	2	3	4	5	
Strongly Agree	◯	◯	◯	◯	◯	Strongly Disagree

6. **Using the proposed approach increases my productivity** *
Mark only one oval.

	1	2	3	4	5	
Strongly Agree	◯	◯	◯	◯	◯	Strongly Disagree

Effort expectancy

7. **It would be easy for me to become skillful at using the proposed approach** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. **Overall, I believe that the proposed approach is easy to use** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. **Learning to use the proposed approach is easy for me** *
Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

Facilitating Conditions

10. **I have the knowledge necessary to use the proposed approach** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

11. **I have the resource necessary to use the proposed approach** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. **I think that using the proposed approach fits well with the way I like to work** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Self-efficacy

13. **I would use the proposed approach if could get a help from someone if I got stuck** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

14. **I would use the proposed approach if there is built-in guide for assistance** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Behavioral Intention to Use

15. **I intend to use the proposed approach in the future to help me completing my job in dealing with clients** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

16. **I predict that I would use the proposed approach in the future to help me completing my job in dealing with clients** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

17. **I plan to use the proposed approach in the future for helping me in dealing with the clients** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Additional Feedback

18. **Please state any additional feedback regarding the proposed approach**

Figure 51 Workshop Questionnaire

Appendix O: Questionnaire Result

Table 71 Questionnaire Result

Question		N	R1: Technical Writer	R2: Research Consultant	R3: Research Consultant	R4: R&D Team Leader	Min	Max	Sum	Mean	SDEV
PE1		4	3	4	3	4	3	4	14	3.5	0.577
PE2		4	3	3	3	3	3	3	12	3	0
PE3		4	3	3	3	3	3	3	12	3	0
EE4		4	3	4	4	4	3	4	15	3.75	0.5
EE5		4	3	5	4	3	3	5	15	3.75	0.957
EE6		4	3	4	4	4	3	4	15	3.75	0.5
FC7		4	1	3	4	4	1	4	12	3	1.414
FC8		4	1	4	3	4	1	4	12	3	1.414
FC9		4	1	5	4	4	1	5	14	3.5	1.732
SE10		4	4	3	3	4	3	4	14	3.5	0.577
SE11		4	4	5	3	4	3	5	16	4	0.816
BI12		4	3	2	4	4	2	4	13	3.25	0.957
BI13		4	3	2	3	4	2	4	12	3	0.816
BI14		4	3	3	3	4	3	4	13	3.25	0.5
Average PE		-	3	3.333	3	3.333	3	3.333	12.667	3.167	0.192
Average EE		-	3	4.333	4	3.667	3	4.333	15	3.75	0.652
Average FC		-	1	4	3.667	4	1	4.333	12.667	3.167	1.520
Average SE		-	4	4	3	4	3	4.5	15	3.75	0.697
Average BI		-	3	2.333	3.333	4	2.333	4	12.667	3.167	0.758

Note:
N : Total number of participants
R : Respondent
Min : Highest score for each statement
Max : Lowest score for each statement
Sum : Total score from all participants for each statement
Mean : Average of total score
SDEV : Standard deviation