UNIVERSITY OF TWENTE.

Faculty of Electrical Engineering, Mathematics & Computer Science

Project Portfolio Valuation with Enterprise Architecture

Anastasia Maria Krisnawati
M.Sc. Thesis
August 2015

BiZZdesign

Supervisors:
Dr. Maria-Eugina Iacob
Dr. Ir. Marten J. van Sinderen
Dr. Lianne Bodenstaff

MASTER THESIS

PROJECT PORTFOLIO VALUATION WITH ENTERPRISE ARCHITECTURE

ANASTASIA MARIA KRISNAWATI

S1341677

anastasiamariakrisnawati@student.utwente.nl

Master of Science in Business Information Technology

University of Twente

Enschede, The Netherlands

Graduation committee

Dr. Maria-Eugenia Iacob, University of Twente

Dr. Ir. Marten J. van Sinderen, University of Twente

Dr. Lianne Bodenstaff, BiZZdesign

Acknowledgement

Praise the Lord, for His blessing and giving me strength so that I can finish my master degree study at University of Twente.

This thesis report is the result of my final project for Business Information Technology MSc program at University of Twente. The research has been conducted as a graduate internship assignment at BiZZdesign B.V. It has been a very challenging yet gives me valuable learning experience. Thus, I would like to acknowledge the people that support, encourage and contributed to this work.

Firstly, I would like to give my gratitude to my supervisors from University of Twente: Ms. Maria Iacob and Mr. Marten van Sinderen for their guidance, critical feedback and helpful input so that I can finish my thesis. My sincere thanks also to Ms. Lianne Bodenstaff from BiZZdesign for her support, motivation, guidance and helpful input. I would like to pay my thanks to Mr. Dick Quartel for giving me the opportunity doing internship in BiZZdesign and give freedom of choosing my research topic. I would not have been able to finish this thesis graduation assignment without all of your support.

Secondly, I would like to thank the Ministry of Communication and Information Technology of the Republic of Indonesia (MCIT), to give me the opportunity in pursuing my master study through its scholarship program.

Thirdly, to all my friends in Enschede who color my life here. Retno, Rindia, Iwan and all PPIE members that make me feel like home in Enschede. Shu and Zaharah, who always motivate and make seven months doing internship and working on my thesis is enjoyable. Diego and Hao Ding, who often be my teammates. Special thanks to Uli, Anisah and Sanny for continuous support and motivation to finish this thesis and our study in Europe.

Last but not least, I would like to thank my beloved family in Indonesia: Bapak, Mama, Siska and Rio for your everlasting support and never-ending prayers

Enschede, August 2015

AM Krisnawati

Executive Summary

In the dynamic environment nowadays, organizations are required to transform continuously and steadily improve their current situation in order to achieve their goals. This transformation process could be accomplished by executing a number of projects periodically. As consequence, the ability to assess and prioritize the projects becomes highly important, which is achieved by performing a project portfolio valuation. However, this process in practice is often solely based on manager's personal belief or by using minimal portfolio method. Therefore, this research aims at finding an approach to improve the decision making in project portfolio valuation.

Enterprise Architecture (EA) is a comprehensive concept that illustrates the business process, application and infrastructure that could be used throughout the entire process, starting from the design, analysis and transformation phase of the organization. In this study, we explore the potential of using the information from EA for project portfolio valuation. Firstly, different project portfolio methods are evaluated based on specified criteria. The criteria consist of the possibility of using the information from EA and that the evaluation should be as comprehensive as possible; e.g. based on financial, non-financial and risk.

EA-based Investment Portfolio method is introduced and designed based on Investment Portfolio method combine with the information that is obtained from the architecture. Three domains that are subjected to assessment are: business domain, technology and financial domain. For the first two domains, the factors from Information Economics method are adopted to score the projects. The scoring process is performed by combining the original IE score card and the information from EA. Subsequently, the result of the appraisal process is visualized in the bubble chart and used to specify the project prioritization.

ArchiPharma case study is carried out to demonstrate the application of the proposed method. Semi-structured interviews with four research and business consultants are conducted to evaluate the ease of understanding, the applicability, and the usefulness of the proposed method. In conclusion, EA-based Investment Portfolio Method is able to facilitate the project portfolio valuation with a comprehensive justification. It also reveals the importance of collaboration between EA and PPM (Project Portfolio Management) in the practice.

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1. Introduction

This chapter describes an overview of the problem statement that motivates the research, which is followed by the research goal. Subsequently, main objective of the study and three research questions are formulated as the structural basis to conduct the research. Lastly, the research methodology chosen to be carried out in the research is elaborated and concluded by the structure of the thesis report.

1.1 Problem Statement

Project portfolio selection and associated activity of managing selected projects throughout their lifecycles are important activities in many organizations (Archer & Ghasemzadeh, 1999). At the beginning of a year, a semester, or a quarter, the executive board in an organization will have to reach an important decision to select and execute a number of critical project proposals. The list of the projects in an organization, either public or commercial, can be influenced by internal and external factors. Internally, an organization needs to transform the current situation into a better condition in the future based on their goals, by executing the critical projects. Externally, they need to face and deal with their changing environment in their business. For example, the projects could be proposed to meet customers' demands, adapt to new regulations, etc. Thus, selecting and ranking the proposed projects is an initial and important activity for an organization.

Nowadays, most modern organizations are all heavily dependent on the smooth operation of Information System (IS) to support their industrial production, service provision, and business administration (Deng & Wibowo, 2008). Thus, a number of proposed IT projects will continue to exist depending on the necessity of the organization. With the increasing number and complexity of IT projects, the tension to make timely decisions in fluctuating environments intensifies the difficulty in ranking the projects. Proper justification is needed to be able to come up with a ranking list that accommodates different perspectives; e.g. multiple selection criteria, a possibility of subjective assessments, budget constraints, overlapping with other projects, and the organization's strategy alignment.

Along with the aforementioned issues, a structured and comprehensive approach is required to analyze the given list of the IT projects. Moreover, this approach is expected to optimize a particular goal that the organization considers as the most important one. By this means, Enterprise Architecture(EA) gives a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure (Lankhorst, 2005). With the use of

enterprise architecture (EA)-based method, an organization can have a holistic view of the enterprise as the basis of their analysis process. (Jensen, Cline, & Owen, 2011)

Furthermore, according to Martin Op't Land et al., a project is aimed to realize parts of the *to-be* situation. In doing so, the projects need to have a clear view of the *to-be* and the *as-is* situation (Op't Land et al., 2009). They also identify seven key applications for EA that provide an instrument to ensure compliance, governance, and informed decision-making regarding the transformation from the *as-is* to the *to-be* situation. Figure 1 highlights these seven applications: situation description, strategic direction, gap analysis, tactical planning, operational planning, selection of partial solutions and solution architecture.
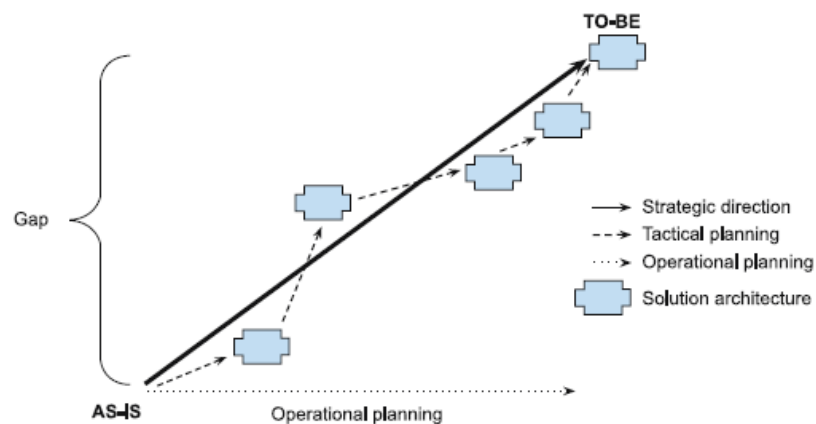
Figure 1: Applications for enterprise architecture (Op't Land et al., 2009).

Hence, the EA-based method can give a comprehensive approach in order to make a list of ranked projects as a means to support the investment decision making process. In spite of this, only a few researches have implemented this approach. Ring S.J. et al. conducted a research of an integrated architecture-based investment decision at the U.S. Department of Defense (DoD), implemented with the linkage of an integrated DoDAF architectures and their portfolio analysis tool(Ring, Lamar, Heim, & Goyette, 2005). Another study by Quartel D. et al. also formalized IT portfolio valuation by using enterprise architecture and business requirements modeling, which is realized using ArchiMate and BiZZdesign Architect (Quartel, Steen, & Lankhorst, 2010).

1.2 Research Goal
The purpose of this research is to develop an EA-based method for project portfolio valuation. The proposed method here is used in the early process of project management in prioritizing a set of projects that needs to be defined in order to transform their organization from the current state to the desired situation in the future. The research focuses on defining the criteria to valuate projects which taking into account financial, non-financial, risk and architecture

perspectives. By conducting a literature study, we develop a comprehensive project portfolio valuation method and use the architecture as an input. Therefore, this thesis aims at finding an approach to improve the decision making of project portfolio valuation using Enterprise Architecture.

1.3 Research Objective and Questions

Based on the goal in the previous section, we define the main objective of this study as follows:

"To develop an EA-based method for project portfolio valuation"

Afterwards, three research questions are formulated to investigate the process of developing the method. The research questions are:

RQ1 . Which project portfolio valuation techniques can be the basis for the EA-based method?
    RQ1.1. What are the existing techniques for project portfolio valuation?
    RQ1.2. What are the criteria for choosing the project portfolio valuation technique?
The first research question and its sub-questions aim to seek the suitable basis method(s) that support the decision making process and could extract the information from EA. After gathering the possible available methods from literature studies, the basis method will be selected based on the defined criteria.

RQ2. How can EA support the project portfolio valuation?
    RQ2.1. What is the relationship between EA and portfolio valuation?
    RQ2.2. What information could be taken from EA to support project portfolio valuation?
The second research question and its sub-questions investigate the concrete information from EA to serve project portfolio valuation. First, the relationship between EA and project portfolio valuation is discussed as the background concept. Afterwards, the potential information that could be used as an input in the portfolio valuation process is presented.

RQ3. How to design an EA-based method for project portfolio valuation?
After addressing the previous research questions and gathering the relevant information, the third research question aims to design the proposed method and achieve the main objective.

1.4 Research Methodology

In this study, the Design Science Research Methodology (DSRM) by Peffers et al. (2008) is carried out to conduct the research. Six activities which are defined in DSRM will be used to address the previous research questions (as illustrated in Figure 2).

- **Problem Identification and motivation**

The importance of establishing a ranking from the given list of projects in an organization is addressed in section1.1. Furthermore, the motivation behind the research conducted in this thesis is also described. As mentioned before, EA-based method is chosen to rank the projects to improve the decision making of project portfolio valuation with comprehensive justification.

- **Define the objectives of a solution**

Research goal is formalized to ensure that the research advances in the intended direction. Afterwards, the main objective and three research questions are determined to elaborate a detailed guideline for achieving the objective of the research.

- **Design and development**

Literature review will be conducted in the research to give an insight into the important concepts related to the proposed method. It is carried out as a part of the development method to investigate various methods that are used to establish a project ranking. After reviewing relevant literatures in order to formulate the important concept of the developed method, an analysis will be carried out by means of making criteria to evaluate the existing method based on BiZZdesign's needs.

- **Demonstration**

The proposed method could be demonstrated to solve one or more instance of the problem using experimentation, simulation, case study, proof or other appropriate activity. In this research, the efficacy of the method is executed by the use of the Archipharma case study from BiZZdesign.

- **Evaluation**

For the evaluation, an interview with EA consultant(s) will be held for further notice on the strength and weaknesses of the method. Analysis of the interview's result will also be carried out by the author.

- **Communication**

In the end, the research is delivered in the form of a thesis report and a presentation to the committee to elaborate the complete processes from problem identification and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness (Peffers et al., 2008).
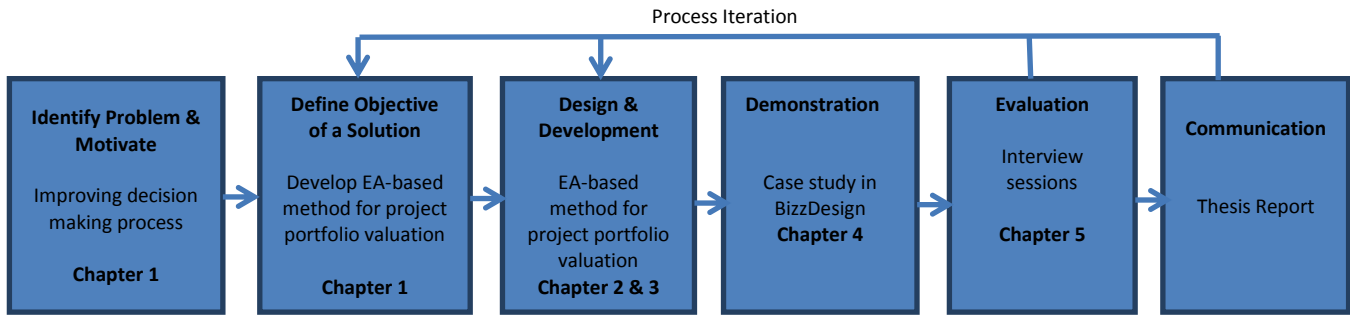
1.5 Structure of the Report

The thesis report is structured in six chapters to communicate the process of defining the method to the readers. Furthermore, it is also the outcome of the thesis project as a whole. As shown in Figure 2, Chapter 1 acquaints the reader to the major highlight of the report. The identification of the research problem and motivation behind it is also defined in Chapter 1 (Introduction). In the next chapter, the summary of literature review about the important concepts and techniques that are related to project portfolio valuation and EA are described. Furthermore, in Chapter 3, the development of EA-based project portfolio valuation method is clarified with the explanation of the selected criteria.

Chapter 4 illustrated the feasibility of the method by using it in Archipharma case study in BiZZdesign that showed the project valuation processes. After showing the implementation of the method, the evaluation of the method is presented in Chapter 5. This chapter aims to evaluate the efficacy of the method by means of interviews. Finally, Chapter 6 comprises the research with the conclusion and answers of the entire research questions. The highlight about the structure of the thesis report is shown in Table 1.

Table 1: Thesis structure

Chapter	Activities	Research Questions
1	**Introduction** Problem identification, motivation, research goal, research objective and questions, and research methodology.	
2	**Literature Review** Theoretical background of key concepts (Strategy, EA and Portfolio Management), Selection of the reference method.	RQ 1 – RQ 2
3	**Design and method development** Design of proposed method.	RQ 3
4	**Demonstration** ArchiPharma case study.	
5	**Evaluation** Interview sessions.	
6	**Conclusion** Answers to research question, research contribution, research limitations, future works and recommendations.	All research questions

2. Theoretical Background

This chapter aims to provide relevant existing literature on the relationship between Business Strategy, Enterprise Architecture, Portfolio Management and Portfolio Management Methods. Section 2.1 underlines the relationships between EA and Portfolio Management, then in Section 2.2 and 2.3 details information about portfolio management and EA is described respectively. Finally, Section 2.4 discusses the existing portfolio management methods.

2.1 Relation between EA and Portfolio Management

As discussed in the Introduction, this research explores the application of using information from EA to improve the decision making of project portfolio valuation. EA is a coherent set of descriptions, covering a regulation-oriented, design-oriented and patterns-oriented perspective on an enterprise which can help organizations and their transformations processes in successfully executing their strategy (Op't Land et al., 2009). While project portfolio valuation is one of the process in the Portfolio Management, which is an approach of managing a collection of projects based on the organization's goals. In this section, the relationship between EA and Portfolio Management is discussed further to get theoretical background for developing an EA-based method for project portfolio valuation.

In order to develop a Project Portfolio Valuation method from EA perspective, the relationship between related fields (Strategy, EA and Portfolio Management) and how they influence each other are explained afterwards. To do so, three (3) sources are discussed to demonstrate the use of Portfolio Management based on an EA perspective by using an EA modeling language. The further discussion is provided in the following paragraphs.

First, M. E. Iacob et al. (2012) identify three related disciplines that need to be aligned with each other in order to achieve certain goals of an organization. They are business strategy, EA and Projects and program that are related to each other and contribute to the success of business requirement management. How those three components are related to each other is shown in Figure 3. In this figure, Projects and programs represents portfolio management.
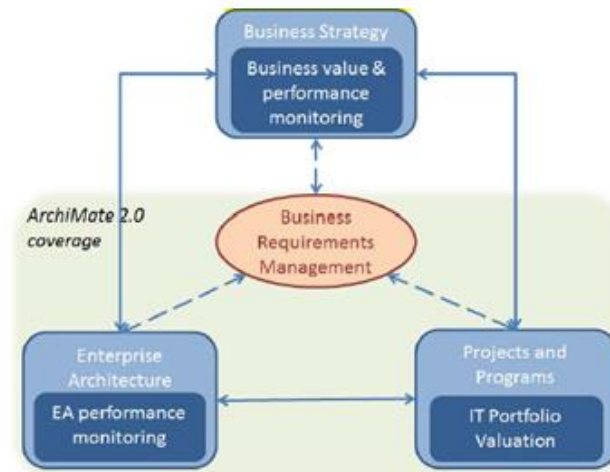
Figure 3: Relationships between three disciplines (Iacob, Quartel, et al., 2012)

Several aspects which are embodied in the business strategy are strategic goals, resources, competencies and capabilities that an organization aims to achieve in the future. Business requirement management derives the strategy into more concrete goals and requirements to form tactical and operational planning. Moreover, some of architecture elements realize these goals and requirements, while others are emphasized on the projects and programs. The dashed arrows among the related fields indicate the indirect contribution of EA and Projects and Programs to the business strategy for the goals and requirements.

Portfolio management uses the tactic that an organization employs to achieve its strategy, whereas the "operation" is captured by the EA via the contribution of IT artifact, such as software services and applications, to improve the business processes, services and products of the organization.

In this research, we mainly focus on the relationship between EA and portfolio management as a means of an organization to evaluate the projects. Furthermore, we investigate the existing methods and techniques for the appraisal of IT investment. More exploration on how EA and portfolio management is investigated in the research in order to assist an organization to reach a better decision making process with holistic consideration in managing their portfolio that eventually lead them to achieve their goals.

The second literature is provided by Bodenstaff et al., (2014) which addressees multiple disciplines ; strategy management, portfolio management and EA (shown in Figure 4) that are involved in the planning and implementation of large business transformation.

They argued that EA provides an organization the basis to analyze and communicate the information on the impact changes to close the gap between strategy planning and implementation.
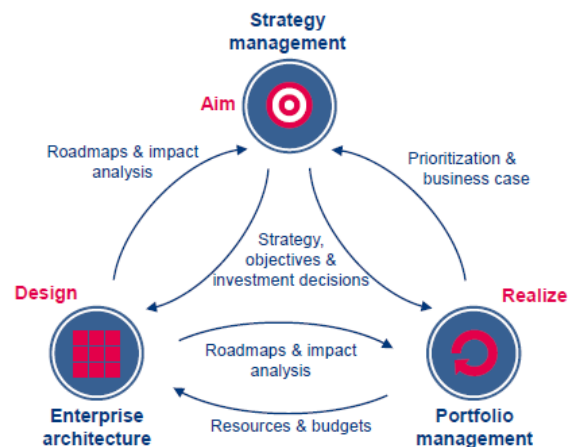
Figure 4: The triangle between strategy management, project portfolio management and enterprise architecture(Bodenstaff et al., 2014)

Similar to both previous studies (M. E. Iacob et al., Bodenstaff et al.), Op't Land et al. (2009) also depicted the relation between strategy, EA and Programme Management (shown in Figure 5). They started with a problem in executing a strategy which the research revealed that less than 60% of an organization's strategic objectives were actually reached. Thus, they considered that an instrument is urgently needed to support the process of executing the strategy. Two primary requirements for the instrument are "organizing the organization" and "change management". The first requirement demands the formulated strategy to be more specific, unambiguous, achievable, relevant and actionable, while at the same time is capable to provide an overview of the desired future state and the impact of change with respect to the current state. The second requirement is to achieve a common understanding and to share the commitment among all stakeholders that are involved. Consequently, a common language and models are required as a tool for an effective communication among the stakeholder. In more concrete and detail points, they identified seven key applications for enterprise architecture:

1. **Situation description**; Examining (shortcoming) problems in advance, including the existing situation.
2. **Strategic direction**; Conveying (and motivate) the forthcoming direction of the enterprise and investigate various alternatives.
3. **Gap analysis**; determining key problems, challenges issues, impediments, chances, etc. and also enacting well-motivated design decision to enable the organization to move from the current situation into the desired strategic direction.
4. **Tactical planning**; Specifying boundaries and determining plateaus (intermediary steps) for the enterprise transformation with regards to the strategic direction.

5. **Operational planning**; Providing obvious context and direction for a portfolio of projects working against the realization of the first plateau as specified in the tactical planning level.
6. **Selection of partial solutions**; Choosing one or more standard solution and/or packages that become part of the solution.
7. **Solution architecture;** producing high level design of current step for the transformation of the enterprise that will be realized (and implemented) with a specific project.

Figure 5 shows the relation between the three fields which are strategy, architecture and program management that are used for the governance of the enterprise transformation. Here, EA provides a "dashboard" that gives a perspective for the architect and stakeholders to steer the enterprise's transformation process. The term of "dashboard" highlights the relevant aspects of the existing state of the enterprise, its future direction and the desired state of the enterprise.
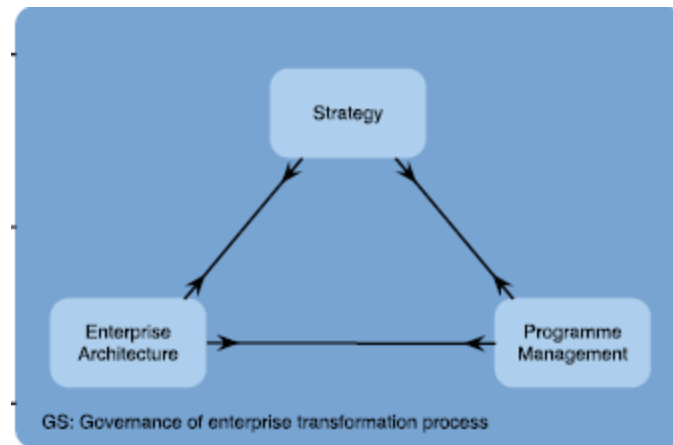
Figure 5 : The role of enterprise architecture (Op't Land et al., 2009)

In this section, we discussed three sources that give a strong motivation regarding the relation between Strategy management, EA, and Portfolio Management. It describes that after defining its strategy formulation, an organization needs to synchronize the three fields (Strategy, EA and Portfolio Management) in order to achieve their goals. In the following section, the Portfolio Management and EA are discussed in depth to gain more insight to establish a portfolio method from EA perspective.

2.2 Portfolio Management
Following the general description of the relationship between business strategy, EA, portfolio management, a thorough explanation of portfolio management is elaborated provided in this section. According to Project Management Institute (PMI), project management and program

management have traditionally focused on "doing the work right", while portfolio management is concerned with "doing the right work".

PMI defines portfolio as a collection of projects (temporary endeavors undertaken to create a unique product, service or result) and/or programs (a group of related projects managed in a coordinated way to obtain benefits and control which is not available from managing them individually) and other work that are grouped together to facilitate the effective management of that work to meet strategic business objectives.

In order to realize the strategic business objective, a portfolio should be managed in a process that is called as portfolio management. Project Portfolio management is an approach to achieve strategic goals by selecting, prioritizing, assessing, and managing projects, programs and other related work based upon their alignment and contribution to an organization's strategies and objectives (Project Management Institute, 2006). Table 2 summarizes the comparative overview of Project, Program and Portfolio Management from PMI (2006). It shows that portfolio management deals with the business scope related to the goals of an organization. Thus, it combines (a) an organization's focus of ensuring that the selected projects for investment meet the portfolio strategy with (b) the project management focus of delivering projects effectively and within their planned contribution to the portfolio (Project Management Institute, 2006).

Table 2 : Comparative overview (Project Management Institute, 2006)

PROJECT	PROGRAMS	PORTFOLIOS
Projects have a narrow scope with specific deliverables	Programs have a wide scope that may have to change to meet the benefit expectations of the organization.	Portfolio have a business scope that changes with the strategic goals of the organization.
The project manager tries to keep change to a minimum	Program managers have to expect change and even embrace it.	Portfolio managers continually monitor changes in the broad environment.
Success is measured by budget, on time, and products delivered to specification.	Success is measured in terms of Return On Investment (ROI), new capabilities, and benefit delivery.	Success is measured in terms of aggregate performance of portfolio components.
Leadership style focuses on task delivery and directive in order to meet the success criteria.	Leadership style focuses on managing relationships, and conflict resolution. Program manager's need to facilitate and manage the political aspects of the stakeholder management.	Leadership style focuses on adding value to portfolio decision-making.
Project managers manage technicians, specialists, etc.	Program managers manage project managers.	Portfolio managers may manage or coordinate portfolio management staff.
Project managers are team players who motivate using their knowledge and skills.	Program managers are leaders providing vision and leadership.	Portfolio managers are leaders providing insight and synthesis.

Project managers conduct detailed planning to manage the delivery of products of the project.	Program managers create high-level plans providing guidance to projects where detailed plans are created.	Portfolio managers create and maintain necessary process and communication relative to the aggregate portfolio.
Project managers monitor and control tasks and the work of producing the projects products	Program managers monitor projects and ongoing work through governance structures.	Portfolio managers monitor aggregate performance and value indicators

From the practical perspective, Gartner (2013) defines Portfolio Management as a shift from the practice of using a single integrated application for supporting business requirements to use a collection of application, technologies and services to create a system that addresses the unique requirements of an organization and leverages best-of-breed opportunities.

The stakeholders of an organization have an important role and are involved in portfolio management of projects and programs, which includes, but not limited to (Project Management Institute, 2006):

- Executive managers
- Portfolio review board
- Portfolio managers
- Sponsor
- Program managers
- Project managers
- Program or Project Management Office
- Project team
- Operations management
- Functional managers
- Finance managers
- Customers
- Vendors or Business partners
-

Nevertheless, the portfolio management approach would not be sufficient by solely clarifying its definition and the stakeholders in the abstract level. A clear and concrete stepwise or method is needed in an organization to handle their portfolio management. Three methods are selected and discussed in the following sections to give a concrete insight into the portfolio management. The methods are selected based on their completeness provided by the method related to the relevant feature discussed in portfolio management.

2.2.1 IT portfolio management step-by-step Methodology (Handler & Maizlish, 2005)

According to Handler & Maizlish (2005), IT portfolio management is a tool that supports companies during times of both robust growth and economic downturn. It consists of three

primary phases: IT discovery portfolio, IT project portfolio, and IT asset portfolio. IT discovery contains a typical longer-term IT investment. A typical medium-to short-term investments are included in the IT project phase. Eventually, IT asset phase defines the existing operation and maintenance investment. A proven process for applying IT portfolio management is identified by them consisting of eight stages:

(1) Develop an IT portfolio management game plan: to specify the objective of IT portfolio management.

(2) Planning the IT portfolio: to determine the investment strategy.

(3) Create IT portfolio: to create and store both current and planned projects. The as-is portfolio is captured in a standardized business case and located in a centralized database. Defining the project's metric and building a portfolio view to compare investments against each other. The assessment can be made in the basis of several dimensions such as; technical condition, business value and risk. Thus, a consistent and standardized set of criteria with threshold levels should be established.

(4) Assess IT portfolio: to assess and measure the portfolio against the target continuously, while taking into account the internal and external possible trigger events. The review process should be conducted at least on a quarterly basis. It also suggests frequently evaluating and updating the business case for each project.

(5) Balance IT portfolio: A committee of senior management identifies the optimal allocation of investment by determining trade-offs within the portfolio. The portfolio refers to the investments that have been selected and funded by the same committee.

(6) Communicate IT portfolio: It suggests that the communication regarding the goals, status and what needs to be changed in the portfolio must occur throughout all phases to the entire relevant stakeholder.

(7) Develop and evolve IT governance and organization: This stage defines the roles and responsibilities in the portfolio management process.

(8) Assess IT Portfolio management process execution: Finally, the execution of the projects is evaluated based on the goals defined in the game plan (phase 1).

2.2.2 Project Portfolio Management (PPM) framework by Rajegopal et al., (2007)

Rajegopal et al., (2007)design a high-level view of the PPM framework to provide an overview for the organization with regard to where they should start, and what is the makeup of the PPM process. A PPM framework needs to be designed to map the health/contribution data for each project onto the business decision criteria and needs to empower managers with the ability to see whether a project either sufficiently meets or exceeds the threshold indicator, thereby identifying portions of the portfolio that are out of compliance (Rajegopal et al., 2007). The PPM framework at a minimum should include four processes:

(1) Portfolio definition, strategy alignment and ideas management

The first process is to define the terms, scope, domain and definition of the portfolio. The variables to be considered are domain or scope of organizational coverage include within the portfolio, scope of included work, the key performance indicators (KPIs) and type of scoring models. Afterwards, a strategy alignment is established to recognize what the organization considers as important. Thus, strategic objectives should be clearly defined. To be more specific, three processes are suggested to be implemented: the current state assessment (what is), the future state vision (what should be), and the gap analysis (how to), for defining the business goals and strategies. Lastly, the idea management is defined as the capabilities for managing idea systematically. Thus, the framework suggests ten typical steps: creation, categorization, consolidation, exploration, ensuring strategic fit, business case preparation, commercialization, technology assessment, project registration and submission.

(2) Resource and business capability analysis

In the second process, three steps are suggested to run resource and business capability analysis. Determining the resource demand and constraint is the first step. It is followed by creating resource supply and demand scenarios as the second step and finally allocating the resources.

(3) Portfolio selection, prioritization and authorization

In this process, the key issues that need to be addressed are: documenting a detailed inventory of projects, developing a value ranking for each project based on the tactical criteria and strategic objectives, analyzing and identifying project risks vs. benefits, and developing an idea of an optimum or acceptable size of the project pipeline.

(4) Portfolio execution and monitoring

Five steps are suggested in executing and monitoring the portfolio, that are: Gathering project portfolio information, measuring and analyzing the project portfolio, analyzing the impact of changes towards the project portfolio, reviewing portfolio changes and reforecasting, and lastly communicating and implementing portfolio changes.

2.2.3 BiZZdesign Enterprise Portfolio Management (2014)

BiZZdesign is a spin-off from a large (multi million) research project that was found in 2001 in the Netherlands. (http://www.bizzdesign.com). As an innovative and a leading business design company, BiZZdesign continually delivers added value to their customers in order to improve their businesses more effectively by developing and sharing innovative solutions. BiZZdesign provides integrated solutions consisting of design tools, training, business consultancy and best practices to achieve the true business agility. In the Project Portfolio Management fields, BiZZdesign designs an Enterprise Portfolio Management (EPM) cycle that contains several key elements that are required for a successful implementation process in an organization (Bodenstaff et al., 2014). EPM is an integrated portfolio management approach that tightly

manages the strategy planning based on various portfolios of interdependent assets, for instance product portfolios and project portfolios (Bodenstaff et al., 2014). It consists of two phases (shown in Figure 6): the design phase and the execution phase which contains three activities respectively. In the design phase, the relevant stakeholders firstly define their goals and afterwards the portfolios are aligned with the goals, and finally the stakeholders formulate a valuation model that conveys their concerns. In the execution phase, the stakeholders store and analyze assets and projects first. Subsequently, they visualize the portfolio score of the applicable metrics, which are depicted in the dashboard to facilitate their concerns. Dashboards are a powerful way to address such concerns in a direct way (Bodenstaff et al., 2014). Finally, a decision-making on investments in assets or projects can be made using the result in the portfolio as an input review.
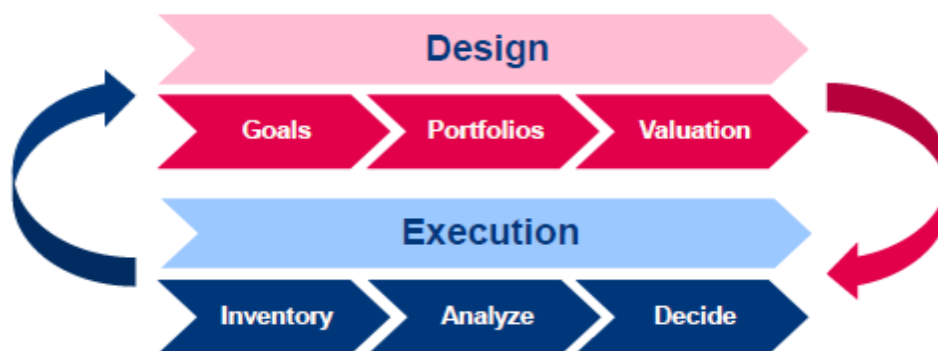
Figure 6 : EPM Cycle(Bodenstaff et al., 2014)

In general, the two previous portfolio methods (Maizlish& Handler, Rajegopal et al) are summarized in the BiZZdesign's EPM cycle. First, the goals need to be defined, along with the portfolio based on the concern of the decision-maker. A valuation model is then carried out to give a prioritization of the proposed projects/assets and finally to execute the portfolio as well as monitor and keep this process as a lifecycle instead of a finite process. In accordance with the objective of the research, the focus on the valuation process in BiZZdesign's EPM cycle will be performed with the utilization of the information gained from the EA. In the next section, a discussion of the EA is provided to gain a clear insight into this topic.

2.3 Enterprise Architecture

The concept of EA has been raised over the last decade to deal with the business and IT complexity. It could be used to address several issues in an organization that requires a holistic approach such as (Iacob et al., 2012):

- The increasing complexity as a result of mergers and acquisitions, outsourcing, internet, mobility, e-business, etc.;
- High IT cost;

- The organization of main processes from business' perspective and IT's perspective e.g., lack of trust, difference in perspective, or conflict of interest;
- Lack of control on IT costs;
- Lack of control on the effects of business changes on supporting information systems.

Iacob et al., (2012) specify the concept of EA as a complete, consistent and coherent set of methods, rules, models and tools which guides the (re)design, migration, implementation and governance of business processes, organizational structures, information systems and the technical infrastructure of an organization according to a vision. From the best practice perspective, Gartner (2015) defines EA as a discipline for proactively and holistically leading an enterprise's response to disruptive force by identifying and analyzing the execution of change toward desired business vision and outcome. EA delivers value by presenting business and IT leaders with signature-ready recommendations for adjusting policies and projects to achieve a target of desired business outcomes that capitalize on relevant business disruption. EA is used to steer decision making towards the evolution of the future state architecture. Moreover, referred to Gartner, EA can be used by an organization to control decision making towards the evolution of the future state architecture, which in this research referred as a target architecture which define the desired future situation according to an organization's vision. While the current situation is referred as baseline architecture.

An organization typically will apply EA's concept by following a specific EA framework, which maps all of the software development processes within the enterprise and how they relate and interact to fulfill the enterprise's mission (Urbaczewski & Mrdalj, 2006). Furthermore, Iacob et al., (2012) determine three ingredients in Enterprise Architecture; a framework, a language and a process. A framework represents the subdivision of architecture in different domains including the relationship between these domains. A language defines the concepts for describing an architecture while a process provides a step-wise prescriptive method for developing architectural descriptions.

TOGAF (The Open Group Architecture Framework) is known as one of the leading enterprise architecture methods (Iacob et al, 2012). With TOGAF Architecture Development Method (ADM), a stepwise, iterative process for the development and implementation of an EA can be carried out. It consists of ten phases, (depicted in figure 7) which can be grouped into four main parts as follows (Iacob et al, 2012):

1. **"Getting the organization committed and involved"**. This section consists of a preliminary phase and phases A (Architecture vision). The preliminary phase includes preparatory measures of the organization, e.g., establishing an architecture capability, tailoring the architecture methods and techniques and determining an initial set of

architecture principal. With the architecture vision, the formulation of architecture vision is performed with a high-level overview of the change that is envisaged.

2. **"Getting the architecture right".** Phase B (business architecture), Phase C (information system architectures and Phase D (technology architecture) are included in this section. Three types of baseline and target architecture **(**business, information system and technology) is developed as well as its gap analysis.

3. **"Making the architecture work".** Three subsequent phases are enclosed in this part. It explores the implementation and migration planning to the desired situation. First, in phase E, Opportunities and Solutions, the result of gap analysis is consolidated while the required work packages are determined. It is then followed by Phase F, Migration planning, in which the work packaged is prioritized while a migration plan is created. Lastly, in Phase G, Implementation Governance, the compliance of the implementation projects is maintained by using the architecture.

4. **"Keep the process running".** In the last phase, Change Management, the new critical requirements that appear during the architecture development cycle are identified.
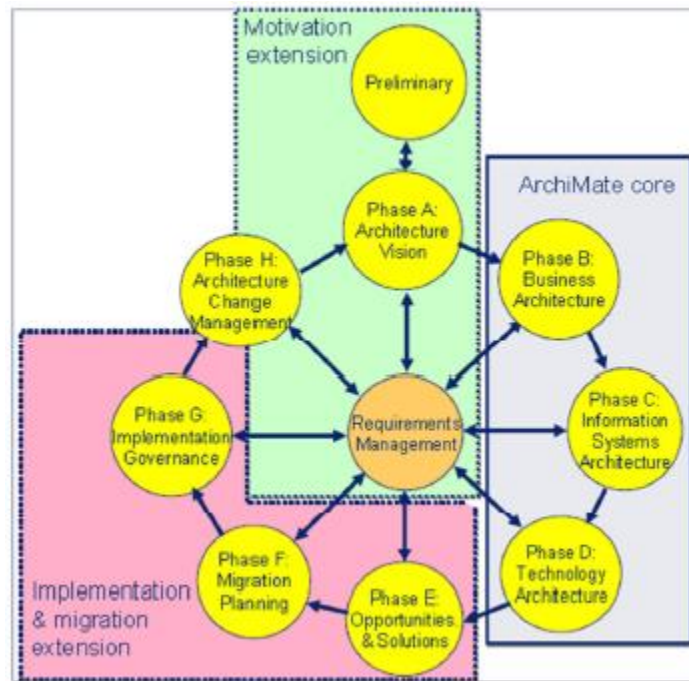
Figure 7: The Archimate Core Metamodel (Jonkers, van den Berg, Iacob, & Quartel, 2010)

Along with TOGAF, Archimate is introduced to define an actual modeling language. There are two dimensions in the Archimate core (Figure 8); layer dimension that represents a successive abstraction level to be modeled, and aspect dimension which reflects different concern of the enterprise that need to be modeled. As depicted in Figure 8, there are three layers in the layer dimension (Iacob et al, 2012):

- Business layer describes the value proposition, business strategy and the working model of the enterprise.
- Application layer determines applications that are employed to deliver services to support all the processes in the business layer of the enterprise.
- Technology layer represents the infrastructural services needed to run the application.

For the aspect dimension, three aspects are identified as follows:
- The structure aspect, that determines actors that are involved and how they are related to each other.
- The behavior aspect shows the behavior performed by the actors and the way the actors interact.
- The information aspect reflects problem domain knowledge used by and communicated between the actors through their behavior.
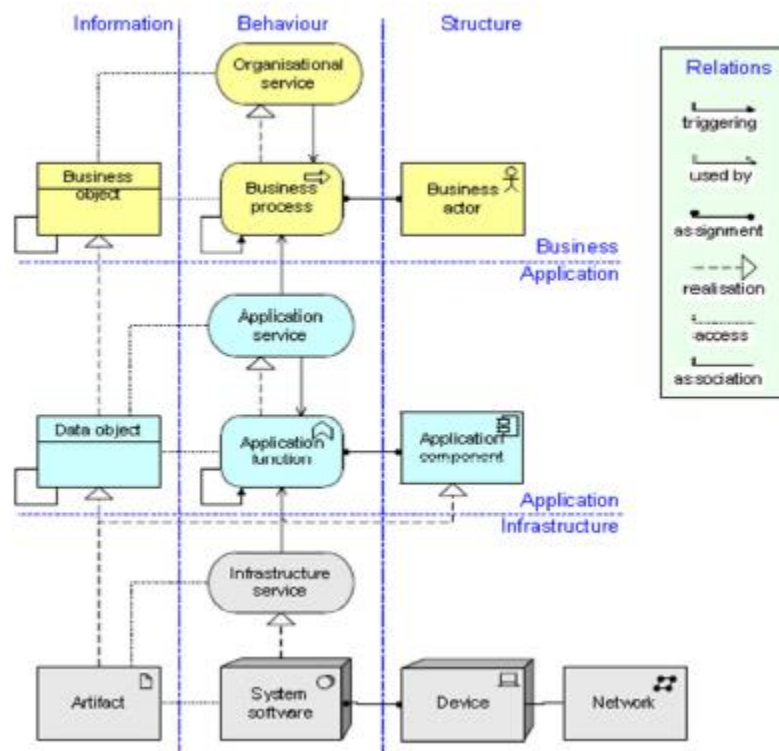
Figure 8: TOGAF-Archimate (Iacob & Jonkers, 2006)

2.3.1 The value of EA Framework and modeling

According to Op't Land et al., (2009) EA can deliver value to the business in many different ways. Furthermore they also group it specifically into business, IT, and both for business and IT. Various values are identified in the three categories, but one value of each category is described which indicate its value for this research.

Translating strategy in executable projects is one of the values of EA for the business stakeholder. The modeling tool in EA is able to facilitate the organization to portray the high level goal or strategy into detailed project. In the Archimate, EA's modeling language that followed TOGAF framework; realize this value in the motivation extension and implementation and migration extension. Figure 9 shows the summary of these two extensions.
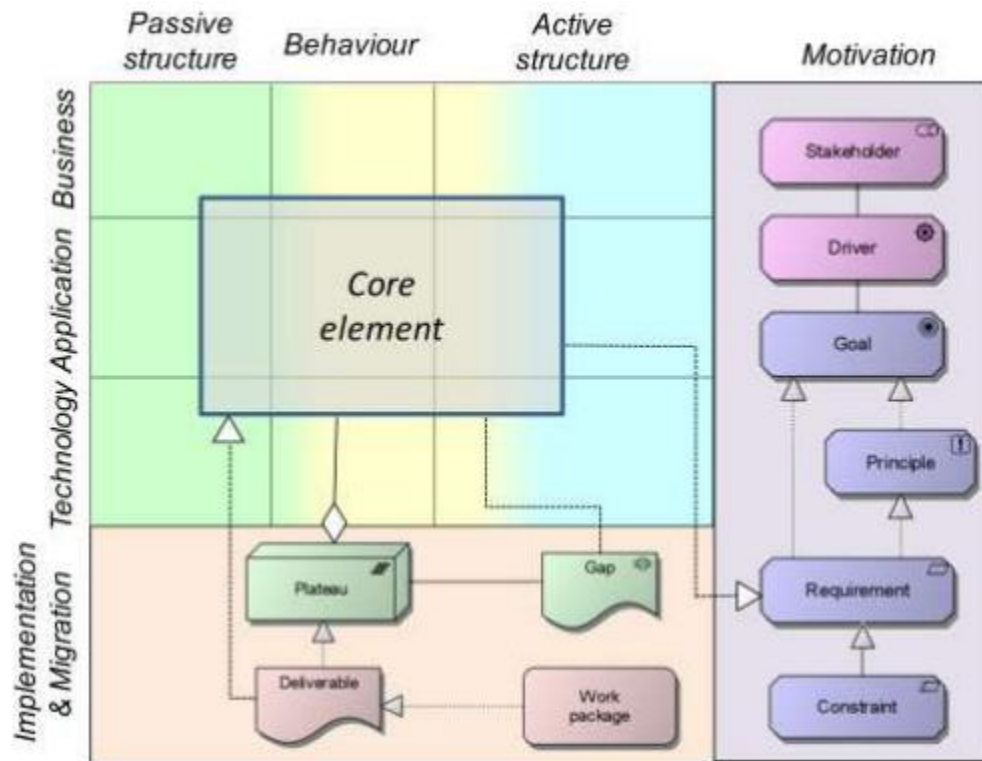
Figure 9: Motivation and implementation extension (Jonkers, Quartel, van Gils, & Franken, 2012)

The second group is the value of EA for IT. The value of EA for IT that is pointed out in this research is EA ensure effective IT planning and management of IT roadmaps (and portfolio management), also enabling improved planning for resource skills and training and including application portfolio rationalization. This value is realized since EA gives clear picture of the organization's structure and development, from different viewpoint, during various stages of the transformation process (Bodenstaff et al., 2014).

The last category is the value of EA for business and IT. It improves business and IT alignment, allowing, for example, the identification of misalignment of individual projects with strategic outcome in the early stages. This is similar to the first value for business stakeholder, from the EA model; an organization can identify its entire projects and align it with the goal of the organization. From the process of modeling, then the misalignment can be identified as early as possible.

2.3.2 ArchiMate Viewpoints

In order to maintain a coherent enterprise architecture which represents complex activities in an organization, various people with diverse backgrounds are needed to be involved. Thus, various architectural frameworks (e.g TOGAF, Zachman framework) are developed to explain the architectural description in accordance with its stakeholder. However, the problem of looking at enterprise architecture through the lens of an architectural framework is that it categorizes and divides architectural descriptions rather than providing insight into their coherence (The Open Group, 2012). ArchiMate accommodate this problem with a flexible approach in which architects and other stakeholders can define their own views on architecture. A definition of view and viewpoints are described in the ArchiMate 2.1 specification. A view is defined as a part of an architecture description that addresses a set of related concerns and is addressed to a set of stakeholder. A Viewpoints specify the view, which prescribe the concepts, models, analysis techniques, and visualizations that are provided by the view (The Open Group, 2012). In the specification documents, these two concepts are simplified, where a view is what you see and a viewpoint is where you are looking from.

There are 15 viewpoints in the ArchiMate core viewpoints, 6 viewpoints in the motivation extension, and 3 viewpoint in the implementation and migration viewpoints. In total, there are 24 viewpoints and it is classified into two dimensions; the purpose and the content of views (Iacob et al., 2012). The purposes of the views are:
- Designing
  Architects and designers are supported by the design viewpoints in the design process from initial scratch to detailed one.
- Deciding
  With the decision support viewpoints, the managers get a more insight into cross-domain architecture relationships that support the decision-making process.
- Informing
  Informing viewpoints aim to inform the stakeholders about the architecture so that they can acquire an understanding and commitment.

While the content of a viewpoint consists of following abstraction levels:
- Details
  The content typically considers one layer and one aspect of the ArchiMate framework.
- Coherence
  The view here includes multiple layers or multiple aspects.
- Overview
  This is an abstraction level that addresses both multiple layers and multiple aspects.
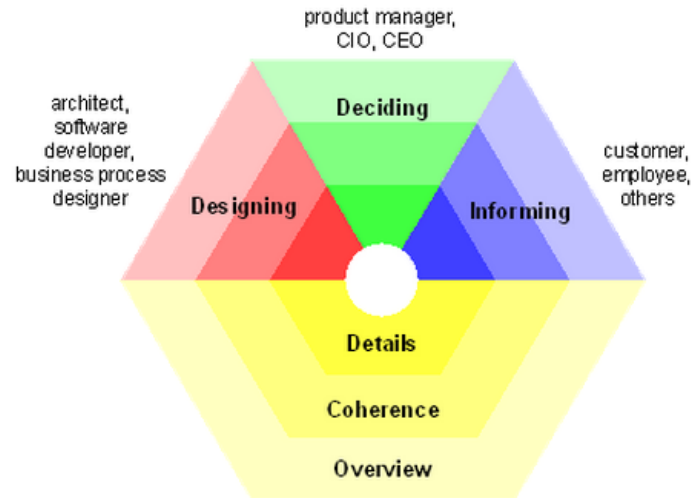
Figure 10: View Categories (Iacob, Jonkers, et al., 2012)

The list of viewpoints which its goal is for deciding and informing is presented in Table 3. The stakeholders can choose from the list to support both the decision-making process and communication process by presenting models that will give more insight about a specific concern. Figure 11-15 show some of the concepts and relationships of ArchiMate viewpoints described by M.E Iacob et al (2012).

Table 3: Viewpoint classified by goal and level of detail (Iacob, Jonkers, et al., 2012)

Goal/ level	Detail	Coherence	Overview
Decide	• Actor cooperation view • Stakeholder • Goal refinement • Goal contribution • Principles • Requirements realization • Motivation	• Landscape maps • Layered view • Service realization view • Organization structure view • Business process cooperation view • Business products view • Stakeholder • Goal refinement • Principles • Requirements realization • Motivation	• Landscape maps • Layered view • Motivation • Programs and projects • Migration • Implementation and migration
Inform	• Organization • Business function • Business process • Information structure • Application structure • Application behavior • Technology infrastructure	• Actor cooperation • Business process cooperation • Application cooperation • Product • Stakeholder • Goal refinement	• Service realization • Implementation and 'deployment' • Application usage • Layered view • Motivation • Programs and projects

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	• Stakeholder • Goal Refinement • Goal contribution • Principles • Requirements realization • Motivation	• Principles • Requirements realization • Motivation	• Migration • Implementation and migration
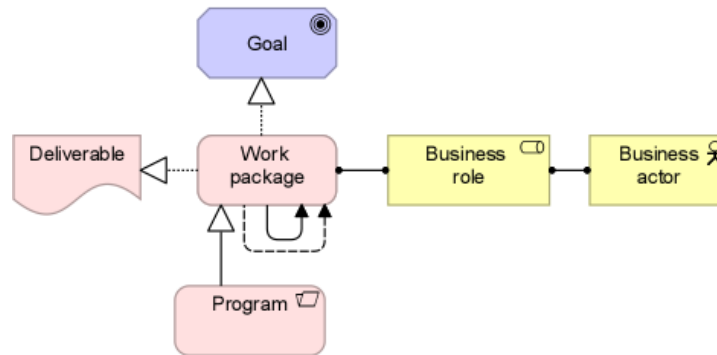
Figure 11: Project Viewpoint
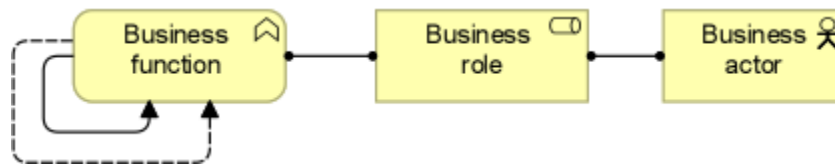
Figure 12: Business function viewpoint
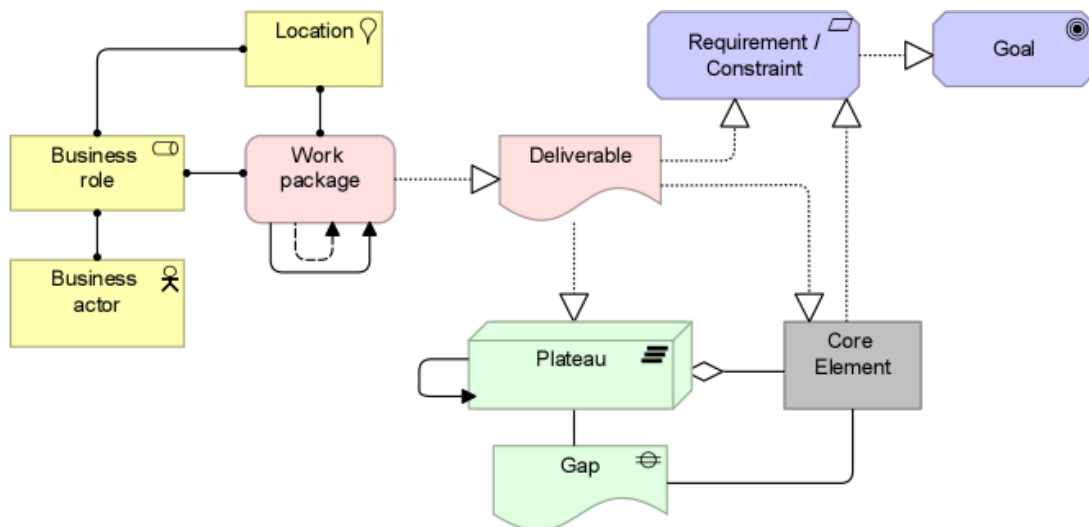
Figure 13: Architecture implementation and migration viewpoint
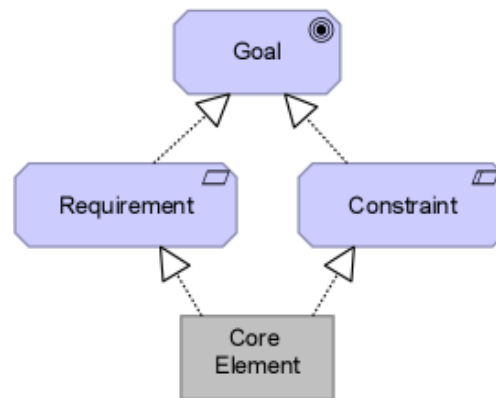
Figure 14: Requirements realization viewpoint
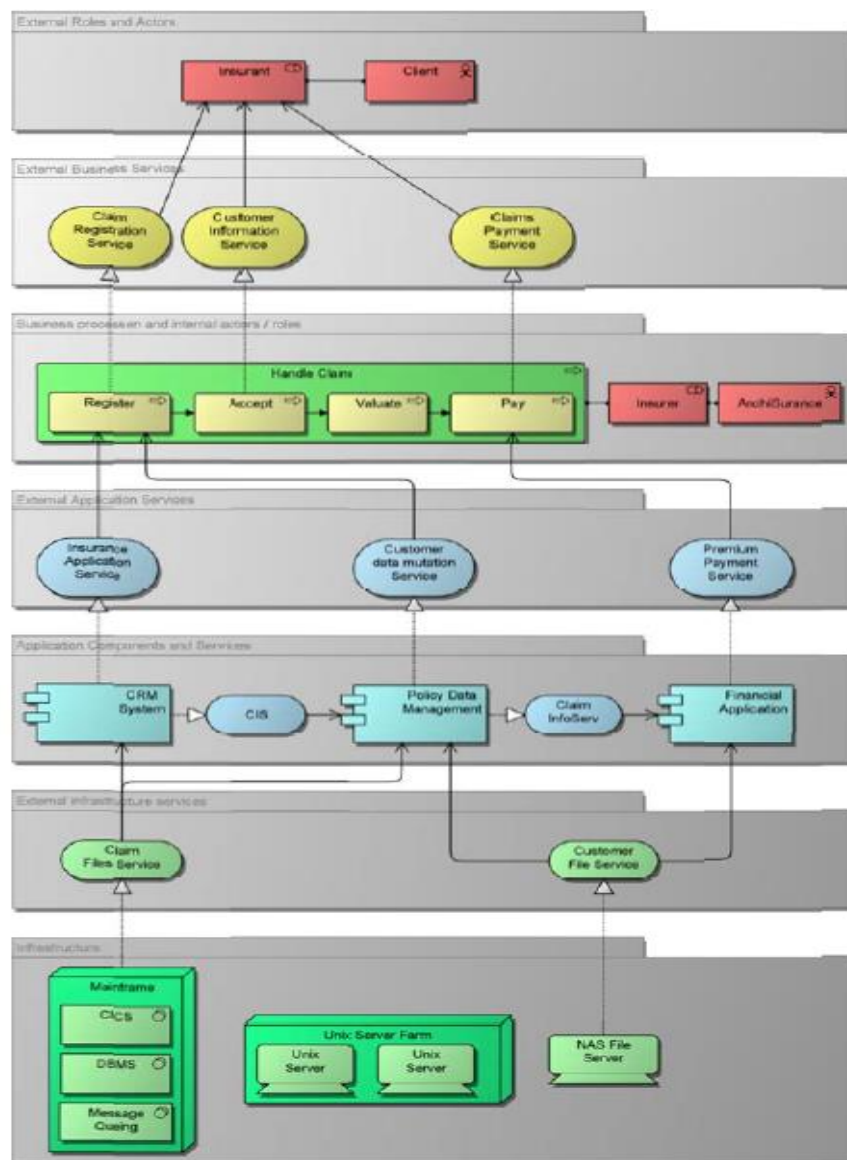
Figure 15: Layered viewpoint

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2.4 Project Portfolio Valuation Methods

There is immense number of categories of IT investment methods provided by various researchers. The practitioner also has seen this as an essential for them, since a number of financial, hardware and human resources are invested by the organization to achieve their goals. Managers still draw some of their IS investment decisions on so-called "acts of faith", i.e. on their intuition and instincts (Walter & Spitta, 2004). The investment decision is a result of some implicit and non-transparent process, that based on, mostly qualitative, business cases, mixed with politics and power (Bodenstaff et al., 2014). Thus, the research in this topic is seen as an important theoretically and practically to help an organization have a better decision making process. One way to help the decision-making process in the organization is by providing a list of project ranking from their project's list. To provide the ranking of the project, each project should assess with sufficient method. A number of existing IT valuation methods are described in the next section, to give a theoretical foundation in this research and give various insights about the technique for support IT/IS (information technology/ information system) investment decision. Four basic approaches proposed by Renkema & Berghout(1997) are adopted as a guideline to determine a number of methods distinguished by financial approach, multi-criteria approach, and portfolio approach.

2.4.1 Financial Approaches

Most of the organizations used financial technique to assess the proposed project, so that the return value of the investment can be evaluated. The methods regarding assessment of the financial value are also discussed in number of literature (Schnierderjans et al, Renkema et al, Irani et al). The majority of financial methods are:

- Net Present Value (NPV)

The net present value is the technique for discounting all the costs (consumed cash flows) and benefits (generated flows) of a project to the present value of money (Roditi, 2014). Typically, if the result of this appraisal is more than zero, the project can be approved.

Limitation: The decision-maker is considered to have an aversion to risk (Renkema & Berghout, 1997) and many IT investment decisions are not made based on longer-term cash flows (Schniederjans et al, 2004)

- Payback Period (PP)

Payback Period is the period between the moment that the IS investment is made and the moment that the total sum of the investment is recovered through the incoming cash flow (Renkema & Berghout, 1997). It is the most extensively used financial methodology to evaluate IT investment project, because of the simplicity and familiarity (Schniederjans et al, 2004).

Limitation: This method would appear counterproductive to those IT/IS deployments that seek long-term flexibility and integration (Irani & Love, 2002)

- Internal rate of return (IRR)

Internal rate of return or discounted-cash-flow rate of return is the discount rate that makes the NPV of a project equals zero (Schinerdejans et al). The project considers as beneficial, if the IRR is greater than the opportunity cost of capital.

Limitation: Schinederjans et al describes two problems exist with the IRR. First, there may be more than one IRR that equates the NPV of investment to zero, and in many situations the opportunity cost of capital may not be equal for each cash flow.

- Return on Investment (ROI)

Return on Investment evaluates profitability based on total investment, both debt and equity (schinerdejans et al). It is a ratio of the profit to the total cost showing how many times the profit of the IT investment (benefit minus costs) is higher than the capital spent for the investment (Roditi, 2014).

Limitation: Although the calculation is quite simple, but it ignores the time value of money.

2.4.2 Multi-criteria Approaches

Information System (IS) investment not only can be expressed in monetary term, there are other positive or negative non-financial consequences. Methods from the multi-criteria approach can be used to compare the different consequences on an equal basis (Renkema & Berghout, 1997).

- Information Economics

  Information economics evaluates IS investment by three criteria; enhanced ROI, Business domain and Technology domain. The enhance ROI not only looks at cash flows, arising from cost reduction and cost avoidance, but also provides some additional techniques to estimate incoming cash flows by value linking, value acceleration, value restructuring, and innovation valuation (Renkema et al). Five factors are assessed in the business domain:

    1. Strategic Match (SM)
       This factor is assessed on the degree which an information technology project supports or aligns with enterprise or line of business stated strategic goals.
    2. Competitive Advantage (CA)
       This factor is rated on the degree to which the project facilities automated inter-organizational collaboration or other competitive advantages.
    3. Competitive Response (CR)
       Competitive response evaluates the degree to which failure of the system will cause competitive damage to the enterprise.

4. Management Information (MI)

   The assessment of this factor depends on the degree to which the project provides management information on the core activities of the enterprise or line of business

5. Organizational Risk (OR)

   This factor measures the degree to which the organization is capable of carrying out the changes required by the project.

Technology domain factors are:

1. Strategic Information System (IS) Architecture (SA)

   This factor assesses the degree to which the project is aligned with the overall information systems strategies.

2. Definitional Uncertainty (DU)

   Definitional uncertainty measures the degree to which the requirements and/or the specification are known.

3. Technical Uncertainty (TU)

   This factor evaluates the readiness of the technology domain to undertake the project. Four assessments consist of: skills required hardware dependencies, software dependencies, and application software.

4. IS Infrastructure Risk (IR)

   IS infrastructure risk is rated on the degree of nonproject investment necessary to accommodate the project.

The evaluation process in the business and technology domain is scored and range from 0-5, the detail score card for each factor are listed in Appendix1, and the calculation of IE score card is depicted in Figure 17. The measurement calculates the values of the business and technology domain factors multiplied by the weight. The weighting proposed by Parker et al. (1988) is based on four quadrants in the corporate values; Investment, strategic, infrastructure and breakthrough management, is showed in Figure 16. The detail weight value for each quadrant is described in Appendix2.
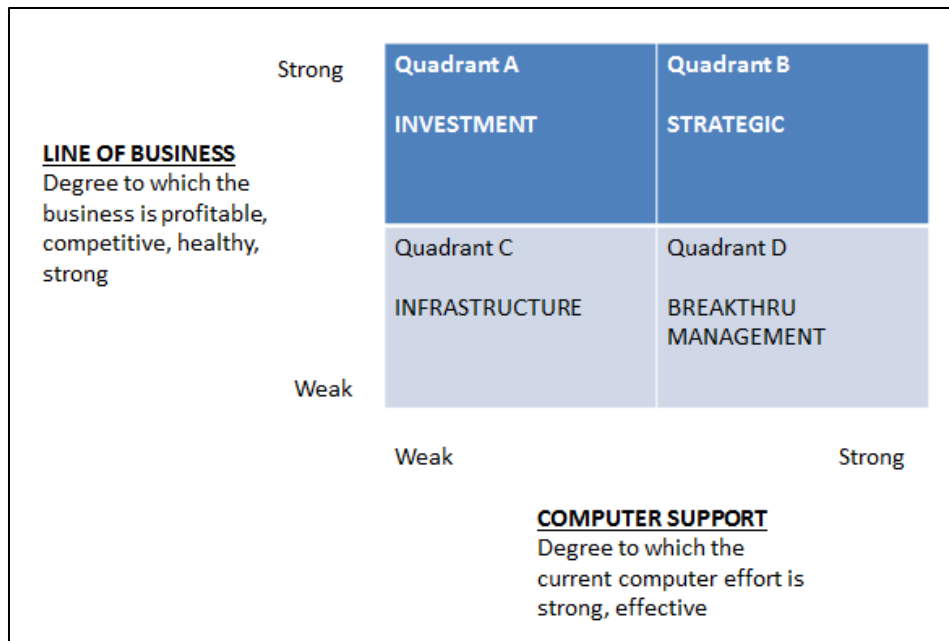
Figure 16: Corporate Values(Parker et al., 1988)

Evaluator		Business Domain					Technology Domain			
	ROI	SM	CA	MI	CR	OR	SA	DU	TU	IR
Business Domain										
Technology Domain										
Where: ROI = Enhance simple ROI SM = Strategic Match CA = Competitive Advantage MI = Management Information CR = Competitive Response OR = Organizational Risk SA = Strategic IS Architecture DU = Definitional Uncertainty TU = Technical Uncertainty IR = IS Infrastructure Risk										

Figure 17: IE score card

- SIESTA (Strategic Investment Evaluation and Selection Tool Amsterdam)

University of Amsterdam designed a multi-criteria method that supported by several questionnaires and additional software (Renkema et al, 1997). Figure 18 shows the general evaluation criteria in the SIESTA's model; contain business and technology domain. In detail, it consists of seven business criteria, six technological criteria, four business risks, and eight technological risks. The SIESTA method probably is the one of the most comprehensive multi-

criteria methods available to the evaluator (Renkema & Berghout, 1997), yet it difficult to use because the various number of the criteria.
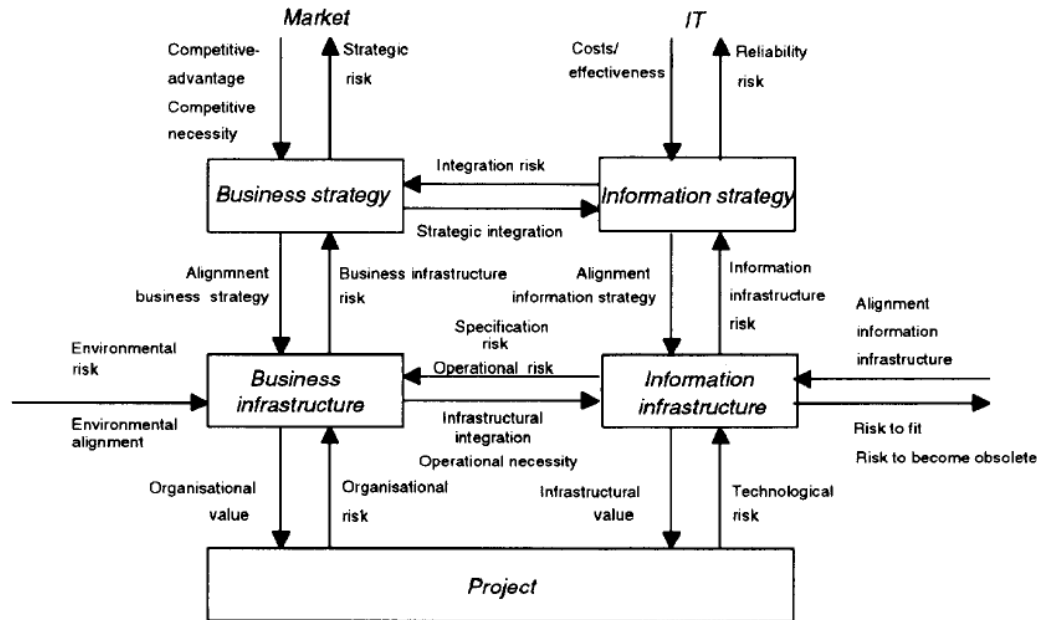
Figure 18: SIESTA (Renkema & Berghout, 1997)

2.4.3. Portfolio Approaches

- Bedell's Method

Bedell's method presents a decision support for IS resource allocation by answering three questions (Quartel et al, Renkema et al, Shuurman et al):

1. Should the organization invest in information systems?
2. On which business processes should the investments focus?
3. For which activities within these processes should information systems be developed or improved?

The main idea of this method is the balance needed between "effectiveness of the information system" and "their level of strategic importance". In order to answer the three questions and calculate the balance ratio, a number of information needs to be specified (Quartel et al., 2010):

- The importance of each business process to the organization
- The importance of each business activity to the business process
- The effectiveness of an information system in supporting business activities

The contribution of each information system and three portfolios (organization-level portfolio, business process-level portfolio, and activity-level portfolio) are used to prioritize the investment proposals. The importance of the system multiplied with the improvement of quality after development is used to determine the contribution of an IS. Finally a Project-Return index (PRI) could be calculated by relating the contribution of the IS to the development costs (Renkema & Berghout, 1997).

- Investment Portfolio

In this method, IS investment proposals are evaluated based on three criteria simultaneously (Renkema & Berghout, 1997), then mapped into Figure 19. It evaluates an IT investment's contribution the following three criteria;

- The contribution to the business domain.
- The contribution to the technology domain.

  The evaluation criteria of the *information economics* method are used to measure the business and technology contribution (Schniederjans et al., 2004).

- The financial consequences, by means of net present value (NPV) calculation. The size of the circle on the map indicates the NPV value.

The visualization of the portfolio depicts in Figure 19; the contribution to technological domain plot on the horizontal axis and contribution to business domain on the vertical axis.
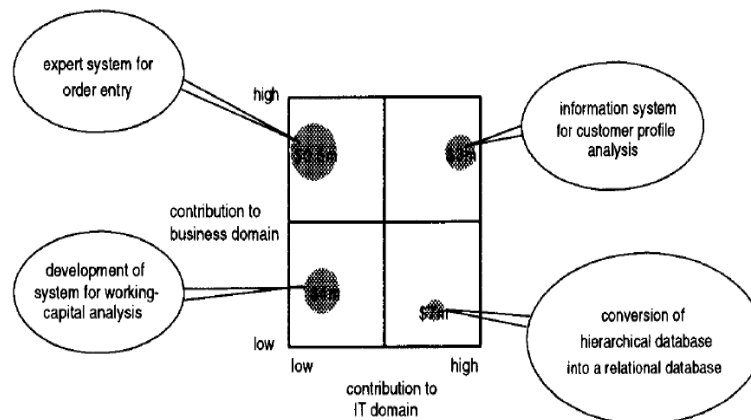
Figure 19: Investment Portfolio (Renkema & Berghout, 1997)

- Road Map

A road map for the evaluation of IT investment is formalized by Mo A. Mahmood (1999) as shown in Figure20, is made based on three major consideration :

(1) The process of evaluating all types of IT investments should assess both tangible and intangible benefits. Even though each type of IT investment could need different consideration, most IT investments entangle both quantitative and qualitative benefit to a certain degree.

(2) Assessing the risk of IT investments also seen as something urgent and required in the IT evaluation process to ensure the benefits fairly compensate the risks.

(3) The process argues to evaluate intangible benefits and risks prior to tangible benefit. Since in cognitive psychology recommend for individual confronted with both qualitative and quantitative factors simultaneous consideration, tends to decide more into the concrete factors than the abstract criteria.

The road map can be used, first by measuring the benefits and risks on the left, and then selects an appropriate evaluation method on the right.

IT benefits / risks to be measured   IT evaluation methods may be used

• Management Support • Competitive Advantage • Business Transformation	Step 1 : Intangible Benefits Evaluation	• Multi-objective, Multi-criteria • Value Analysis • Critical Success Factors
• Physical Risks • Managerial Risks	Step 2 : IT Investment Risk Analysis	• Real Options • Risk Portfolio Approach • Delphi Approach
Productivity and Operating Process Performance	Step 3 : Tangible Benefits Evaluation	- Return on Investment - Cost-Benefit Analysis - Real Options - Risk Portfolio Approach

Figure 20 : Road Map(Mo A. Mahmood, 1999)

- Hourglass Method

In the Hourglass method, the portfolio management is developed for non-profit organization; the municipality of Groningen. Prioritization is chosen for the portfolio method design. To ensure a proper prioritization, projects have to be set against certain criteria and need to be weighed (Kleersnijder & Berghout, 2012) . The method is based on two main categories of criteria; being 'necessity' and 'business'. Table 4 shows the list of the necessity criteria, while for the business criteria are indicated in Table 5. Each project will be scored using the weight scoring model (two main categories), then divide it as priority one (score=>80 point), priority two (score >60 and <80 point), priority three (score < 60 point). The status of the project (time, finance and resource) also indicated by green, orange and red color.

Table 4: Necessity Criteria(Kleersnijder & Berghout, 2012)

Necessity	Weight	Description	Score		
			0	1	2
Legal necessity	24	A change in existing legislation or new legislation as a result og the project. Example: under usual Law Disclosure of public law restrictions, a digital registration system is required	Project has no legal necessity	Project has no clear legal necessity	Project has a legal necessity
Political priority	18	A change in existing local policy or new local policy as a result of the project,	Project has no political priority	Project has a partial political priority	Project has a high political priority
Public interest	18	The project is directly relevant to citizens. This can be both a direct and an indiriect interest. Example: Expansion of digital	Project has no interest for civilians	Project has a partial interest for civilians	Project has a high interest for civilians

Necessity	Weight	Description	Score		
		services on the website			
			0	1	2
Organizational necessity	12	The project is important for the development of the organization. Example: Replacement of an application with another application, making the organization work more effectively.	Project has no organizational necessity	Project has a partial organizational necessity	Project has a high organizational necessity
Technical necessity	12	A project must be executed technically. Hardware/software is replaced/outdated or support has stopped: a project is technically necessary or a prerequisite for another project.	Project has no technical necessity	Project has a partial technical necessity	Project has a high technical necessity

Table 5: Business Criteria (Kleersnijder & Berghout, 2012)

Business	Weight	Description	Score		
			0	1	2
Communality	8	The implementation of the project affects a large part of the organization. For example: The introduction of the 'Complaints' system for all departments.	No communality. It is department related.	Some communality between departments	High communality. It affects all departments.
Time	6	A project that is under pressure and has certain deadlines.	No direct effect on the organization.	Project should be completed within two years	Project should be completed within one year.
Return	6	Projects with a return on investments; Clarified in the business proposal	Project does not get finances returned.	Project possibly gets finances returned.	Project gets finances returned.
ICT vision	3	Project that is part of the ICT vision.	Project does not fit into the ICT vision.	Project partly fits into the ICT vision.	Project fits into the ICT vision.
Finance	3	The basis of the funding of the project.	Finance and budget are not arranged.	Finance and budget might be arranged.	Finance and budget are arranged.

2.4.4 Portfolio approaches evaluation

In this section, a brief comparative evaluation of the portfolio approach is carried out to specify which of the existing method can be adopted to develop an EA-based IT investment in the valuation process in the Portfolio lifecycle. The criteria to be used for the evaluation are subsequently:

- Evaluation criteria

  Financial, non-financial and risks are used as the factors in the evaluation criteria. Since the consequence of IS investment not only can be evaluated based on the monetary term, but also non-financial one. Risks also should be considered by the stakeholder when they prioritize the project.

- Ease of Use

  As the objective of this research is to give recommendations for the organization by providing a list of projects that have already been prioritized. The ease of use is required to give the organization a clear insight and rapid decision making processes.

- Information from architecture

  Investigate the extraction processes from the architecture also needed, thus the developed method can be assigned as an EA-based analytical method.

Table 6 : Portfolio methods analysis

	Bedell's Method	Investment Portfolio	Road Map	Hourglass's Method
Evaluation Criteria				
Financial	No preference	Return (NPV)	ROI/ROM	None, only the status of financial budgeting
Nonfinancial	Quality and importance	Business and IT domain	Critical Success Factors	Necessity and business' criteria
Risks	None	Deduction from expectation	Risk analysis	None
Ease of Use	More difficult	Quite easy	Quite easy	Quite easy
Information from Architecture	Effectiveness & importance of IT in the architecture relation	Possibility to obtain the information of IT domain, Risk assessment	Possibility takes the risk assessment from architecture, modeled the CSF as a goal in the architecture	Less possibility

From the evaluation depicted in Table 6, the Investment portfolio, road map and Hourglass's method have fulfilled the evaluation criteria and the ease of use compared with Bedell's method. However, the road map does not provide a guideline to summarize the result of the overall method. A portfolio's dashboard could be used to plot the intangible and tangible evaluation in the horizontal and vertical axis, with additional color to define the risk level.

In the evaluation criteria, Bedell's method does not conduct the risk evaluation mechanism in their method. Moreover, architecture-based approach to IT valuation using extended Bedell's method has been carried out (Quartel et al., 2010). The Hourglass method seems to have the least possibility to get the information from architecture, since most of data that could be used in the evaluation criteria is based on the interview with the relevant stakeholder.

The information portfolio appears to become the most convenient reference method for valuation process analysis in this research. The author suggested using the criteria from information economics to evaluate of business and technology domain. Furthermore, information economics give clear quantification of two domains by using the scorecard of each factor. However, further investigation is needed to seek the relevant information that could be gained from the architecture. Other relevant literature about the EA-based analysis also could be used, so that can give insight information for the organization to combine the method and utilize the information from the architecture.

3. EA-Based Investment Portfolio Method

This chapter illustrates an EA-based Investment Portfolio method for valuation process in BiZZdesign's EPM cycle. Firstly, a brief overview of the method is described in section 3.1, then the detail explanation about the factors needed to be assessed and the mechanism to collaborate with organization's architecture is provided.

3.1 EA-based Investment Portfolio Method

An EA-based Investment Portfolio method is elaborated in this section. As described in section 2.4.4, the original method evaluates three criteria simultaneously (Renkema & Berghout, 1997): the contribution to business domain, the contribution to technology domain and the financial consequences. The assessment of business and technology domain is performed by means of information economics method. In order to develop an EA-based investment portfolio method, the information from EA will be included in two factors of business domain: SM and MI, and all factors of technology domain. Furthermore, a weight-scoring is applied to rank the project score.

Figure 21 shows the high-level process in the EA-based investment portfolio method. In the business domain, two of the four factors in the business domain: Strategic Match (SM) and Management Information (MI) will use the information taken from the EA. Detailed information about the requirement of the architecture and the type of architecture's viewpoint are explained in section 3.2. The information extracted from the EA is used to carry out the assessment for each particular factor. For the rest of the factors, competitive strategy and risk analysis are the input to perform the assessment process. Subsequently, the original IE score card is used for these three factors, but an EA-based IE score card is defined for the previous two.

Four criteria in the technology domain will use the information taken from the architecture, as the basis to perform an assessment in the technology domain. Section 3.2 describes the assessment mechanism; from extracting the architecture's information to the scoring in the technology domain. And section 3.3 describes the formula to calculate the financial consequence. Finally, the project's value can be calculated from the formula in the Information Economics Method, then the three criteria of EA-based investment portfolio method is visualized in the bubble chart. From this valuation process, the relevant stakeholders will receive a number of prioritized projects based on their project's value for each program in the organization's portfolio. With the project value score, the organization not only can get the prioritize project, but also can analyze the mapping of the project from three dimensions;

contribution to business domain, contribution to technology domain and its financial consequences.

The proposed method emphasizes on the utilization of EA as an input from the original method. With the input from EA, the organization could have a more comprehensive and concrete idea as the basis of their decision making process. The visualization of EA could improve the objectivity of the stakeholder in the project valuation process. An outline regarding the EA which give the overview of the organization from different layers and viewpoint is elaborated in the section 3.2 and section 3.3.
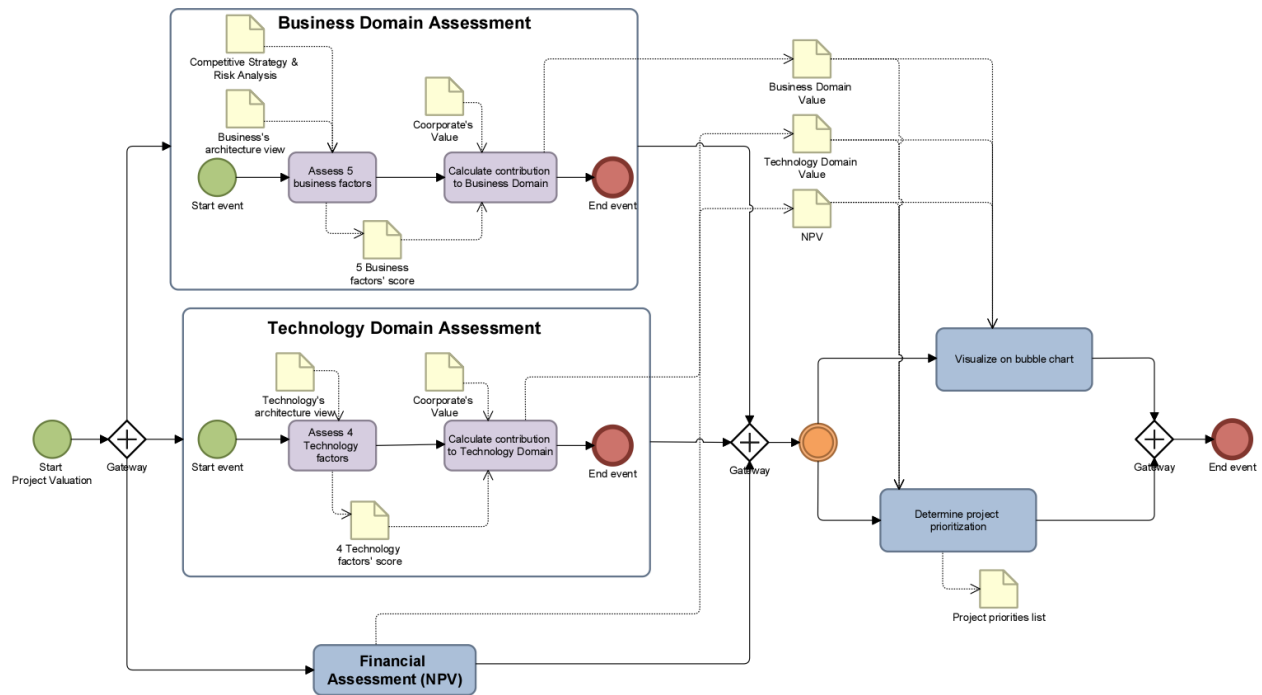
Figure 21: EA-based Investment Portfolio Method

3.2 Business domain assessment

Five factors are valuated in the business domain; Strategic Match (SM), Competitive Advantage (CA), Management Information (MI), Competitive Response (CR) and Organization Risk (OR). Based on the characteristic of each factor defined by Parker et al in the Information Economics, two factors will be assessed using the input from EA. These two factors are; Strategic Match (SM) and Management Information (MI). The summary of the business domain assessment is illustrated in Figure 22. After the assessment of five factors, the five business factors' score and the corporate value are used to calculate the business domain value. The description of each business domains' factor, the input, output and the assessment process will be elaborated in the following section.
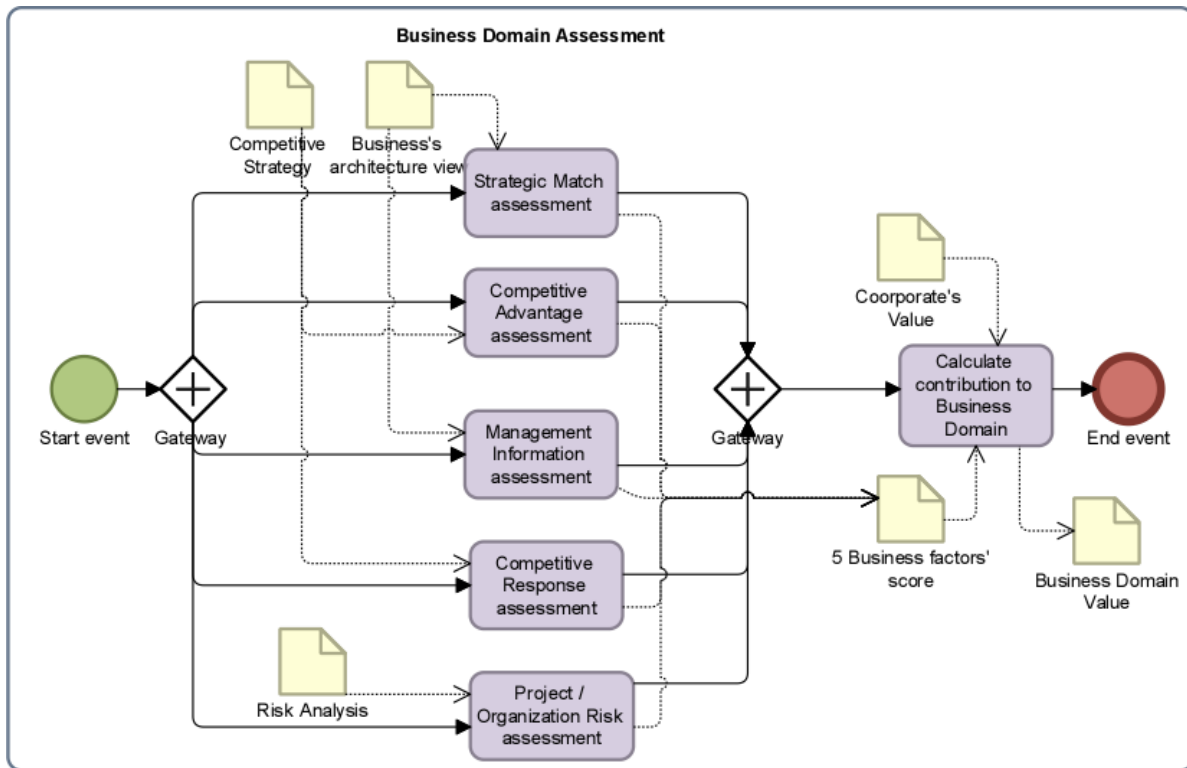
Figure 22: Business Domain Assessment Process

3.2.1 Strategy Match (SM)

The assessment of strategy match concentrates on the alignment of an information technology project with the enterprise or line of business stated strategic goals. In the original method (information economics), it is assumed that the strategy is clearly stated and sufficiently understood by the participants in the

scoring process (stakeholder). However, it does not have a supporting illustration to help the relevant stakeholder to "understand sufficiently". Modeling the strategy on ArchiMate, provides a means for the organization and the stakeholder to gain more insight into its strategy and the alignment with the projects.
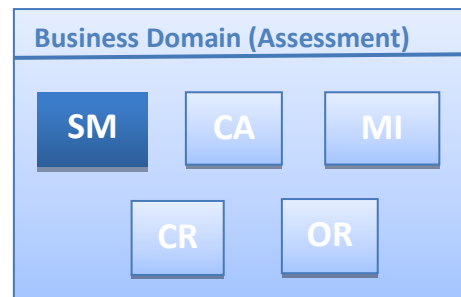
ArchiMate facilitates the high-level business goals, architecture principles and initial business requirements with the motivational concept. These high level business goals also could be related to the proposed project using implementation and migration extension. Figure 23 shows the activities overview for the first factor (SM) of business domain assessment.
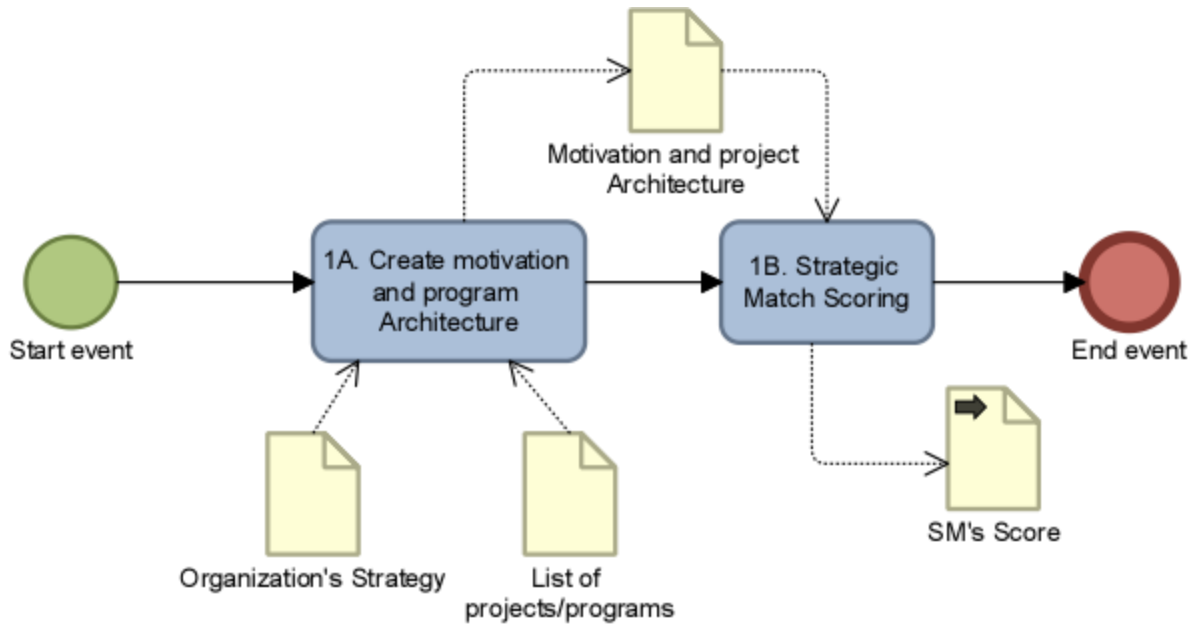
Figure 23: Business domain – SM's process

(1A) Create motivation and program architecture

The purpose of the first activity in the SM's process is to create the motivation and program architecture viewpoint of an organization. Using the organization's strategy and the list of projects/programs, a model that illustrates the primary goals of the organization and the relation to its projects/programs can be created. In this step, it is assumed that the organization already defines its strategy. A brief guideline to define a clear and well-defined business strategy can be carried out from step A of the capability-based planning method (Anastasios, 2014).

A summary of "create motivation and program architecture" activity is given in Table 7. The same template will be used for other activities. Figure 25 illustrates the example of the architecture. However, the structure of the architecture could be different from one to another depending on the condition of the organization. The main idea in this activity is to create an architecture that shows the relation (if any) between the strategic goals of the organization with the list of programs/projects.

Table 7: Overview of "Create motivation and program architecture" activity

1A. Create Motivation and program Architecture	
Description	Creation of Motivation and program architecture
Input	Organization's Strategic Goal, List of projects/programs
Possible Actor(s)	Enterprise Architect
Technique	General Architecture Modelling Approach (M. E. Iacob et al., 2012)using EA modeling tool
Output	Motivation and program architecture of the organization

(1B) Strategic Match Scoring

By using the input architecture, the organization has a basis to assess the score of the strategic match using EA-based SM's worksheet (Figure 24).

Table 8: Overview of "strategic match scoring" activity

1B. Strategic Match Scoring	
Description	Scoring activity to determine the degree to which an information technology project supports or aligns with the enterprise or line of business stated strategic goals modeled on the architecture.
Input	Motivation and project architecture of the organization Architecture Layer : Implementation and Migration Extension Architecture Aspect : Motivation Extension
Possible Actor(s)	Program or Project Management Office, Enterprise Architect
Technique	Scoring using EA-based SM worksheet and input architecture
Output	Architecture-based SM's score (0-5)

EA-based SM's worksheet is adopted from the Information Economic's Strategic Match worksheet (Parker et al., 1988) and combine with the information from EA. The score for "strategic match" factor in business domain is formulated based on the description in the worksheet. The example of scoring for this factor is shown in Figure 25, which could be the basis for the score of 2, 3, 4 and 5. For scoring 0 and 1, the description in the worksheet explicitly describes that they indicate that there is no direct or indirect relationship between the projects and the strategic goals. Nevertheless, if the project could improve the operational efficiency in the organization, scoring 1 would be considered. Since the operational processes of each organization are different from one another, the justification between these scoring also will be distinct from each other.

0. The project has no direct or indirect relationship with the achievement of stated corporate (or departmental) strategic goals modeled on the architecture.
1. The project has no direct or indirect relationship to such goals modeled on the architecture, but will lead to improved operational efficiencies.
2. The project has no direct relationship to such goals, but the project is a prerequisite system (precursor) to another system that achieves a portion of corporate strategic goal modeled on the architecture.
3. The project has no direct relationship to such goals, but the project is a prerequisite system (precursor) to another system that achieves a corporate strategic goal modeled on the architecture.
4. The project achieves a portion of a stated corporate strategic goal modeled on the architecture.
5. The project achieves a stated corporate strategic goal modeled on the architecture.

Figure 24: EA-based SM's worksheet
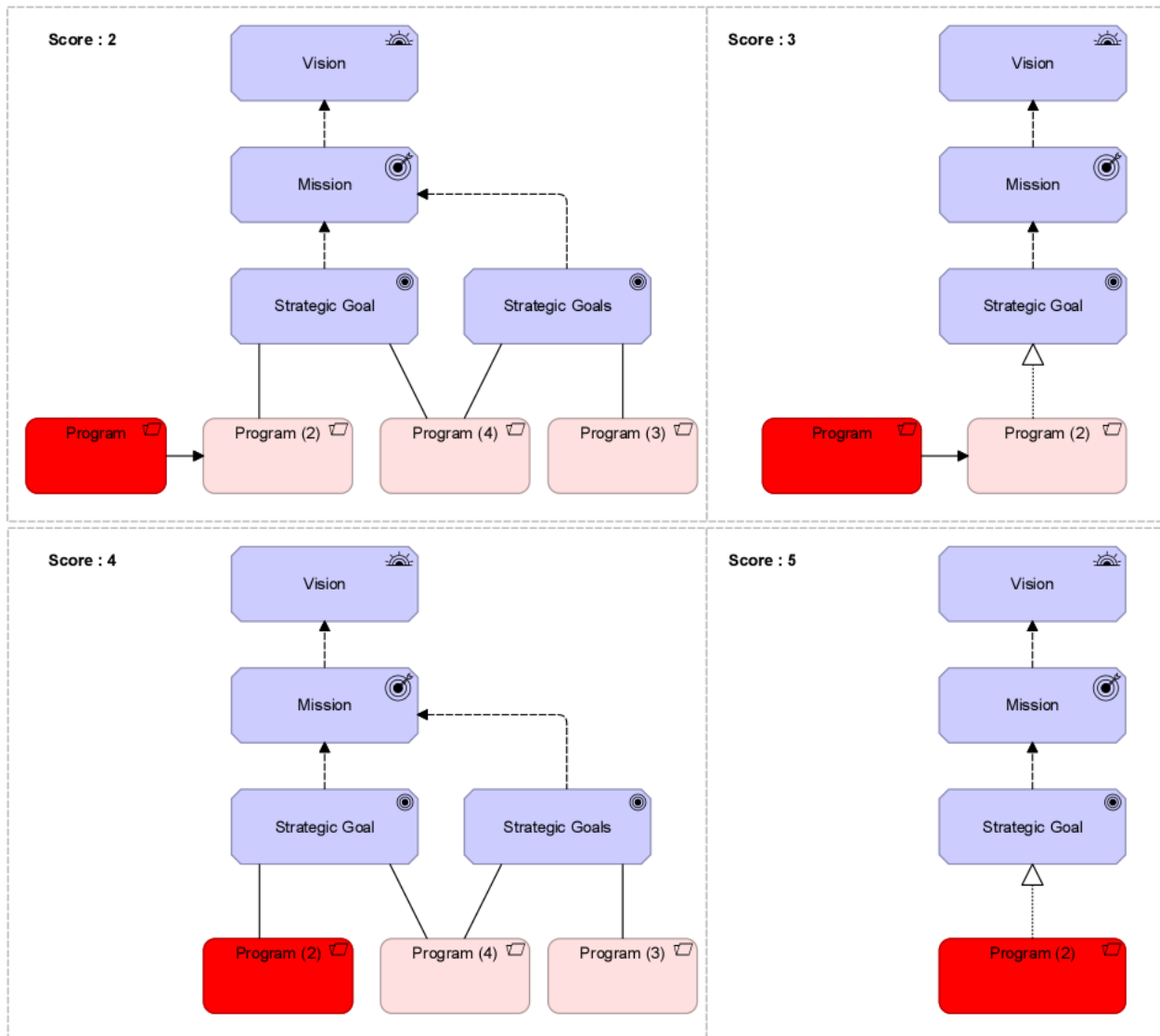
Figure 25: Architecture SM's scoring overview

3.2.2 Competitive Advantage (CA)

The question in this factor is: what makes this service unique? (Gronlund, 2000) by considering the major strategy that is implemented by the business (Parker et al., 1988). Porter (1998) indicated the type of competitive advantage by implementation of cost leadership, differentiation or focus. In this factor, the basis for decision making is not from the EA, but based on the CA's worksheet (e.g.: Appendix 1.2).
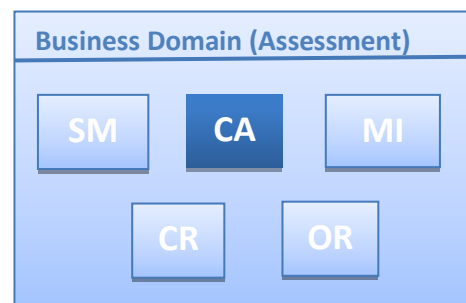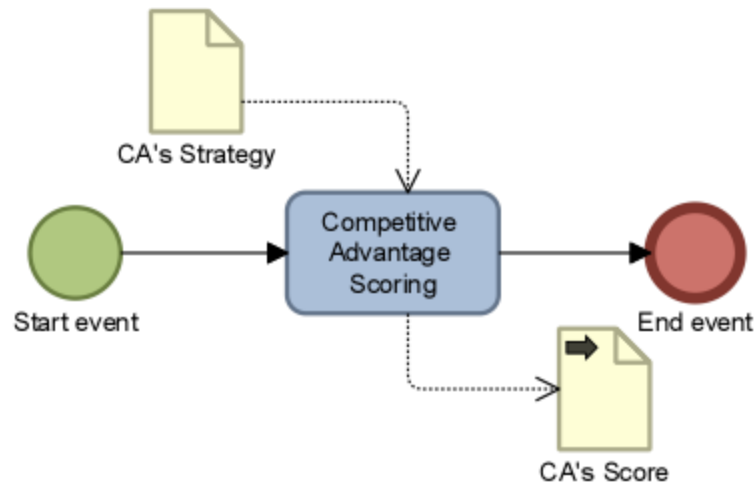
Figure 26: Business domain – CA's process

Figure 26 shows the process of CA scoring that uses the major strategy that is followed by the business. This factor assesses the value or contribution of the project to accomplish the organization's objective to achieve its competitive advantage. The organization could adopt Porter's generic competitive strategies (Porter, 1998) to develop their strategy in order to gain a competitive advantage. Thus, CA worksheet which is used to assess this factor will be different from one another.

Table 9: Overview of "competitive advantage scoring" activity

Competitive Advantage Scoring	
Description	Scoring activity to appraise the degree to which the proposed project provides an advantage in the marketplace.
Input	Business strategy to gain competitive advantage or Competitive Advantage strategy.
Possible Actor(s)	Program or Project Management Office
Technique	Scoring using CA worksheet
Output	CA's score (0-5)

3.2.3 Management Information (MI)

The evaluation process for MI should be conducted based on the relationship between the project and the core activities modeled in the business layer. Thus, the description about the core activities in the organization is required. Parker et al., (1988) gives the examples of management information about the core activities:

- Strategic Planning : Services, Marketing, Product Planning Capacity, Facility Forecasting
- Management Control : Budget, Sales Target, Service Performance, Capacity, Facility Utilization
- Operation Control: Customer Services, Information, Claims, Capacity, Facility Scheduling.

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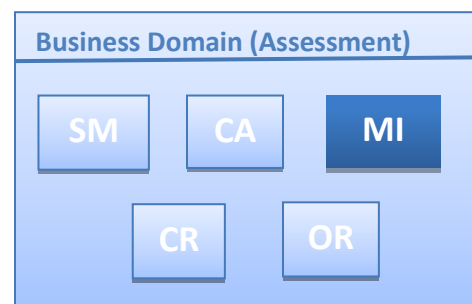
By modeling the core activities in the organization's business layer architecture, the relevant stakeholder can obviously assess whether a particular project related with its MISCA (Management Information support of core activities).
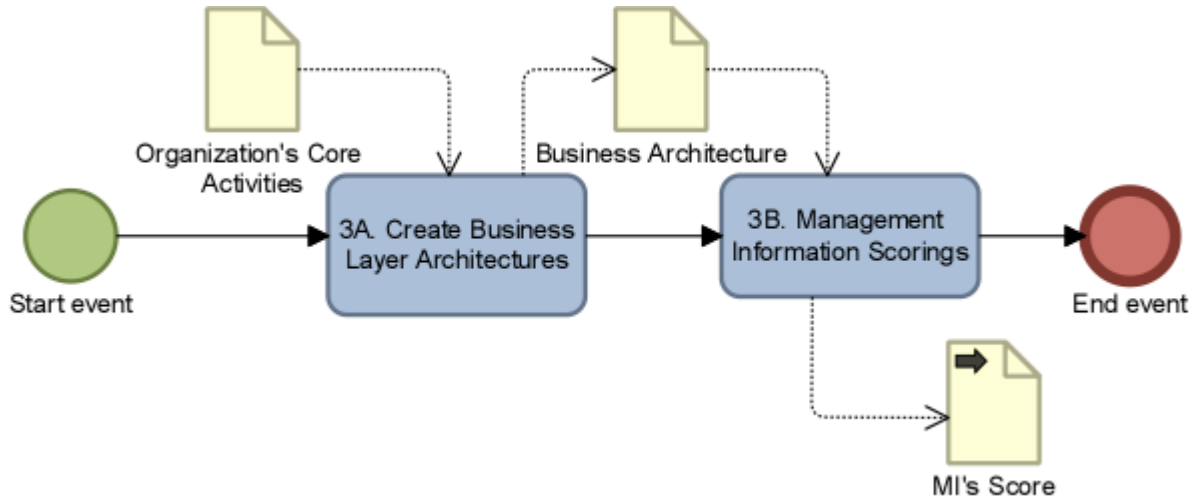
Figure 27: Business domain – MI's process

(3A) Create Business Layer Architecture

The first activity in this factor is creating business layer architecture of the organization which describes the core activities that are used as the basis to carry out the assessment process.

Table 10: Overview of "create business layer architecture" activity

3A. Create Business Layer Architecture	
Description	Creation of business layer architecture of the organization
Input	Organization's Core activities
Possible Actor(s)	Enterprise Architect
Technique	General Architecture Modelling Approach (M. E. Iacob et al., 2012) using EA modeling tool
Output	Business architecture of the organization

(3)-b Management Information Scoring

The purpose of this step is to assess the core activity in the MI's process. The relevant stakeholder; e.g. Program or Project Management Office evaluates the proposed projects/programs by comparing them with the business architecture as the output from the previous activity. The input architecture and EA-based MI worksheet (Figure 28) facilitate the scoring decision on this factor.

Table 11: Overview of "management information scoring" activity

3B. Management Information Scoring	
Description	Scoring activity to specify the degree to which the project provides management information on the core activities modeled on the architecture.
Input	Business architecture of the organization Architecture Layer : Business Layer Architecture Aspect : Behavior, structure
Possible Actor(s)	Program or Project Management Office
Technique	Scoring using EA-based MI worksheet and input architecture
Output	Architecture-based MI's score (0-5)

0. The project is unrelated to management information support of core activities (MISCA) modeled on the architecture.
1. The project is unrelated to MISCA modeled on the architecture, but does provide some data on functions that bear on core activities in the enterprise.
2. The project is unrelated to MISCA modeled on the architecture, but does provide information on functions that directly support core activities.
3. The project is unrelated to MISCA modeled on the architecture, but provides essential information on function identified as core activities. Such information is operational in character.
4. The project is essential to providing MISCA modeled on the architecture in future.
5. The project is essential to providing MISCA modeled on the architecture in a current period.

Figure 28: EA-based MI's worksheet

The overview of the architecture for scoring 4 and 5 is displayed in Figure 29. Scoring 4 gives the example of modeling MISCA in the future by relating the project with the defined core activities which modeled on the target architecture. If the project contributes to MISCA in the current situation, then the score 5 can be given. Illustration of others score (1, 2 & 3) quite depend on the condition of the organization. If the project is unrelated to the MISCA, the score of this factor will be 0. For the justification of scoring 1, 2 and 3; the actor(s) should have an understanding of the function and its information that are required by the organization's core activities.
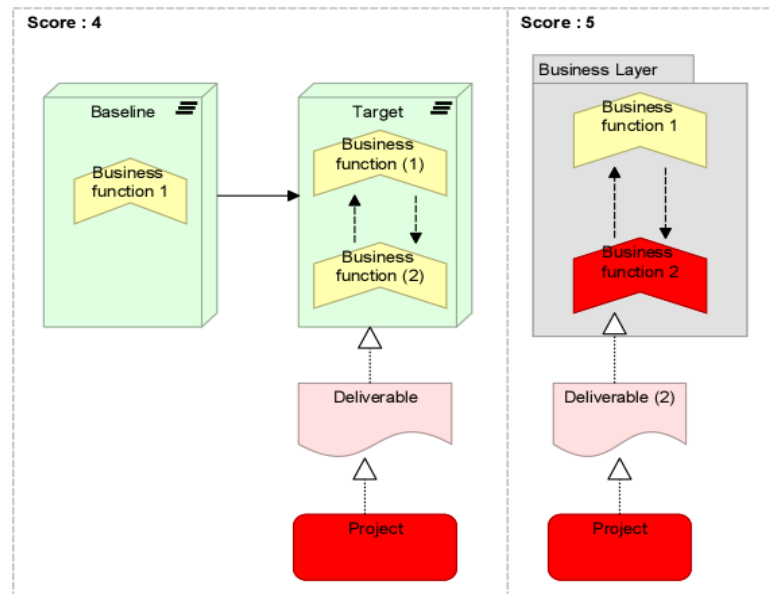
Figure 29: Architecture MI's scoring overview

3.2.4 Competitive Response (CR)

The assessment of competitive response is related to the business risk associated with not undertaking the project. The basis of this factor is not gain from EA, but from the CR's worksheet (appendix 1.4). The rating process for CR is varied by examining the effect of postponing the project for at least a year (low score) until there is a loss of competitive opportunity for the organization by doing so. The question in this factor is: how long is it possible to delay the project without any significant reduction of competitive strength? (Andresen, 2001).
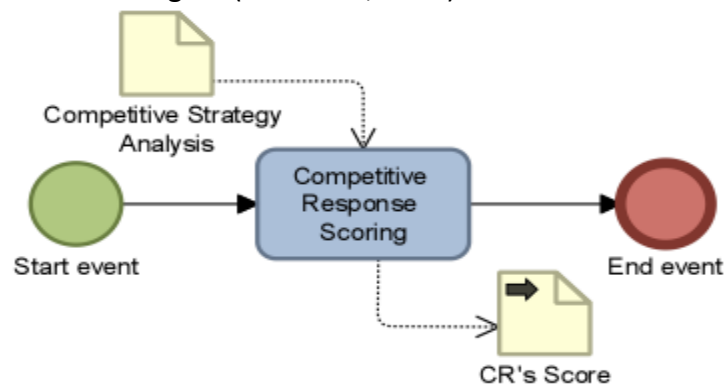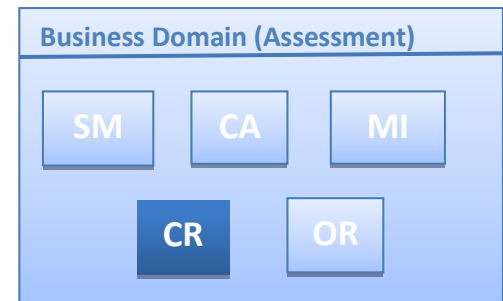
Figure 30: Business domain – CR's process

In this step, it is assumed that the proposed project has a business case accordingly or any document with a detailed description about the necessity of the project. However, information

about the process of making a business case is not covered in this thesis. The organization could adopt a business case development method by (Ward, Daniel, & Peppard, 2007) and (Harvard Business Review Press, 2010) which provide a stepwise approach to develop the business case.

Table 12: Overview of "competitive response scoring" activity

Competitive Response Scoring	
Description	Scoring activity to measure the degree to which failure to implement the project will cause competitive damage to the organization.
Input	Competitive strategy analysis
Possible Actor(s)	Program or Project Management Office
Technique	Scoring using CR worksheet
Output	CR's worksheet (0-5)

3.2.5 Project or Organization Risk (OR)

Similar to CA and CR, the measurement process of OR is based on the OR's worksheet at Appendix 1.5. This factor assesses the preparedness of the business for the changes caused by implementing the proposed project. In the OR's worksheet, eight elements of the risk that being assessed are: formulation of a business domain plan to implement the project, the presence of business management, contingency plan, documentation of processes and procedures, user training plan, the existence of management champion, product's definition, and market's understanding.
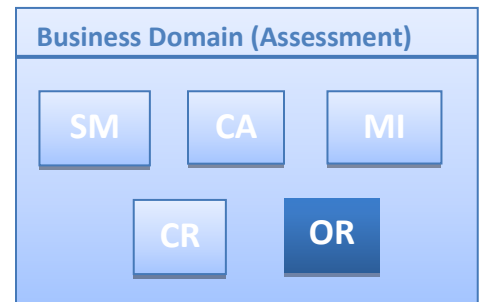
Figure 31: Business domain – OR's process

The description of the changes needed in the organization for enabling project's benefits and its associated risk analysis in the business case document could be used as the input to score CR. Hence, it is again assumed that the proposed project has a business case accordingly or any

document that has a detailed description about the risk analysis of the project. By assessing this factor, the organization may know the reason why the proposed project does not work as it should and become less valuable, which could be considered as the most crucial risk of all (Willcocks, 2013).

Organization Risk Scoring	
Description	Scoring the activity to assess the degree to which the organization is capable of carrying out the changes required by the project.
Input	Business case
Possible Actor(s)	Program or Project Management Office
Technique	Scoring using OR worksheet
Output	OR's worksheet (0-5)

3.3 Technology Domain Assessment:

There are four criteria to assess the technology domain; Strategic IS Architecture (SA), Definitional uncertainty (DU), IS Infrastructure Risk (IS), and Technical Uncertainty (TU). The input for all factors can be gained from the architecture view. Similar to the business domain, the calculation of technology domain is executed after multiplying each technology factors' score by the corporate's value (the weight). The description of each technology domains' factor, the input, output and the assessment process will be elaborated in the following section.
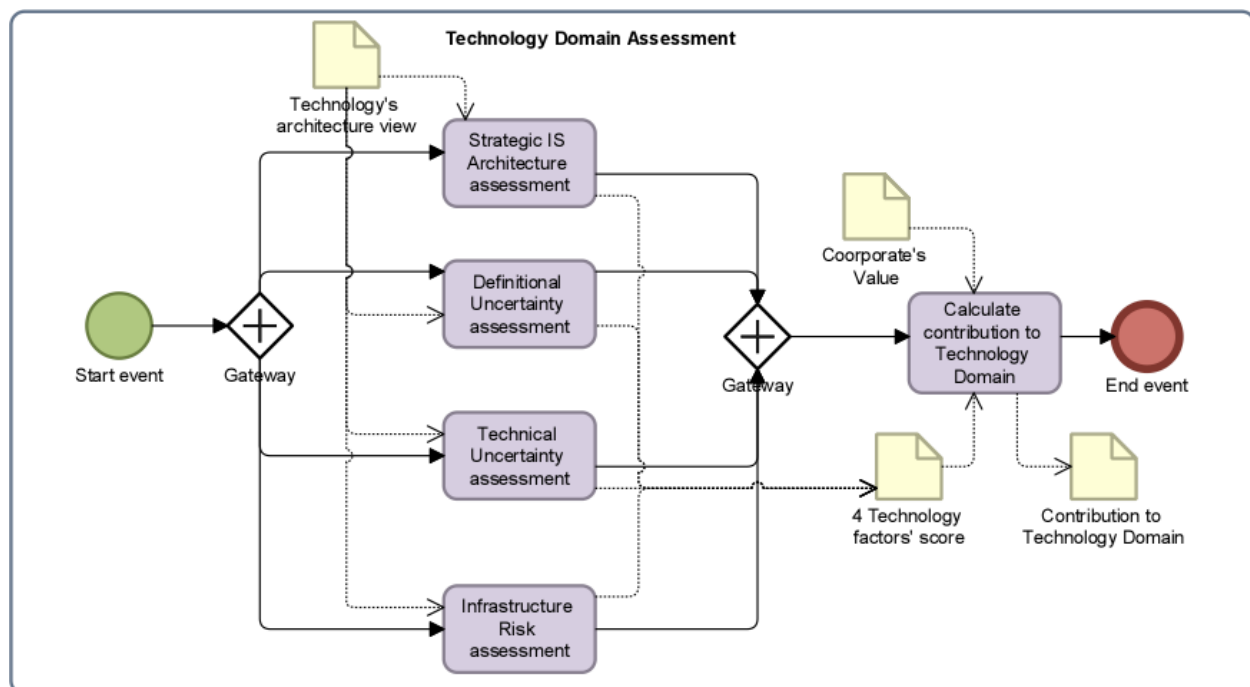
Figure 32: Technology domain assessment

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3.3.1 Strategic IS Architecture (SA)

SA assesses the degree to which the project is aligned with the current IT strategy. The score of each projects/programs is evaluated based on its integration with the current Information systems plan (the blueprint). The information systems plan reflects the alignment of the projects and overall IS strategy (Parker et al., 1988). The overview of required steps to carry out the assesment is indicated in Figure 33.

Technology Domain (Assessment)

SA	DU
IR	TU
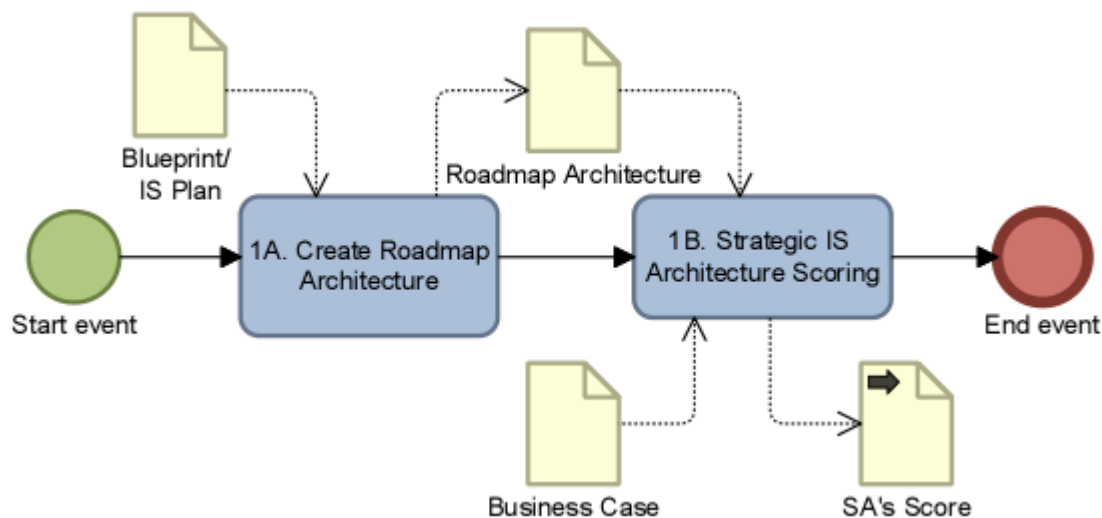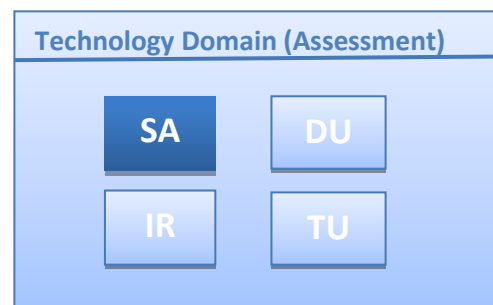
Figure 33: Technology domain – SA's process

(1A) Create Roadmap Architecture

The first step in the SA's process is creating roadmap architecture of the organization. The architecture roadmap lists individual work packages that will realize the target architecture and lays them out in a timeline to show the progression from the Baseline Architecture to the Target Architecture (The Open Group, 2011). In accordance with a blueprint or IS plan of the organization, a roadmap architecture can be developed. This roadmap architecture will be used in the next step as the basis to assess SA's score of the projects.

Table 14: Overview of "Create Roadmap Architecture" activity

1A. Create Roadmap Architecture	
Description	Creation of organization's roadmap architecture
Input	Organization's Blueprint/ IS Plan
Possible Actor(s)	Enterprise Architect
Technique	General Architecture Modelling Approach (M. E. Iacob et al., 2012) using EA modeling tool

Output	Roadmap architecture of the organization

(1B) Strategic IS Architecture Scoring

The next step for scoring SA, EA-based SA worksheet (Figure 34) is used to specify the degree alignment between projects and overall IS strategies.

Table 15: Overview of "Strategic IS Architecture Scoring" activity

1B. Strategic IS Architecture Scoring	
Description	Scoring the activity to determine the degree of the project alignment with the overall information system strategies.
Input	- The roadmap of an organization's information systems plan modeled on the implementation and migration viewpoint. Architecture Layer : Business layer, application layer, technology layer, Implementation and migration extension Architecture Aspect : Motivation Extension - Business case.
Possible Actor(s)	Program or Project Management Office
Technique	Scoring using EA-based SA worksheet, input architecture and business case.
Output	EA-based SA's score (0-5)

0. The proposed project is unrelated to the roadmap architecture.
1. The proposed project is a part of the roadmap architecture, but its priorities are not defined.
2. The proposed project is a part of the roadmap architecture, and has a low $ payoff; it is not prerequisite to other roadmap projects, nor is it closely linked to other prerequisite projects.
3. The proposed project is an integral part of the roadmap architecture, and has medium $ payoff; it is not prerequisite to other roadmap projects, but is loosely linked to other prerequisite projects.
4. The proposed project is an integral part of the roadmap architecture, and has a high $ payoff; it is not prerequisite to other roadmap projects, but is closely linked to other prerequisite projects.
5. The proposed project is an integral part of the roadmap architecture, and is one that is to be implemented first; it is prerequisite projects to other roadmap projects.

Figure 34: EA-based SA worksheet

A roadmap architecture from Archimethal case study (Bjekovic et al., 2014) is used with additional fictional projects modeled in the architecture (shown in Figure 35) to show the example of SA's scoring process. The example for scoring 1 until 5 is given, while for 0, it depends on the organization blueprint whether a specific project is unrelated with its roadmap architecture. As depicted in Figure 35, score 2, 3, 4 and 5 cannot be distinguished by the structure of roadmap architecture alone. As long as the projects/programs are modeled on the roadmap architecture and being a part of the timeline, the possible score range lies in between 2-5. Therefore, more detailed information from the business case or another document about the projects/ programs is needed. The examples of information needed are the payoff of projects in terms of finance, the dependency with other projects, and the urgency of the project.
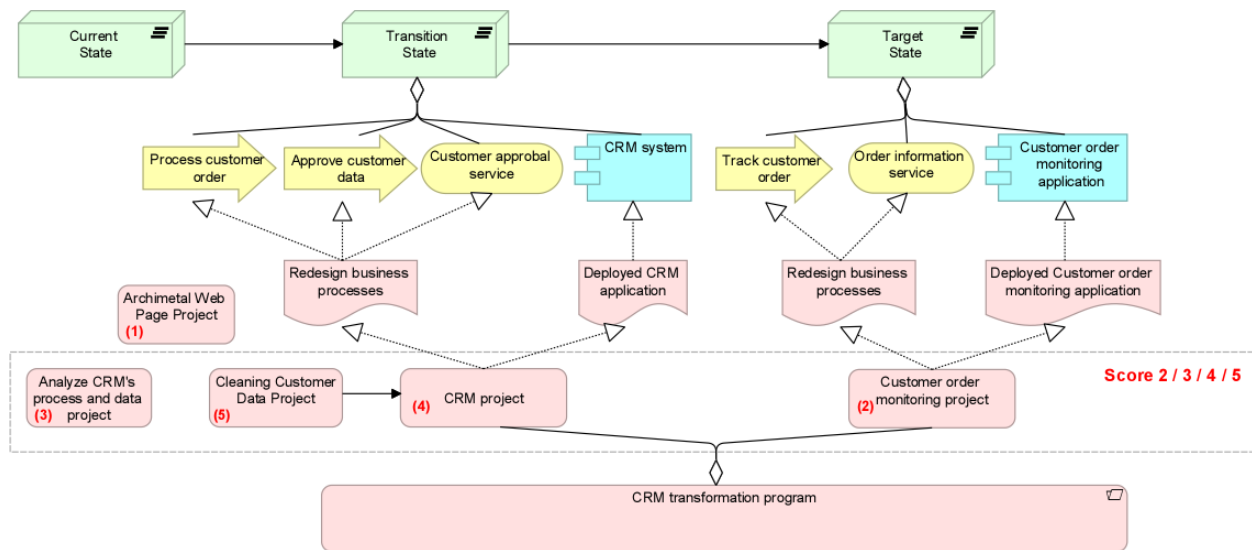
Figure 35: Archimetal SA's scoring overview

3.3.2 Definitional Uncertainty (DU)

DU is the first risk addressed from technology domain. It assesses the degree to which the project specification is ill-defined and/or unapproved; the key here is the unknown requirements (Parker et al). Before deciding the scoring, the relevant stakeholder can analyze the current EA, which is modeled in the requirements view of the architecture. However, the requirements modeled on the architecture are not necessarily sufficient to assess DU factor. Thus, related document which has detailed description of the requirements and specification of each project (e.g. Business case document) is needed.
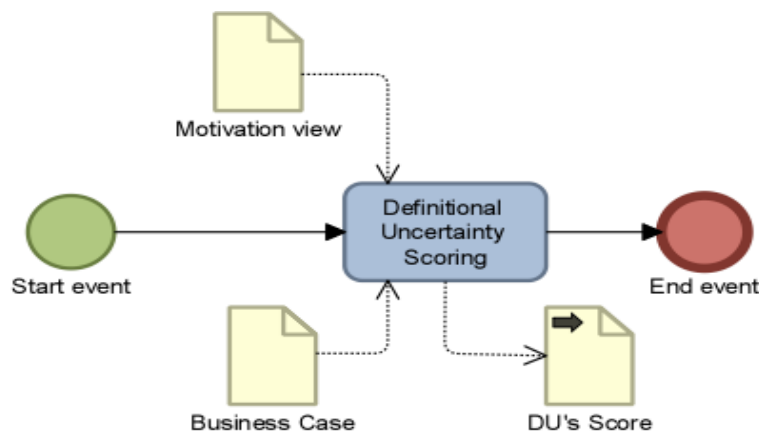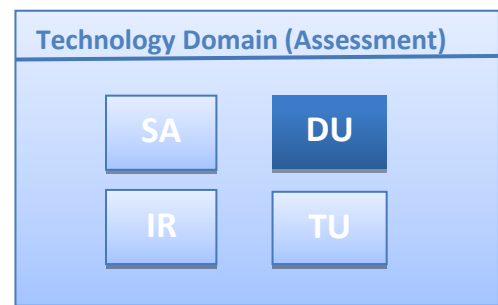
Figure 36: Technology domain – DU's process

Definitional Uncertainty Scoring	
Description	Scoring the activity to specify the degree to which requirement, specifications and changes in the project are known.

Input	- Motivation architecture of the organization
	   Architecture Layer : Business, application, technology layer,
	   Architecture Aspect : Motivation
	- Business Case document

Possible Actor(s)	Program or Project Management Office, Enterprise Architect
Technique	Scoring using EA-based DU worksheet and input architecture
Output	EA-based DU's score (0-5)

The process of scoring DU's factor is briefly illustrated in Figure 36. Motivation view architecture and business case could be used to adjust the score of DU's factor. Definitional Uncertainty is the assessment of "to what degree the requirements and specification are known and how great the complexity of the area and the probability of non-project routine changes in the information system are (Gronlund, 2000). Thus, DU's score of the project is defined based on the input documents and EA-based DU worksheet (Figure 38). It is assumed again that the project should have a business case accordingly or any document that has the detailed description of the specification or requirement of the project.
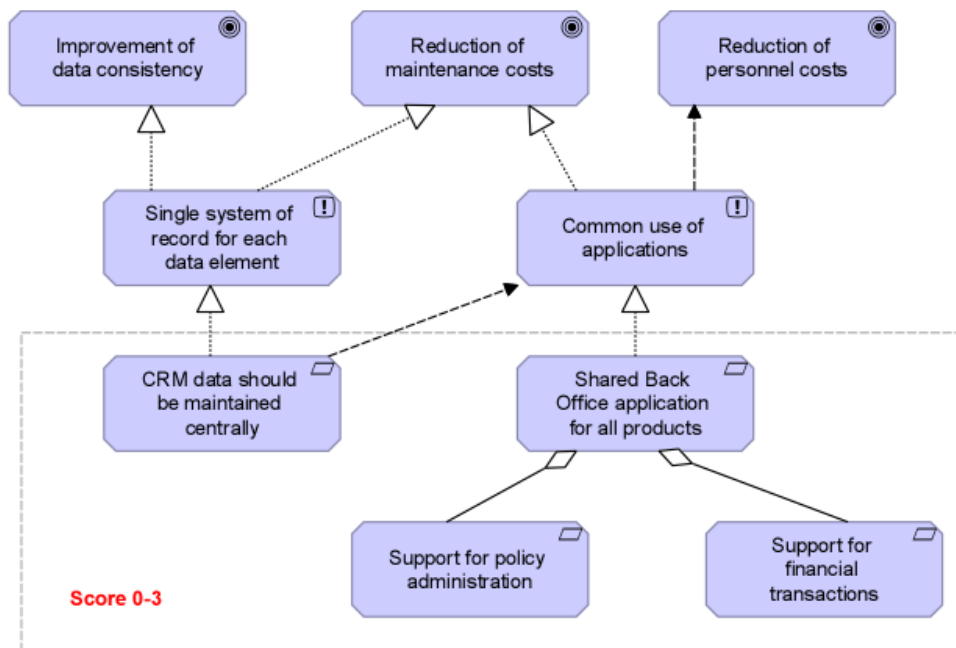
Figure 37: Archisurance Motivation View

Using the motivation view modeled in the architecture, the organization could have a general or a high-level requirement derived from the organization's strategic goal. However, the detailed requirements, specifications and change in risk information related to the project are obtained from the business case document. Figure 37 shows the possibility of scoring 0 to 3 from the motivation view of Archisurance's case study. It depends on the detail of the proposed project that will be assessed.

SCORE (0-5)
0. Requirements modeled on architecture are firm and approved. Specifications are firm and approved. Investigated area is straightforward. High probability of no changes.
1. Requirements modeled on architecture moderately firm. Specifications are moderately firm. No formal approvals. Investigated area is straightforward. Low probability of nonroutine changes.
2. Requirements modeled on architecture moderately firm. Specifications are moderately firm. Investigated area is straightforward. Reasonable probability of nonroutine changes.
3. Requirements modeled on architecture moderately firm. Specifications are moderately firm. Investigated area is straightforward. Changes are almost certain almost immediately.
4. Requirements modeled on architecture not firm. Specifications are not firm. Area is quite complex. Changes are almost certain, even during the project period.
5. Requirements modeled on architecture unknown. Specifications are unknown. Area may be quite complex. Changes may be ongoing, but the key here is unknown requirements.

Figure 38: EA-based DU Worksheet

3.3.3 Technical Uncertainty (TU)

As specified in Information Economics (Parker et al., 1988), the purpose of technical uncertainty assessment is to recognize the risk and emphasize the preparedness and preparations needed for a successful project. The project will be assessed based on four separate aspects: skills required, hardware dependencies, software dependencies and application software. Similar with other factors, two steps are carried out to develop the architecture and specify the score of the projects in this factor (shown in Figure 39).

Technology Domain (Assessment)

SA DU

IR TU
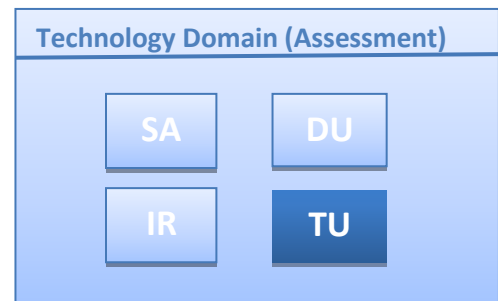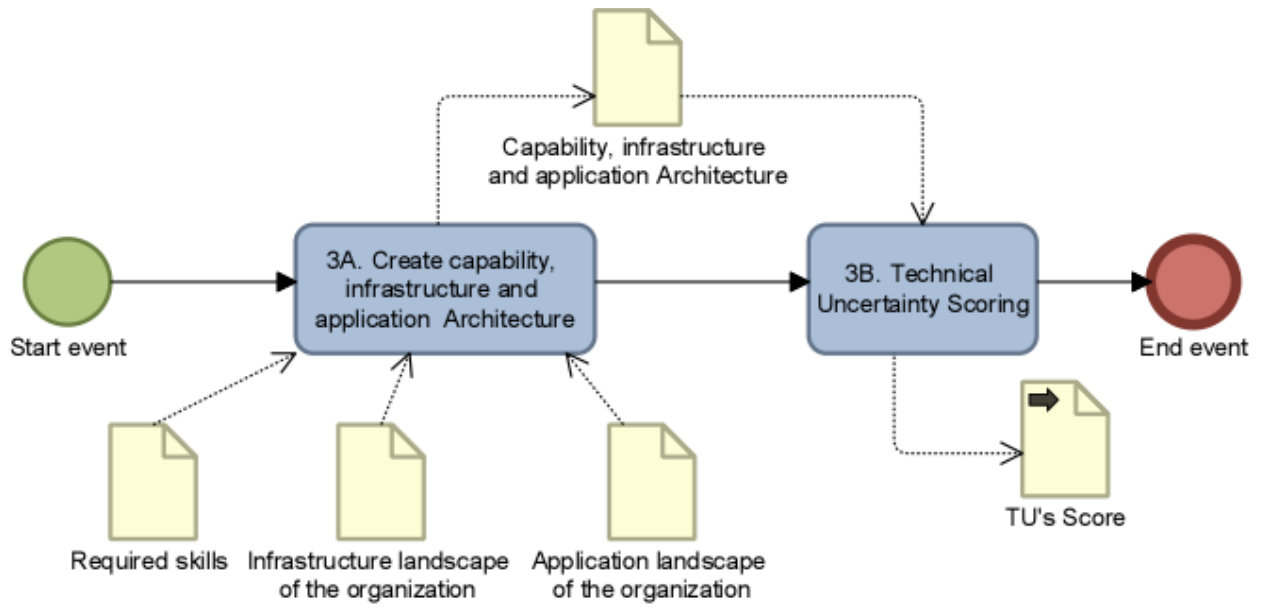
Figure 39: Technology domain – TU's process

(3A) Create Capability, Infrastructure and Application Architecture
The goal of this step is to develop three architecture viewpoints of the organization. Since four separate aspects are assessed in this factor, a capability, infrastructure and application architecture can be developed. Capability is a concept in ArchiMate recommended by M.-E. Iacob et al., (2012), Aldea et al. (2015), and Anastasios (2014). In this method, the concept of capability is used to model the skills capability of the organization. In the meantime, by using the infrastructure and application landscape, the architect could model the infrastructure and application architecture of the organization.

Table 17: Overview of "Create capability, infrastructure and application architecture" activity

3A. Create Capability, Infrastructure and Application Architecture	
Description	Creation of capability, infrastructure, and application architecture
Input	Required skills, infrastructure landscape of the organization, application landscape of the organization
Possible Actor(s)	Enterprise Architect
Technique	General Architecture Modelling Approach (M. E. Iacob et al., 2012) using EA modeling tool
Output	Capability, infrastructure and application architecture of the organization

(3B) Technical Uncertainty Scoring
After modeling the architecture, the next step is scoring the technical uncertainty factor of the project. Similar with the previous steps, EA-based TU worksheet (Figure 40) and the input architecture will be used to define the score.

Table 18: Overview of "Technical Uncertainty Scoring" activity

3B. Technical Uncertainty Scoring	
Description	Scoring the activity to determine the readiness of the technology domain to carry out the project.
Input	Capability, infrastructure and application architecture of the organization
	Architecture Layer : Application layer, technology layer, implementation and migration extension
	Architecture Aspect : Behavior, structure, information
Possible Actor(s)	Program or Project Management Office, Enterprise Architect
Technique	Scoring using EA-based TU worksheet and input architecture
Output	EA-based TU's score (0-5)

The first aspect assessed in the TU is the required skill, Figure 41 give an overview of the scoring capability architecture. The scoring overview is defined into two categories: first for scoring 1-3, and second for 4-5. The first category shows that some new skills are required, while the second shows that extensive (new) skills are required by the organization.

Infrastructure architecture of the organization is used to score the hardware dependencies and the system software dependencies using different viewpoints (Section 2.3.2). For instance, the infrastructure usage viewpoint is used for scoring the hardware dependencies, while infrastructure viewpoint and motivation viewpoint are used to score the system software dependencies. The scoring overview of 0, 1, 2 and 3 for hardware dependencies is illustrated in Figure 42. The concept of infrastructure service depicts the use of the hardware in a similar or different application (scoring 0/1). The score 2 shows that the service exists but is not yet used operationally by any application, while score 3 indicates that the hardware is available but does not give any service yet. Lastly, the score 4 and 5 depend on the condition of the organization on whether the requirement of the project related to the infrastructure's state of affairs in the organization is satisfied: whether the infrastructure is not available or the key feature are not tested or implemented.

The scoring overview of the system software dependencies is shown in Figure 43. The motivation extension is used to show the programming requirement of the system software. For scoring 0/1 the project depends on the standard software with or without programming's requirement. Meanwhile, the scoring 2/3 is considered when the interface is a requirement and whether the programming or new feature in the operating software is needed. The last overview of scoring 4/5 is based on the project's dependency with the advance level of the system software's requirement.

Afterwards, the illustration of application architecture (Figure 44) is used to determine the dependency on application software development. When the existing application service can be used by the project, the score is 0. Meanwhile, if a modification is needed, the score range considered is 1-3, depending on the level of complexity and difficulty level of the software modification. Finally, after each aspect is already assessed, the score of EA-based TU is defined from the average value of the previous four separate assessments. TU's score is calculated with equation (3.1)

$$\text{TU's score} = \frac{A+B+C+D}{4}$$

Where: (3.1)

A = Score of skills required

B = Score of hardware dependencies

C = Score of system software dependencies (other than application software)

D = Score of application software dependencies

SCORE (0-5)	
A. Skills required are available in the technology domain	
B. Dependency on specific hardware is not currently available	
C. Dependency on software capabilities is not currently available	
D. Dependency on application software development	

Total (A+B+C+D)/4 = Rating:

A. Skills required
   0. No new skills for staff nor management. Both have experience.
   1. Some new skills for staff, none for management.
   2. Some new skills required for staff and management.
   3. Some new skills required for staff, extensive for management.
   4. Extensive (new) skills required for staff, some for management.
   5. Extensive (new) skills required for staff, and management.

B. Hardware dependencies
   0. Hardware modeled in the architecture is in use for similar application.
   1. Hardware modeled in the architecture is in use, but for a different application.
   2. Hardwaremodeled in the architecture exists, and has been tested, but not operationally.
   3. Hardware modeled in the architecture exists, but is not utilized yet within organization.
   4. Some key features are not tested or implemented.
   5. Key requirements are not now available in MIS configuration.

C. System software dependencies (other than application software)
   0. Standard software, or straight-forward or no programming required.
   1. Standard software is used, but complex programming is required.
   2. Some new interfaces between software are required and complex programming may be required.
   3. Some new features are required in operating software, and complex interfaces between software may be required.
   4. Features not currently supported are needed, and moderate advance in local state of the art is required.
   5. Significant advance in state of the art is required

D. Application Software
   0. Application services exist with minimal modification required.
   1. Programs are available commercially with minimal modifications or programs available in-house with moderate modifications, or software will be developed in-house with minimal complexity.
   2. Programs are available commercially with moderate modifications, or in-house programs are available but modifications are extensive, or software will be developed in-house with minimal design complexity but moderate programming complexity.
   3. Software is available commercially but the complexity is high, or software will be developed in-house and the difficulty is moderate.
   4. No package or current in-house Software exists. Complexity design and programming are required, with moderate difficulty.
   5. No package or current in-house Software exists. Complexity design and programming is required, even if contracted outside.

Figure 40: EA-based TU worksheet
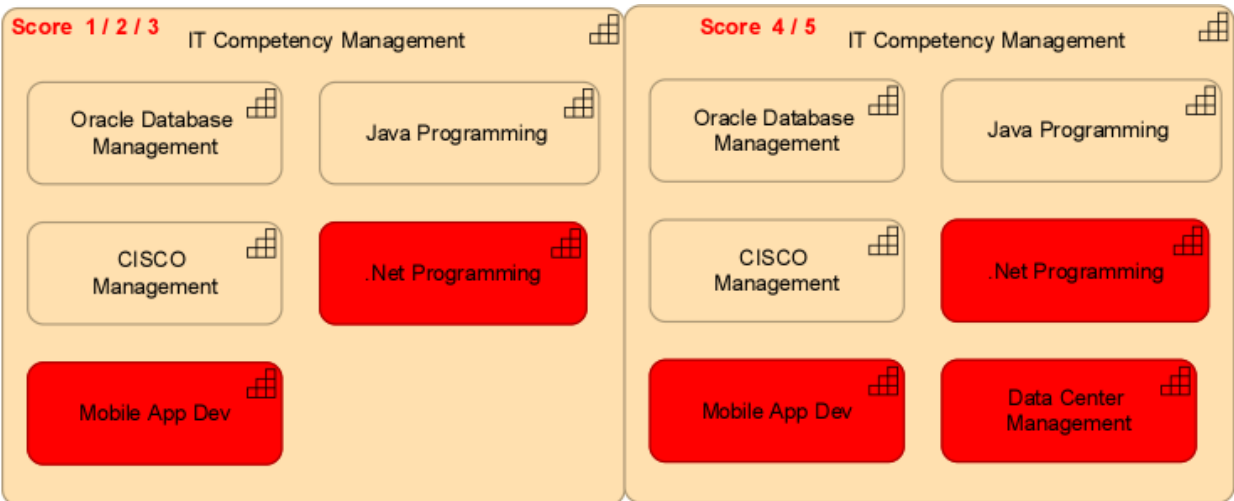
Figure 41: IT competency capability overview
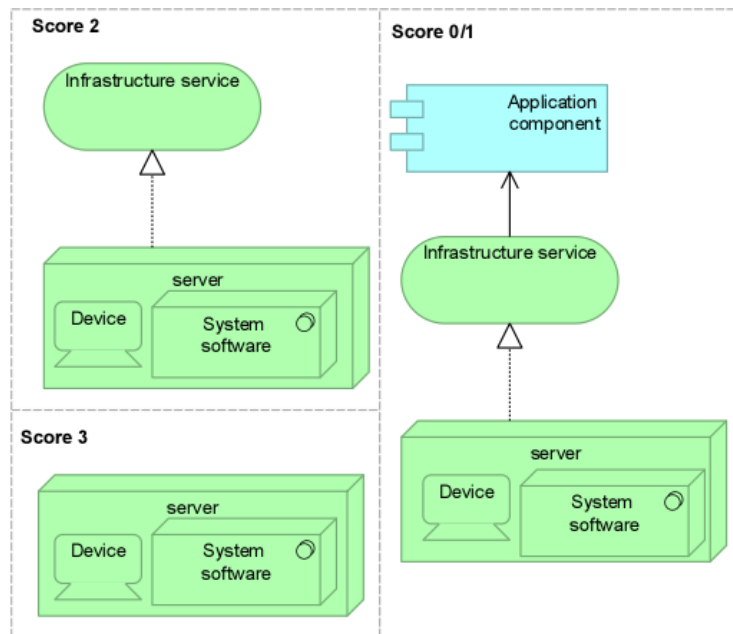
Figure 42: Hardware dependencies scoring overview

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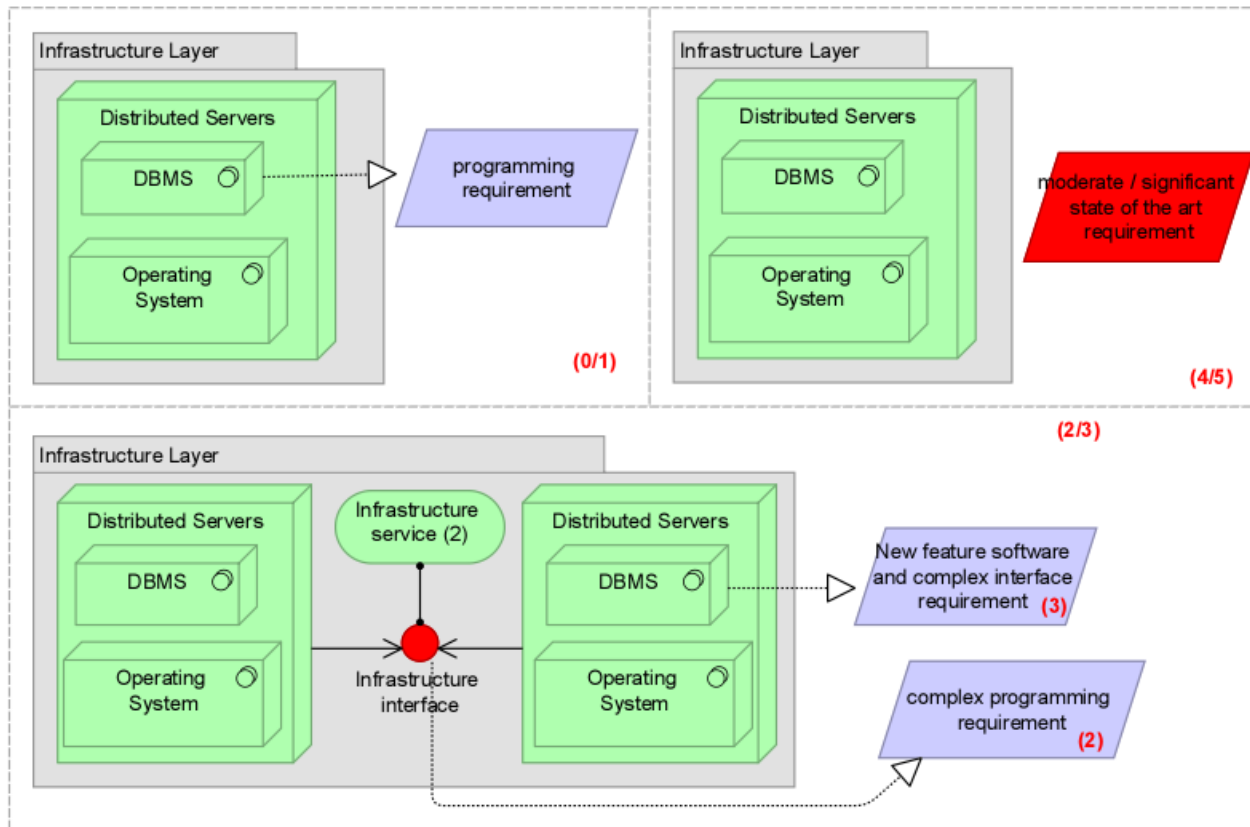
Figure 43: Software dependencies scoring overview
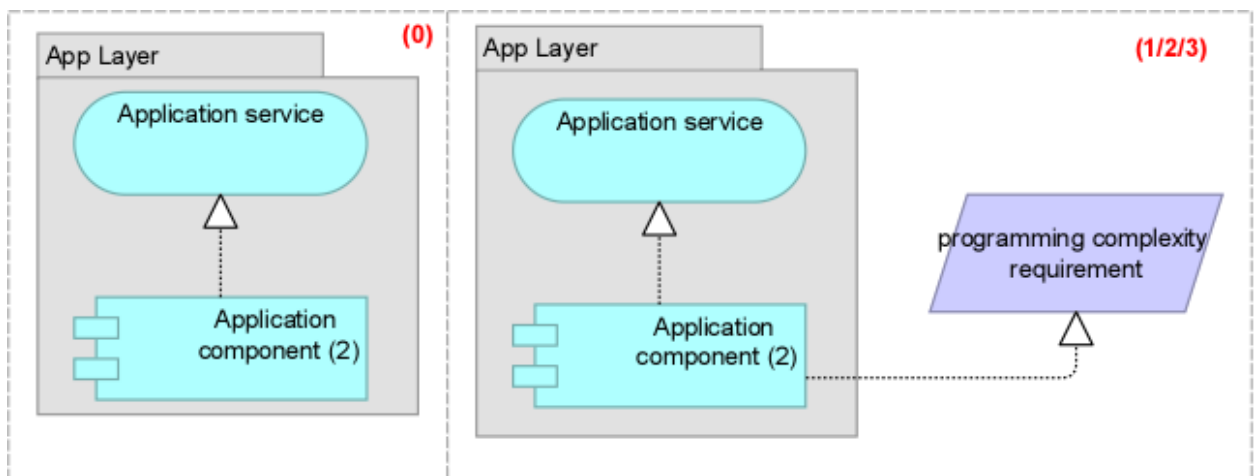
Figure 44: Application dependencies scoring overview

3.3.4 IS Infrastructure Risk (IR)

IR measures the degree to which the entire IS organization is both required to support the project and prepared to do so (Parker et al., 1988). The terms of entire IS organization points out the hardware, software and staff that are needed to accommodate the proposed project.
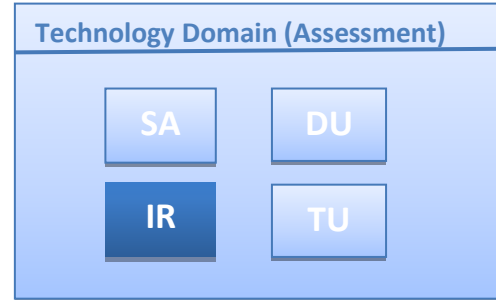
It is also seen as an environmental assessment including the factors such as data administration (for instance new data dictionary requirements), communications (e.g. new forms of communications capabilities required), and distributed systems (such as new methods of data access required).
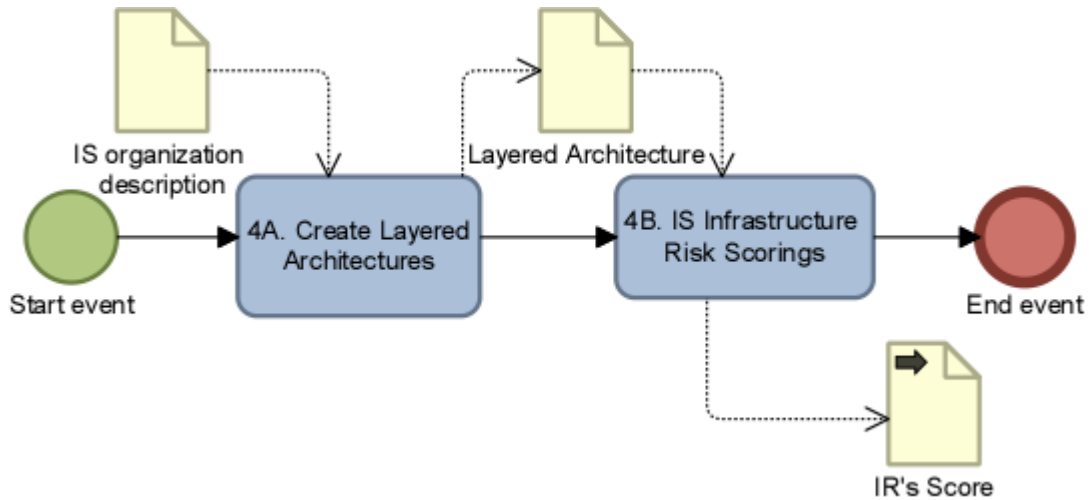
Figure 45: Technology domain – IR's process

(4A) Create Layered Architecture

In this factor, a layered architecture will be used in order to illustrate the current IS environmental support in the organization. By using a layered viewpoint, an overview of IS infrastructure can be represented in one diagram. Thus, it can be used as a support for impact of change analysis and performance analysis or for extending the service portfolio (The Open Group, 2012).

Table 19: Overview of "Create layered architecture" activity

4A. Create Layered Architecture	
Description	Creation of the organization's layered architecture
Input	IS organization description
Possible Actor(s)	Enterprise Architect
Technique	General Architecture Modelling Approach (M. E. Iacob et al., 2012) using EA modeling tool
Output	Layered architecture of the organization

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(4B) IS Infrastructure Risk Scoring

The next step is to rate the score of IS infrastructure risk using the original IS infrastructure risk worksheet based on the input architecture. The range of the score (0-5) is based on the necessary changes of the current IS organization. It varies from small, moderate and substantial changes needed for the existing infrastructure.

Table 20: Overview of "IS infrastructure risk scoring" activity

4B. IS Infrastructure Risk Scoring	
Description	Scoring the activity to specify the degree of nonproject investment necessary to accommodate the proposed project.
Input	Layered architecture of the organization Architecture Layer : Application layer, technology layer Architecture Aspect : Information, behavior, structure
Possible Actor(s)	Program or Project Management Office
Technique	Scoring using IR worksheet and input architecture
Output	EA-based IR's score (0-5)

> 0. The system uses the existing services and facilities. No investment in IS prerequisite facilities (e.g., database management) is required; no up-front costs not directly a part of the project itself are anticipated.
> 1. Change in one element of the computer service delivery system is required for this project. The associated up-front investment other than direct project costs is relatively small.
> 2. Small change in several elements of the computer service delivery system are required. Some up-front investment is necessary to accommodate this project. Some later investment for subsequent integration of this project into the mainstream of the IS environment may be necessary.
> 3. Moderate changes in several elements of the computer service delivery system are required. Some up-front investment is necessary to accommodate this project; some later investment for subsequent integration of this project into the mainstream of the IS environment will be necessary.
> 4. A moderate change in elements of the computer service delivery is required, in multiple areas. Moderate to high up-front investment in staff, software, hardware, and management is necessary to accommodate the project. This investment is not include in the direct project cost, but represents IS facilities investment to create the needed environment will be necessary for the project.
> 5. Substantial change in elements of the computer service delivery is required, in multiple areas. Considerable up-front investment in staff, software, hardware, and management is necessary to accommodate the project. This investment is not include in the direct project cost, but represents IS facilities investment to create the needed environment for the project.

Figure 46: EA-based IR worksheet
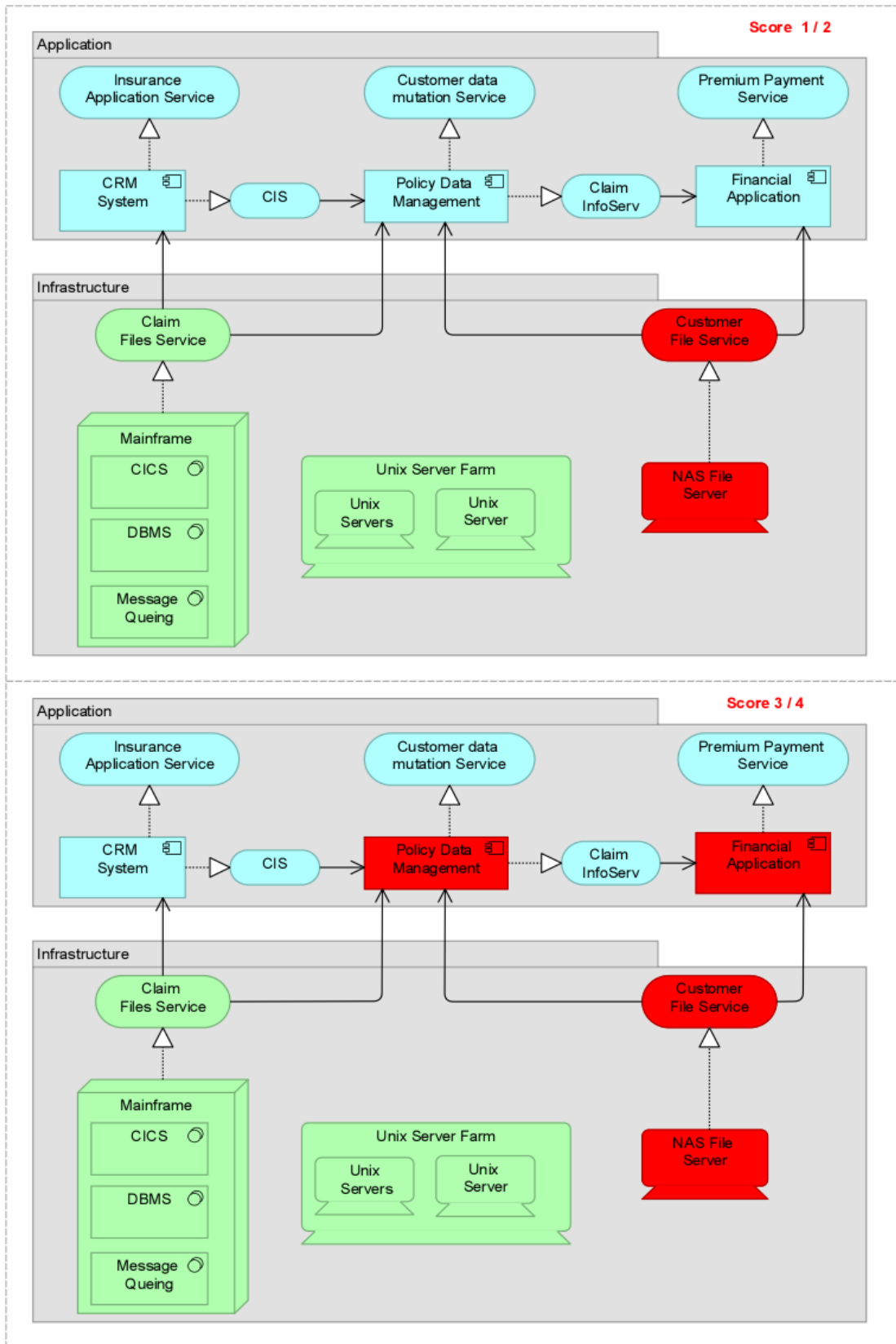
Figure 47: Architecture IR's scoring overview

3.4 Financial assessment

The third domain of the proposed method is financial assessment of a project. This section reviews several financial analysis formulas that could use to represent the financial consequence of the projects.

PP (Payback Period) specify the time at which the project return the initial investment. If the PP of a project is shorter, then it is more attractive than the one that longer. A precise formula to define specific point of the PP is specified as follows (Crundwell, 2008):

$$Y = ax+b$$

$$0 = \frac{C^+ - C^-}{Y^+ - Y^-} * (PP - Y^-) + C^-$$

Where :

C^+ : Positive cumulative cash flow Y^+ : Year when the Cumulative cash flow is positive

C^- : Negative cumulative cash flow Y^- :Year when the Cumulative cash flow is negative

ROI (Return on Investment) indicates the profitability of the investment and calculate from figures provided on the accounting statements (Crundwell, 2008).According to Mutschle (2008) the formula of ROI is determined as follow:

$$ROI = \frac{benefits - costs}{cost} * 100\%$$

NPV (Net Present Value) is by far the most universally accepted of capital budgeting approach (Harrison et al., 1999)**.**It presents the investment's value on today's value of money (Blekas, 2007). The description and limitation of this method is described in Section 2.4.1. The formula to calculate NPV (Crundwell, 2008)is provided as follow:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$$

Where

CF_t: The cash flow at period t

k: The effective periodic discount rate

Spann (2008) describes cash flow as the difference between the cash flow and accounting income. Using NPV calculation, the organization can measure the benefit of the investment directly. As mentioned in section 2.4.1, one limitation of NPV is that most of the IT investment decisions are not made based on longer-term cash flows. However, still the organization could look at its payback in a specific time to evaluate the financial consequence.

IRR (Internal rate of return) represents the value of the discount rate at which the net present value is zero (Crundwell, 2008). Therefore, the formula is defined as follow:

$$0 = \sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t}$$

This section discusses several analysis techniques in addition to Section 2.4.1 with its formula. The majority techniques to evaluate the financial consequence of a project are NPV, IRR, PP, and ROI. However, other techniques also could be used to represent this third domain, depending on the available data.

3.5 Calculation contribution to Business and Technology domain

After calculating each score in the business and technology domain, the following step in the method is calculating the total score for the contribution to business and technology domain. The score of each factor is multiplied by the weight of this factor. In line with the description in section 2.4.2 in the Information Economic method, the basis of the weight is different between organizations. Two parallel questions to be evaluated are: whether the line of business is currently profitable, considered to be in a good shape, and whether the computer service used in the line of business is currently effective or colloquially, broken (Parker et al., 1988). Parker et al (1988), suggest that a self-assessment is carried out by the organizations to determine in which quadrant they belong to. The detailed weight of each quadrants of corporate value is given in Appendix 2. Table 21 gives the example of the calculation for both values of the business and technology domain in the strategic quadrant.

Table 21: Example contribution to business and IT domain

	Business Domain					Technology Domain			
	SM	CA	MI	CR	OR	SA	DU	TU	IR
Weight	4	6	2	4	-1	1	-2	-1	1
Score	5	5	5	5	0	5	0	0	5
Total Score	80					10			

The value of the project in the business and technology domain is calculated using formula equation (3.2):

$$\sum_{i=1}^{n} S_i W_i$$

Where (3.2)

S_i : The score of each factor in its domain

W_i : The weight of each factor in its domain

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3.6 Project Visualization

The next step in EA-based Investment Portfolio method is to visualize the three values: contribution to the business domain, contribution to the technology domain and financial consequence calculation in the bubble chart. A well-conceived and designed charts is another form of language that provides a faster and clearer means of communications in comparison to the presentation of data in tabular forms (Zelazny, 2001).

Since EA-based investment portfolio method appraises the three criteria concurrently, a bubble chart is a suitable type of chart to present the data. A bubble chart is a variety of dot chart which shows a third variable in different size. Zelazny (2001) suggests the use of dot chart to shows a correlation comparison between two variables that follows or fails to follow the pattern that the audience normally expect. In this method, the stakeholder expectation is that the proposed project will contribute positively both to business and IT domain. Then, the feasibility of a proposed project in term of financial resource is shown by a financial consequence calculation. Figure 48 depicts an example of project's visualization in a bubble chart. It shows the visualization of three proposed projects in an organization and maps its contribution to the business and IT domain.
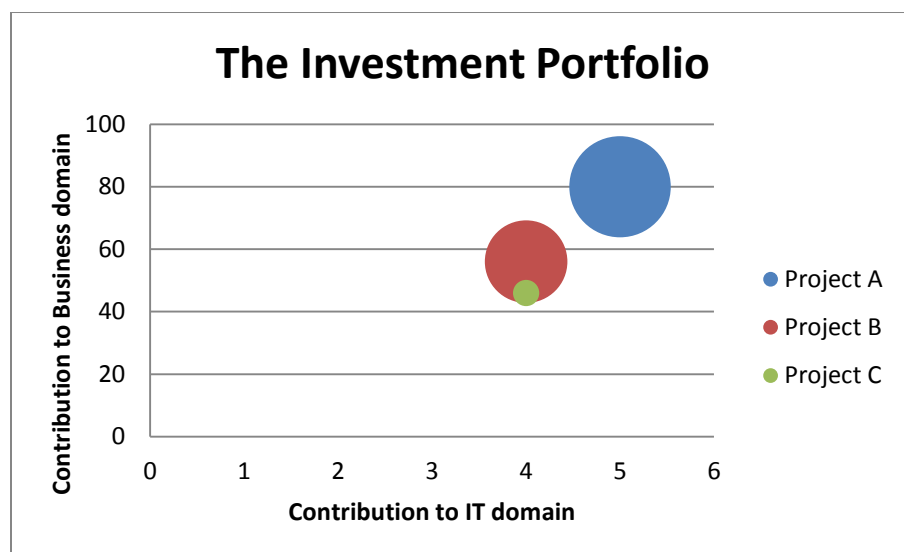
Figure 48: Example EA-based investment Portfolio visualization

After visualizing the proposed projects in a bubble chart, we could map the projects in four (4) quadrants. By analyzing the position of the projects in the quadrants, the organization could review their projects from two perspectives: whether it has higher business or IT value. In this thesis, we refer the four (4) quadrants in the bubble chart as portfolio map. MoSCoW rules (Stapleton, 2003) is used to structure the recommendation to the decision maker. Following,

the recommendation description is given to interpret the quadrants in the bubble chart (Figure 49):

- Quadrant A ('Must Have')

  The projects that belong in this quadrant could be considered as the top prioritized projects. Following the MoSCoW rules, the organization **must** carry out the projects here, because they have high score both for the contribution in Business and IT domain. By carrying out the project, an organization gets the benefit for the business. It means that the projects contribute to develop the current business. From the IT perspective, the projects here are supported by IT facilities in the organization.

- Quadrant B ('Should have')

  This quadrant indicates the projects that **should** have by the organization because it enhances the business value. However, from the IT perspective, the projects has low value because several possible reason like : the organization's IT infrastructure is not yet ready to support the projects, the level of the risk from IT side, it is not belong to the IT roadmap strategy, etc. Nevertheless, the projects here represents high-priority items that should be included in the solution of possible(Miranda, 2011) .

- Quadrant C ('Could have)

  The third quadrant depicts the projects that **could** execute by the organization. The projects here are considered desirable but not necessary (Miranda, 2011), because it does not really enhance the business although supported by the IT.

- Quadrant D ('Won't have')

  The organization could consider the projects that belong into this quadrant become the projects that they **won't** have for the moment. The projects in this quadrant could be revisited. There are two possibilities: whether the current IT facility is not support the proposed projects, or it does not give any contribution to the business.

Figure 49: Portfolio Map

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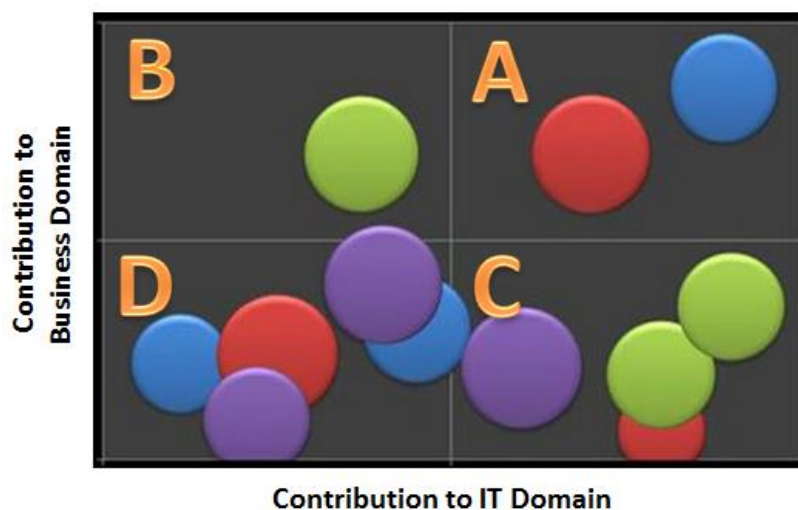
3.7 Project Prioritization

After assessing the position of the project based on the three factors, a list of project priorities is made from the existing data. A 'scoring-weight' method is used to specify the final score of proposed projects. Considering the importance of each domain: business, IT and finance, the weight could be defined (from 0 to 1), then multiplied with each score of the domain.

The formula to calculate the value of the project in the business and technology domain is (equation 3.3):

$$\text{Project's score} = \sum_{i=1}^{3} S_i W_i$$

Where (3.3)

S_i : The score of each domain value

W_i : The importance weight of each domain

The level of importance:

0 = Not Important

0.3 = Somewhat Important

0.5= Important

0.6= Very Important

1 =Absolutely Essential

Table 22: Project prioritization

	Business	Technology	Finance
Project A	0.2	0.5	0.3
	80	5	1.5
	18.95		
Project B	0.2	0.5	0.3
	56	4	1
	13.5		
Project C	0.2	0.5	0.3
	46	4	0.1
	11.23		

The sort of final score determines the ranking of the project. Therefore, the ranking list could be used as a basis to prioritize the project's evaluation and selection. For example, Table 22 shows that the order of the prioritized projects based on total score are: Project A, Project B and Project C.

3.8 Summary

Detailed description of EA-based investment portfolio method is specified in this chapter. Starting from the high-level process in the EA-based Investment Portfolio Method (Section 3.1) and finishing with the project prioritization (Section 3.2.5). To conclude, the steps in the EA-based Investment Portfolio are described as follows:

1. **Define the corporate's value** as a weight basis calculation for IT and business domain (the detailed weight is given in Appendix 2).
2. **Scoring** the five factors in the business domain and four factors technology domain, then multiply the score with the weight based-on 1st step.
3. **NPV** Calculation.
4. **Visualize** three subsets of data in a bubble chart.
5. **Define the importance weightage** of three subset data.
6. **Project prioritization** by multiplying the weight with the score, and sort the project score as a suggestion for the decision maker.

4. Demonstration ArchiPharma Case

Following the forth step of DSRM that is; to demonstrate the use of the artifact to solve one or more instance of the problem. This chapter elaborates the utilization of the method in a case study after developing the proposed EA-based Investment portfolio method in previous chapter. Section 4.1 illustrates briefly the description of the case study. Afterwards, the remaining section shows a thorough process of the proposed method in the ArchiPharma case study.

4.1 Case Study Description

In order to demonstrate the implementation of EA-based information portfolio method, a case study is used as a research method in this thesis. Using the case study method allows the investigators or the researcher to retain a holistic and meaningful characteristic of real-life events (R. K. Yin, 2009). In this research, one case study that being used is the case study on ArchiPharma. ArchiPharma is a case-study, which is currently also a research topic for BiZZdesign Enterprise Portfolio Management. The documentation about the case is taken from BiZZdesign Research and Development department. Some assumptions or additional information are created by the author to provide necessary information to carry out the EA-based method developed in the Chapter 3.

Archiparma is a real, but anonymized large international pharmaceutical organization that has many geographically spread locations. The organization is the result of many mergers and takeovers. The high level end goal of the organization is to become the leading provider of healthcare service in the world. Currently, Archipharma faced several challenges both from external pressure and internal legacy. From the external perspective: there are other competitors which are highly competitive and eager to become the leader in the industry, the company also needs to comply with many (governmental) regulations that change regularly. Internally, Archipharma encounters a large application landscape as a result of the many mergers and take-overs, which simply patched their landscape together. The external challenges force the business to be agile in the operation, which is not easy, partly because of the legacy application landscape.

At the moment, these conditions effect the business interaction with customers. For instance, a process which is executed slightly differently by each business unit. Especially large and international customers, who interact with more than one business unit are more likely to get diverse bills. Their data might appear slightly different in CRM databases managed by different business unit, which result in the differences in addresses, names, etc. The bill also might look slightly different in terms of payment due dates, timing of sending, etc. depend on the business

unit. This contradicts with the goal of having a professional and coherent image towards the customers. Therefore, a number of programs and projects are proposed in order to face all the challenges mentioned above. Their main concern is how to manage and assess all the projects in accordance with their goals. In the following section, the proposed method is implemented to show its efficacy of assessing the projects in a company. Section 4.1.1 illustrates the list of projects to be assessed. Subsequently, section 4.1.2 elaborates the corporate value of Acrhipharma which will be used as the weight to assess the business and technology domain.

4.1.1 List of projects in Archipharma

There are 8 Programs and 50 projects in Archipharma which will be executed. The list of the programs and the following projects are:

Application Rationalization
1. Define Valuation Model
2. Develop application rationalization roadmap
3. Identify obsolete applications
4. Install application lifecycle management approach
5. Inventory application
6. Migrate and eliminate identified applications
7. Valuate application

Harmonize billing process
1. Analyze billing process variance
2. Choose, develop, test and run global, test and run global finance
3. Harmonize process variants
4. Phase out Amsterdam billing applications
5. Phase out London billing applications
6. Phase out New York billing applications

Improve global accessibility database
1. Analyze data sources
2. Develop database authentication protocols
3. Develop integrated reporting
4. Install database authentication
5. Install federated database management system (FDMS)
6. Prepare and adapt database
7. Publish database information

Installment of APM process
1. Choose, configure, test and install APM applications
2. Design and populate application portfolios
3. Design enterprise-wide APM process

Professionalize marketing
1. Align marketing processes
2. Analyze current marketing processes
3. Consolidate marketing applications
4. Install necessary applications for monitoring competitors
5. Install process for monitoring competitors
6. Integrate marketing processes

Revision of PPM process
1. Choose, develop and install enterprise-wide PPM software
2. Develop real-time portfolio monitoring
3. Develop real-time portfolio reporting
4. Harmonize local PPM approaches
5. Install enterprise-wide PPM approach
6. Inventory all PPM processes

Homogenize info & data
1. Analyze heterogeneous data sources
2. Analyze heterogeneous information sources
3. Consistent data model development
4. Data cleaning
5. Data mapping
6. Design data architecture
7. Information cleaning
8. Information harmonization
9. Information mapping

Product rationalization
1. Analyze current product portfolio
2. Expand customer channels with internet
3. Harmonize ordering process
4. Identify products for termination, migration and consolidation
5. Rationalize product portfolio
6. Redesign portfolio into limited set of highly configurable products

4.1.2 Corporate Value of Archipharma

The current condition of Archipharma shows that the line of business is profitable, competitive, healthy and strong. With a set of their product as the result of merger and takeovers, they could build a competitive position among their competitor. The current business also supported with a strong and effective computer service. The combination of strong line of business and

computer support reinforces the position of Archipharma in the Strategic Quadrant (Appendix 2.2) as the base of the relative weight in the business and technology domain.

Table 23: Archipharma Corporate Values

DOMAIN	LIKELY VALUE	RESULTING WEIGHT
BUSINESS DOMAIN		
1. Strategic Match	High	4
2. Competitive Advantage	Highest	6
3. Management Information	Medium	2
4. Competitive Response	High	4
5. Organizational Risk	Low	-1
TECHNOLOGY DOMAIN		
1. Definitional Uncertainty	Medium	-2
2. Technical Uncertainty	Low	-1
3. Strategic IS Architecture	Low	1
4. IS Infrastructure Risk	Low	1

Table 23 shows the resulting weight of Archipharma, which will be used to assess all the factors in business and technology domain. With this resulting weight, the score of the project would be varied from -5 to 80 for business domain and -15 to 10 for technology domain. This relative weight reflects that Archipharma wants to focus on the investment that could give them an opportunity to strengthen the company in the future. Thus, it emphasizes on the competitive advantage, strategic match, and competitive response.

4.2 Business Domain Assessment

As described in the previous chapter, five factors will be assessed in the business domain. Detailed description of the Archipharma's business domain is carried out in the following section.

4.2.1 Strategic Match (SM)

Step 1A : Create motivation and program architecture

In order to create a motivation and program architecture of Archipharma, vision and mission (Figure 50) are used to formulize two strategic goals of Archipharma.

Figure 50 : Archiparma's Vision, Mission and Strategies

Output1A: Motivation and project architecture (Figure 51)

Afterwards, those strategic goals are used to model Archipharma's strategy implementation, which relates the strategic goal with a specific program.
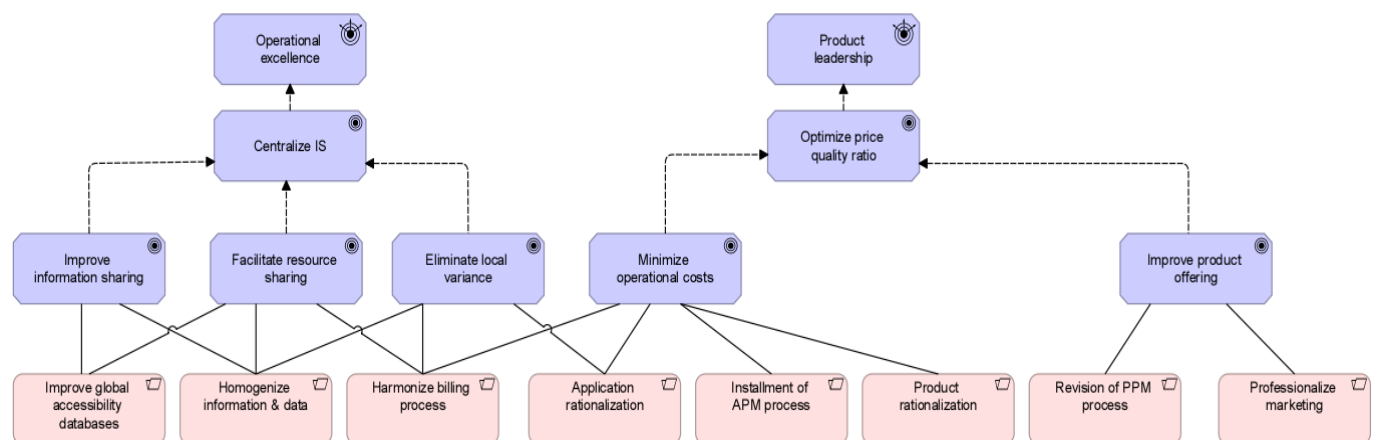
Figure 51: Archipharma's Strategy Implementation

Step 1B: Strategic Match Scoring

In the original SM's worksheet, the score 5 is given to the project that directly achieves a stated corporate strategic goal. Using BiZZdesign's Architect, the direct achievement of the corporate strategic goal can be translated into a quantitative assessment called the strategic value project. The general step to calculate the strategic value project is described as follows (detailed script is given in Appendix 3) :

> **BiZZdesign's Strategic value project algorithm:**
>
> **Step 1** Model the strategic implementation in the motivation extension of Archimate.
>
> **Step 2** Assign the value of the concept and its relationship on the model.
>
> **Step 3** Calculate the bottom-up relationship of each program/project.

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Output 1B : The list of score for SM (Table 24)

Table 24 shows the list of score of SM's factor for all the Archipharma's projects. The score of strategic value is generated with BiZZdesign's strategic value project algorithm (Appendix 3). Afterwards, SM score is calculated by multiplying the weight and the score in this factor.

Table 24: Archipharma SM's score

No	Project Name	Strategic Value Score	Weight SM	EA-based SM	SM-Score
1	Align marketing processes	20	4	4	16
2	Analyze billing process variance	3.9	4	4	16
3	Analyze current marketing processes	20	4	4	16
4	Analyze current product portfolio	8	4	4	16
5	Analyze data sources	5.8	4	4	16
6	Analyze heterogeneous data sources	5.8	4	4	16
7	Analyze heterogeneous information sources	5.8	4	4	16
8	Choose, configure, test and install APM applications	16	4	4	16
9	Choose, develop and install enterprise-wide PPM software	20	4	4	16
10	Choose, develop, test and run global financial application	3.9	4	4	16
11	Consistent data model development	5.8	4	4	16
12	Consolidate marketing applications	20	4	4	16
13	Data cleaning	5.8	4	4	16
14	Data mapping	5.8	4	4	16
15	Define valuation model	20.4	4	5	20
16	Design and populate application portfolios	16	4	4	16
17	Design data architecture	5.8	4	4	16
18	Design enterprise-wide APM process	16	4	4	16
19	Develop application rationalization roadmap	20.4	4	5	20
20	Develop database authentication protocols	5.8	4	4	16
21	Develop integrated reporting	5.8	4	4	16
22	Develop real-time portfolio monitoring	20	4	4	16
23	Develop real-time portfolio reporting	20	4	4	16

24	Expand customer channels with internet	8	4	4	16
25	Harmonize local PPM approaches	20	4	4	16
26	Harmonize ordering process	8	4	4	16
27	Harmonize process variants	3.9	4	4	16
28	Identify obsolete applications	20.4	4	5	20
29	Identify products for termination, migration and consolidation	8	4	4	16
30	Information cleaning	5.8	4	4	16
31	Information harmonization	5.8	4	4	16
32	Information mapping	5.8	4	4	16
33	Install application lifecycle management approach	20.4	4	5	20
34	Install database authentication	5.8	4	4	16
35	Install enterprise-wide PPM approach	20	4	4	16
36	Install federated database management system (FDMS)	5.8	4	4	16
37	Install necessary applications for monitoring competitors	20	4	4	16
38	Install process for monitoring competitors	20	4	4	16
39	Integrate marketing processes	20	4	4	16
40	Inventory all PPM processes	20	4	4	16
41	Inventory applications	20.4	4	5	20
42	Migrate and eliminate identified applications	20.4	4	5	20
43	Phase out Amsteram billing applications	3.9	4	4	16
44	Phase out London billing applications	3.9	4	4	16
45	Phase out New York billing applications	3.9	4	4	16
46	Prepare and adapt databases	5.8	4	4	16
47	Publish database information	5.8	4	4	16
48	Rationalize product portfolio	8	4	4	16
49	Redesign portfolio into limited set of highly configurable products	8	4	4	16
50	Valuate applications	20.4	4	5	20

4.2.2 Competitive Advantage (CA)

Step 2: Competitive Advantage scoring

The second step in the business domain assessment is to appraise Archipharma's competitive advantage factor. As described in section 3.2.2, in order to assess the competitive advantage factor, Archipharma should define their competitive strategy. The essence of formulating competitive strategy is relating a company to its environment (Porter, 1985). Thus, Porter's five force model (Figure 52) is used to understand the structure of pharmaceutical industry and stake out a position that is more profitable and less vulnerable to attack (Porter, 2008).
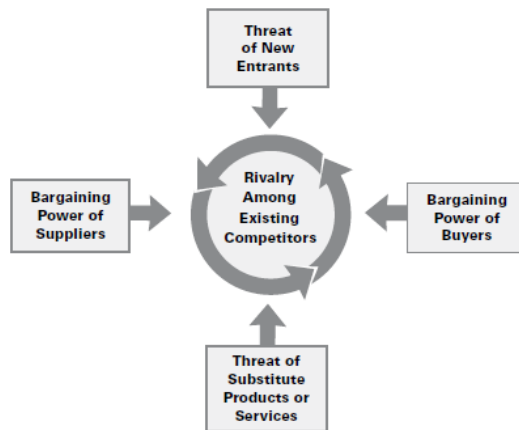
Figure 52: Five force model(Porter, 2008)

Five force model of Porter for Archipharma:

1. Threat of new entrants (Potential entrants)

   The threat of new entrants in the pharmaceutical industry is low. The new entrants need to have a certain economies of scale. They need to prepare enough economical resources due to complex processes in the pharmaceutical industry such as: manufacturing, R&D, marketing, sales, and distribution. Other entry barrier is the regulatory policy, which could have a certain standard, costly and lengthy approval process.

2. Bargaining power of suppliers (Suppliers)

   The power of supplier for Archipharma is low. It is because the sales for pharmaceutical industry concentrate in a few of large players, which decreases the bargaining power of the suppliers. Archipharma could be shifted to third party suppliers anywhere along the supply chain. As a pharmaceutical company that produces their own patent product, Archipharma does not need specialized product form particular supplier. It produces its own finished product from several raw materials. However, product quality could become the bargaining power of the supplier. If Archipharma wants to change the suppliers, the quality of the product still becomes a major point that needs to be taken into account.

3. Bargaining power of buyer (Buyers)

   The bargaining power of buyer could be rated as medium. Hospital and health care organizations as Archipharma's main buyer could have a pressure to keep price in check.

The buyers have their bargaining power to choose which pharmaceutical company will provide them the pharmacy service. Generic drugs also could give them a lower price options.

4. Threat of substitute products or services (Substitute)

The threat from substitute products or services for Archipharma can be assessed as low or medium. The possibilities of substitute products or services are identified as follows:
   - Alternative medicine (e.g. herbal medicine)
   - Healthy lifestyle
   - Generic drug product

5. Rivalry among existing firms (Industry competitors)

The rivalry among existing firms in the pharmaceutical industry is high. It is because there are several key players in the industry, which compete closely and strongly in the market.

Afterwards, to cope with the five competitive forces, Archipharma has adopted a strategy of differentiation (Porter, 1985) as its competitive advantage. The differentiation for Archipharma is interorganizational system (IOS) between internal organization, customer and supplier. It emphasizes on: data interchange between business unit inside Archipharma, data interchange between Archipharma, supplier and customer. Therefore, the assessment of CA factor focuses on this competitive advantage strategy. CA worksheet in Appendix 1 is used to assess the proposed projects.

Output 2 : The list of score for CA (Table 25)

After specifying SA's score, the final score in this factor is calculated by multiplying the weight and the score (third and fourth column of Table 25). Following table is the result of CA assessment:

Table 25: Archipharma CA's Score

No	Project Name	Weight CA	CA	CA-Score
1	Align marketing processes	6	3	18
2	Analyze billing process variance	6	2	12
3	Analyze current marketing processes	6	3	18
4	Analyze current product portfolio	6	1	6
5	Analyze data sources	6	2	12
6	Analyze heterogeneous data sources	6	2	12
7	Analyze heterogeneous information sources	6	2	12
8	Choose, configure, test and install APM applications	6	3	18
9	Choose, develop and install enterprise-wide PPM software	6	5	30

10	Choose, develop, test and run global financial application	6	4	24
11	Consistent data model development	6	3	18
12	Consolidate marketing applications	6	5	30
13	Data cleaning	6	3	18
14	Data mapping	6	3	18
15	Define valuation model	6	2	12
16	Design and populate application portfolios	6	2	12
17	Design data architecture	6	2	12
18	Design enterprise-wide APM process	6	2	12
19	Develop application rationalization roadmap	6	3	18
20	Develop database authentication protocols	6	2	12
21	Develop integrated reporting	6	4	24
22	Develop real-time portfolio monitoring	6	5	30
23	Develop real-time portfolio reporting	6	5	30
24	Expand customer channels with internet	6	5	30
25	Harmonize local PPM approaches	6	4	24
26	Harmonize ordering process	6	4	24
27	Harmonize process variants	6	3	18
28	Identify obsolete applications	6	2	12
29	Identify products for termination, migration and consolidation	6	3	18
30	Information cleaning	6	3	18
31	Information harmonization	6	3	18
32	Information mapping	6	3	18
33	Install application lifecycle management approach	6	4	24
34	Install database authentication	6	2	12
35	Install enterprise-wide PPM approach	6	5	30
36	Install federated database management system (FDMS)	6	2	12
37	Install necessary applications for monitoring competitors	6	3	18
38	Install process for monitoring competitors	6	3	18
39	Integrate marketing processes	6	4	24
40	Inventory all PPM processes	6	2	12
41	Inventory applications	6	2	12
42	Migrate and eliminate identified applications	6	3	18
43	Phase out Amsterdam billing applications	6	4	24
44	Phase out London billing applications	6	4	24
45	Phase out New York billing applications	6	4	24
46	Prepare and adapt databases	6	2	12

47	Publish database information	6	3	18
48	Rationalize product portfolio	6	2	12
49	Redesign portfolio into limited set of highly configurable products	6	1	6
50	Valuate applications	6	3	18

4.2.3 Management Information (MI)

Step 3A: Create Business Layer Architecture

The core activities in Archipharma are similar with other pharmaceutical companies. Six Main business functions are formulated in Archipharma :

1. Marketing and sales

   Currently, the process of monitoring its competitor becomes core activities in this business unit. This is a result of realizing Archipharma's vision. In order to become the leading provider of pharmaceutical services in the world, Archipharma should increase its sales and also understand the condition of market competition.

2. Finance

   At the moment, the concern of core activities in finance is to manage the billing process.

3. IS/IT Management

   The core activity here is to manage the information system and infrastructure.

4. Pharma R&D

   Main core activities to develop new medicine based on the market needs that is approved by medical affairs department

5. Medical affairs

   The function of medical affairs in Archipharma is to facilitate the market needs and the design product development process in the R&D department.

6. Production and distribution

   Production and distribution are also quite important functions for Archipharma. The process of delivering all the products to the customers while maintaining its quality is an important point here.

Output 3A: Archipharma's business function view (Figure 53)
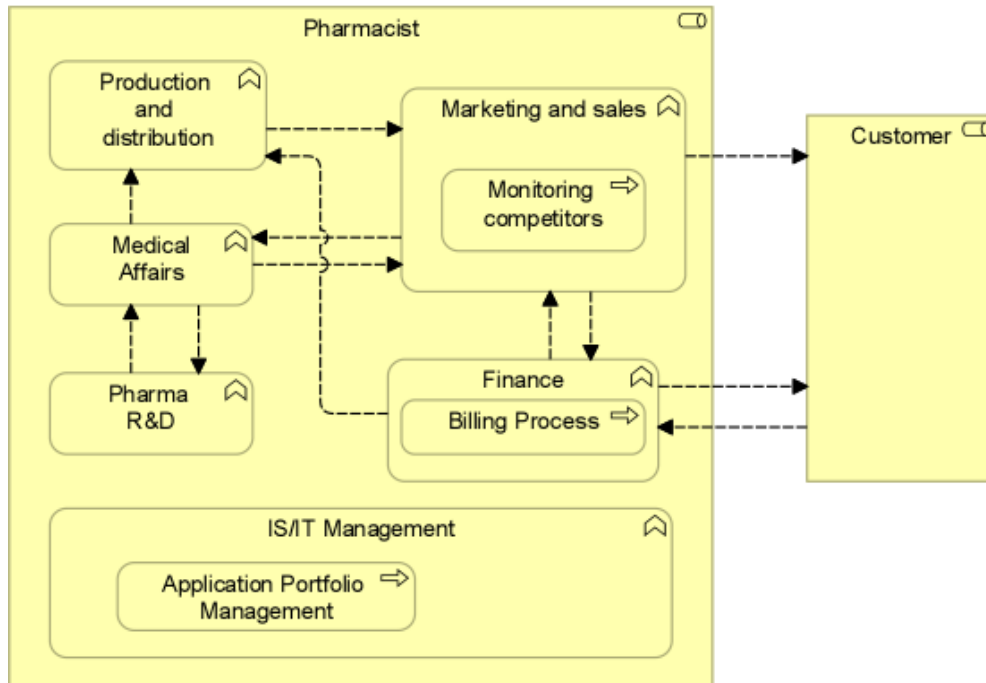
Figure 53: Archipharma- Business Function view-

Step 3B: Management Information scoring

In this step, Figure 53 is used as the basis to assess MI's factor. The description of EA-based MI's worksheet in Section 3.2.3 is used to rate the score of specific project.

Output 3B: Archipharma's MI score (Table 26)

Using the same mechanism to calculate MI's score (multiplying the weight and the score), the following table shows the result of MI assessment:

Table 26: Archipharma MI's score

No	Project Name	Weight MI	MI	MI-Score
1	Align marketing processes	2	4	8
2	Analyze billing process variance	2	5	10
3	Analyze current marketing processes	2	4	8
4	Analyze current product portfolio	2	2	4
5	Analyze data sources	2	2	4
6	Analyze heterogeneous data sources	2	2	4
7	Analyze heterogeneous information sources	2	2	4
8	Choose, configure, test and install APM applications	2	5	10
9	Choose, develop and install enterprise-wide PPM software	2	2	4
10	Choose, develop, test and run global financial application	2	4	8
11	Consistent data model development	2	2	4

12	Consolidate marketing applications	2	4	8
13	Data cleaning	2	3	6
14	Data mapping	2	3	6
15	Define valuation model	2	5	10
16	Design and populate application portfolios	2	5	10
17	Design data architecture	2	2	4
18	Design enterprise-wide APM process	2	4	8
19	Develop application rationalization roadmap	2	4	8
20	Develop database authentication protocols	2	3	6
21	Develop integrated reporting	2	2	4
22	Develop real-time portfolio monitoring	2	3	6
23	Develop real-time portfolio reporting	2	3	6
24	Expand customer channels with internet	2	3	6
25	Harmonize local PPM approaches	2	2	4
26	Harmonize ordering process	2	3	6
27	Harmonize process variants	2	4	8
28	Identify obsolete applications	2	5	10
29	Identify products for termination, migration and consolidation	2	3	6
30	Information cleaning	2	3	6
31	Information harmonization	2	3	6
32	Information mapping	2	3	6
33	Install application lifecycle management approach	2	4	8
34	Install database authentication	2	3	6
35	Install enterprise-wide PPM approach	2	2	4
36	Install federated database management system (FDMS)	2	2	4
37	Install necessary applications for monitoring competitors	2	5	10
38	Install process for monitoring competitors	2	5	10
39	Integrate marketing processes	2	4	8
40	Inventory all PPM processes	2	2	4
41	Inventory applications	2	5	10
42	Migrate and eliminate identified applications	2	4	8
43	Phase out Amsteram billing applications	2	4	8
44	Phase out London billing applications	2	4	8
45	Phase out New York billing applications	2	4	8
46	Prepare and adapt databases	2	2	4
47	Publish database information	2	2	4
48	Rationalize product portfolio	2	2	4

49	Redesign portfolio into limited set of highly configurable products	2	2	4
50	Valuate applications	2	5	10

4.2.4 Competitive Response (CR)

Step 4: Competitive Response scoring

To conduct the assessment of competitive response for Archipharma, the analysis of competitive industry in section 4.2.2 (the five force model) is used. By understanding the condition competitive condition in its industry, Archipharma has more insight on whether the project could be postponed to support its competitive strategy.

Output 4: Archipharma's CR score (Table 27)

In order to calculate the final CR's score, the result of previous step (fourth column of Table 27) is multiplied by the weight (third column of Table 27).

Table 27: Archipharma CR's score

No	Project Name	Weight CR	CR	CR-Score
1	Align marketing processes	4	3	12
2	Analyze billing process variance	4	1	4
3	Analyze current marketing processes	4	2	8
4	Analyze current product portfolio	4	2	8
5	Analyze data sources	4	1	4
6	Analyze heterogeneous data sources	4	1	4
7	Analyze heterogeneous information sources	4	1	4
8	Choose, configure, test and install APM applications	4	3	12
9	Choose, develop and install enterprise-wide PPM software	4	5	20
10	Choose, develop, test and run global financial application	4	4	16
11	Consistent data model development	4	4	16
12	Consolidate marketing applications	4	4	16
13	Data cleaning	4	2	8
14	Data mapping	4	2	8
15	Define valuation model	4	1	4
16	Design and populate application portfolios	4	2	8
17	Design data architecture	4	3	12
18	Design enterprise-wide APM process	4	2	8
19	Develop application rationalization roadmap	4	2	8
20	Develop database authentication protocols	4	4	16
21	Develop integrated reporting	4	5	20
22	Develop real-time portfolio monitoring	4	4	16
23	Develop real-time portfolio reporting	4	4	16

24	Expand customer channels with internet	4	4	16
25	Harmonize local PPM approaches	4	3	12
26	Harmonize ordering process	4	5	20
27	Harmonize process variants	4	3	12
28	Identify obsolete applications	4	1	4
29	Identify products for termination, migration and consolidation	4	3	12
30	Information cleaning	4	2	8
31	Information harmonization	4	3	12
32	Information mapping	4	2	8
33	Install application lifecycle management approach	4	4	16
34	Install database authentication	4	4	16
35	Install enterprise-wide PPM approach	4	4	16
36	Install federated database management system (FDMS)	4	3	12
37	Install necessary applications for monitoring competitors	4	3	12
38	Install process for monitoring competitors	4	3	12
39	Integrate marketing processes	4	4	16
40	Inventory all PPM processes	4	3	12
41	Inventory applications	4	1	4
42	Migrate and eliminate identified applications	4	2	8
43	Phase out Amsteram billing applications	4	4	16
44	Phase out London billing applications	4	4	16
45	Phase out New York billing applications	4	4	16
46	Prepare and adapt databases	4	3	12
47	Publish database information	4	3	12
48	Rationalize product portfolio	4	2	8
49	Redesign portfolio into limited set of highly configurable products	4	3	12
50	Valuate applications	4	3	12

4.2.5   Project/Organization Risk (OR)

Step 5: Project / Organization Risk scoring

The last factor in the business domain is assessing the preparedness of the business for the changes by implementing the proposed project. The ideal condition to assess this factor is by using the business case document and risk analysis of each proposed project. However, the available data is the risk analysis of each project in Archipharma which consists of the risk probability and risk impact (Appendix 4). Thus, a mapping process is carried out to map the current Archipharma's risk analysis to the OR's score.

Table 28: Archipharma's Risk Level matrix

Risk likelihood	Impact				
	insignificant (10)	minor (30)	moderate (50)	major (70)	extreme (100)
Very likely (1)	10	30	50	70	100
likely (0.7)	7	21	35	49	70
moderate (0.5)	5	15	25	35	50
rare (0.3)	3	9	15	21	30
unlikely (0.1)	1	3	5	7	10

Table 28 shows the scale Archipharma's risk level matrix (Stoneburner, Goguen, & Alexis, 2002) at based on the risk likelihood and its impact. Afterwards, Table 29 illustrates the mapping process from Archipharma's risk level to OR's score. So, for example if the score of Archipharma's risk level is in the range 1-20, then the OR's score is 1.

Table 29: Archipharma risk profile mapping

ArchiPharma's Risk Level	OR's score
1-20	1
21-40	2
41-60	3
61-80	4
81-100	5

Output 5 : Archipharma's OR score (Table 30)

Table 30 shows the result of OR's assessment using the same formulation to multiply the score (fourth column of Table 30) and the weight (third column of Table 30). The result is in negative number, since it represents the risk factor of the project.

Table 30: Archipharma's OR score

No	Project Name	Weight OR	OR	OR-Score
1	Align marketing processes	-1	2	-2
2	Analyze billing process variance	-1	1	-1
3	Analyze current marketing processes	-1	2	-2
4	Analyze current product portfolio	-1	1	-1
5	Analyze data sources	-1	1	-1
6	Analyze heterogeneous data sources	-1	2	-2
7	Analyze heterogeneous information sources	-1	2	-2
8	Choose, configure, test and install APM applications	-1	3	-3

9	Choose, develop and install enterprise-wide PPM software	-1	1	-1
10	Choose, develop, test and run global financial application	-1	1	-1
11	Consistent data model development	-1	2	-2
12	Consolidate marketing applications	-1	3	-3
13	Data cleaning	-1	3	-3
14	Data mapping	-1	3	-3
15	Define valuation model	-1	1	-1
16	Design and populate application portfolios	-1	2	-2
17	Design data architecture	-1	2	-2
18	Design enterprise-wide APM process	-1	2	-2
19	Develop application rationalization roadmap	-1	2	-2
20	Develop database authentication protocols	-1	4	-4
21	Develop integrated reporting	-1	1	-1
22	Develop real-time portfolio monitoring	-1	1	-1
23	Develop real-time portfolio reporting	-1	2	-2
24	Expand customer channels with internet	-1	3	-3
25	Harmonize local PPM approaches	-1	1	-1
26	Harmonize ordering process	-1	2	-2
27	Harmonize process variants	-1	3	-3
28	Identify obsolete applications	-1	1	-1
29	Identify products for termination, migration and consolidation	-1	2	-2
30	Information cleaning	-1	5	-5
31	Information harmonization	-1	3	-3
32	Information mapping	-1	2	-2
33	Install application lifecycle management approach	-1	2	-2
34	Install database authentication	-1	2	-2
35	Install enterprise-wide PPM approach	-1	3	-3
36	Install federated database management system (FDMS)	-1	1	-1
37	Install necessary applications for monitoring competitors	-1	2	-2
38	Install process for monitoring competitors	-1	1	-1
39	Integrate marketing processes	-1	1	-1
40	Inventory all PPM processes	-1	2	-2
41	Inventory applications	-1	3	-3
42	Migrate and eliminate identified applications	-1	2	-2
43	Phase out Amsteram billing applications	-1	1	-1
44	Phase out London billing applications	-1	1	-1

45	Phase out New York billing applications	-1	1	-1
46	Prepare and adapt databases	-1	2	-2
47	Publish database information	-1	1	-1
48	Rationalize product portfolio	-1	2	-2
49	Redesign portfolio into limited set of highly configurable products	-1	2	-2
50	Valuate applications	-1	4	-4

4.3 Technology Domain Assessment

In the following section, four factors will be assessed in the technology domain.

4.3.1 Strategic IS Architecture (SA)

Step 1A : Create roadmap architecture

Output1A : Roadmap Architecture (Figure 54)

A roadmap view has been already planned by Archipharma to execute its relating program. By using the list of the projects in the program described in Section 4.1.1, Archipharma could assess the Strategic IS Architecture factor for each project.
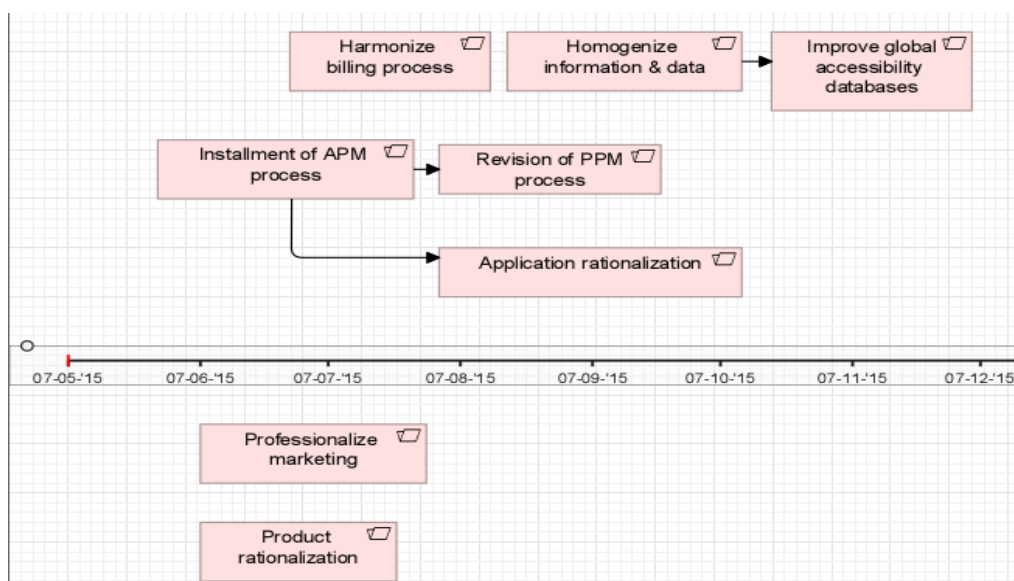
Figure 54: Archipharma Roadmap view

Step 1B : Strategic IS Architecture Scoring

Output1B : SA's score (Table 31)

In order to scoring SA's factor, the description of EA-based SA worksheet in Section 3.3.1 is used. In this assessment step, we do not only use Archipharma roadmap view, but also the project's benefit in terms of financial resource to rate the SA's score. Finally, the final score can be calculated (shown in Table 31) by multiplying the weight and the score.

No	Project Name	Weight SA	EA-based SA	SA-Score
1	Align marketing processes	1	3	3
2	Analyze billing process variance	1	3	3
3	Analyze current marketing processes	1	3	3
4	Analyze current product portfolio	1	3	3
5	Analyze data sources	1	4	4
6	Analyze heterogeneous data sources	1	5	5
7	Analyze heterogeneous information sources	1	5	5
8	Choose, configure, test and install APM applications	1	5	5
9	Choose, develop and install enterprise-wide PPM software	1	4	4
10	Choose, develop, test and run global financial application	1	3	3
11	Consistent data model development	1	5	5
12	Consolidate marketing applications	1	3	3
13	Data cleaning	1	5	5
14	Data mapping	1	5	5
15	Define valuation model	1	4	4
16	Design and populate application portfolios	1	5	5
17	Design data architecture	1	5	5
18	Design enterprise-wide APM process	1	5	5
19	Develop application rationalization roadmap	1	4	4
20	Develop database authentication protocols	1	4	4
21	Develop integrated reporting	1	4	4
22	Develop real-time portfolio monitoring	1	4	4
23	Develop real-time portfolio reporting	1	4	4
24	Expand customer channels with internet	1	3	3
25	Harmonize local PPM approaches	1	4	4
26	Harmonize ordering process	1	3	3
27	Harmonize process variants	1	3	3
28	Identify obsolete applications	1	4	4
29	Identify products for termination, migration and consolidation	1	3	3
30	Information cleaning	1	5	5
31	Information harmonization	1	5	5
32	Information mapping	1	5	5
33	Install application lifecycle management approach	1	4	4
34	Install database authentication	1	4	4
35	Install enterprise-wide PPM approach	1	4	4

36	Install federated database management system (FDMS)	1	4	4
37	Install necessary applications for monitoring competitors	1	3	3
38	Install process for monitoring competitors	1	3	3
39	Integrate marketing processes	1	3	3
40	Inventory all PPM processes	1	4	4
41	Inventory applications	1	4	4
42	Migrate and eliminate identified applications	1	4	4
43	Phase out Amsterdam billing applications	1	3	3
44	Phase out London billing applications	1	3	3
45	Phase out New York billing applications	1	3	3
46	Prepare and adapt databases	1	4	4
47	Publish database information	1	4	4
48	Rationalize product portfolio	1	3	3
49	Redesign portfolio into limited set of highly configurable products	1	3	3
50	Valuate applications	1	4	4

4.3.2 Definitional Uncertainty (DU)

Step 2   : Definitional Uncertainty Scoring

Output2   : DU's score (Table 32)

Archipharma's program motivation view (shown in Figure 55) is used to assess the second factors in the IT domain. However, due to the limitation of available data, the scoring of DU is solely based on the architecture (which is enlarged at Appendix 6.1) without the information of specification of each project or the detailed description from business case document. Hence, a number of assumptions are made when apprising the score of DU.

The DU's score for all the ArchiPharma's projects ranges from 1 to 4, because based on the architecture, it is assumed that all the projects have the requirements. From the output (Table 30), three projects (project no 43, 44 & 45 in Table 30) are scored 4 in this factor, based on the opinion that the projects of 'phase out billing application' in three offices (Amsterdam, London and New York) are quite complex projects. The process of phasing out an application especially a billing application could have some changes even during the project period, depending on the condition when the project is executed. For scoring 3, 16 projects are considered; that changes for these projects are almost certain almost immediately. For instance, the changes in the project of installing FDMS depend on the setting that is the required setting of the system. The last two score: 1 & 2, are made based on the assumption of the probability of nonroutine changes that could occur for a specific project. Finally, the final score in this score is shown in Table 30 by multiplying the weight and the score.
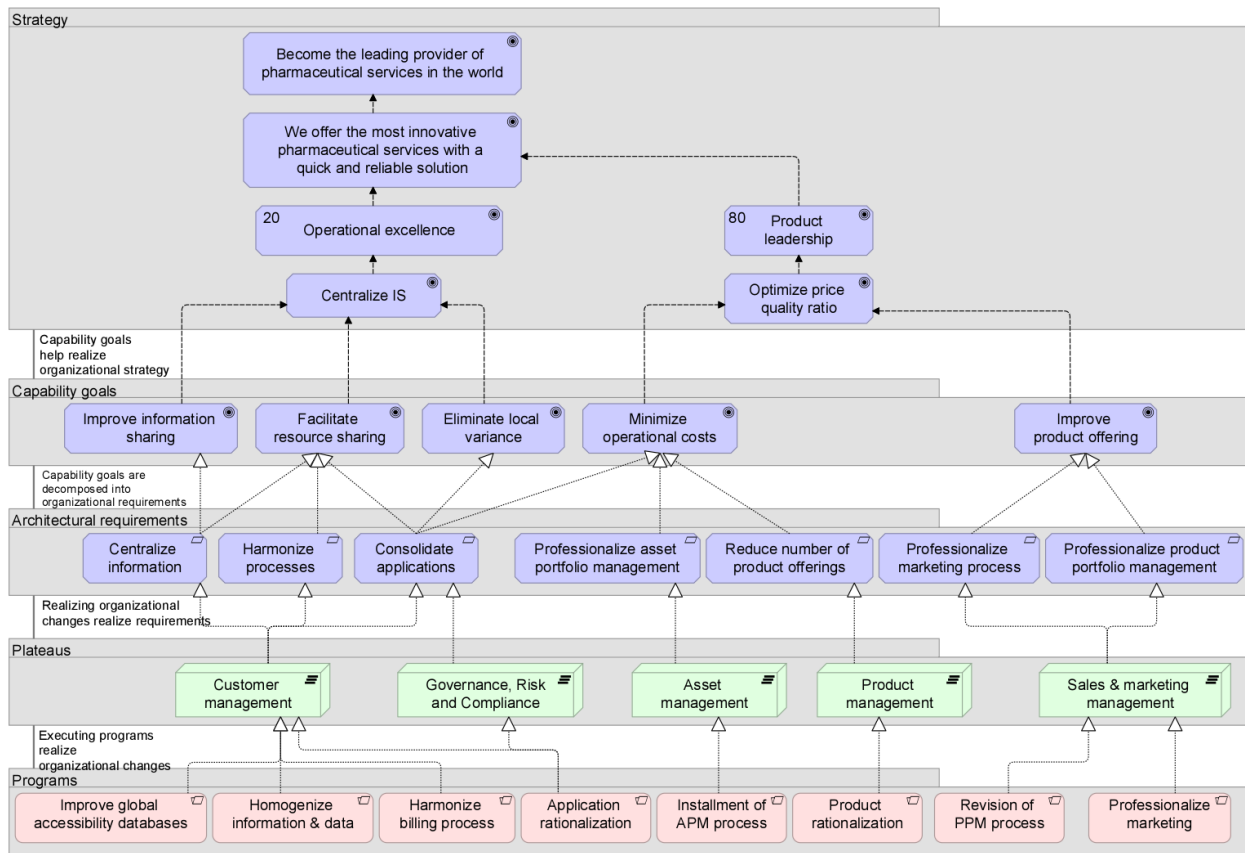
Figure 55: Archipharma's Program Motivation View

Table 32: Archipharma DU's score

No	Project Name	Weight DU	DU	DU-Score
1	Align marketing processes	-2	2	-4
2	Analyze billing process variance	-2	1	-2
3	Analyze current marketing processes	-2	1	-2
4	Analyze current product portfolio	-2	1	-2
5	Analyze data sources	-2	1	-2
6	Analyze heterogeneous data sources	-2	1	-2
7	Analyze heterogeneous information sources	-2	1	-2
8	Choose, configure, test and install APM applications	-2	3	-6
9	Choose, develop and install enterprise-wide PPM software	-2	3	-6
10	Choose, develop, test and run global financial application	-2	3	-6
11	Consistent data model development	-2	1	-2
12	Consolidate marketing applications	-2	3	-6
13	Data cleaning	-2	2	-4

14	Data mapping	-2	2	-4
15	Define valuation model	-2	1	-2
16	Design and populate application portfolios	-2	2	-4
17	Design data architecture	-2	1	-2
18	Design enterprise-wide APM process	-2	2	-4
19	Develop application rationalization roadmap	-2	1	-2
20	Develop database authentication protocols	-2	2	-4
21	Develop integrated reporting	-2	2	-4
22	Develop real-time portfolio monitoring	-2	2	-4
23	Develop real-time portfolio reporting	-2	2	-4
24	Expand customer channels with internet	-2	3	-6
25	Harmonize local PPM approaches	-2	2	-4
26	Harmonize ordering process	-2	3	-6
27	Harmonize process variants	-2	3	-6
28	Identify obsolete applications	-2	1	-2
29	Identify products for termination, migration and consolidation	-2	1	-2
30	Information cleaning	-2	2	-4
31	Information harmonization	-2	3	-6
32	Information mapping	-2	1	-2
33	Install application lifecycle management approach	-2	2	-4
34	Install database authentication	-2	3	-6
35	Install enterprise-wide PPM approach	-2	3	-6
36	Install federated database management system (FDMS)	-2	3	-6
37	Install necessary applications for monitoring competitors	-2	3	-6
38	Install process for monitoring competitors	-2	3	-6
39	Integrate marketing processes	-2	3	-6
40	Inventory all PPM processes	-2	1	-2
41	Inventory applications	-2	1	-2
42	Migrate and eliminate identified applications	-2	3	-6
43	Phase out Amsterdam billing applications	-2	4	-8
44	Phase out London billing applications	-2	4	-8
45	Phase out New York billing applications	-2	4	-8
46	Prepare and adapt databases	-2	2	-4
47	Publish database information	-2	1	-2
48	Rationalize product portfolio	-2	2	-4
49	Redesign portfolio into limited set of highly configurable products	-2	3	-6
50	Valuate applications	-2	2	-4

4.3.3 Technical Uncertainty (TU)

Step 3A : Create capability, infrastructure and application architecture

Output3A : ArchiPharma's capability and infrastructure usage view (Figure 57 and 58)

Figure 56 (which is enlarged in Appendix 6.2) shows the applications that will be required to carry out a particular project. Currently the overview of infrastructure usage and capability in Archipharma is depicted in Figure 57 and 58.
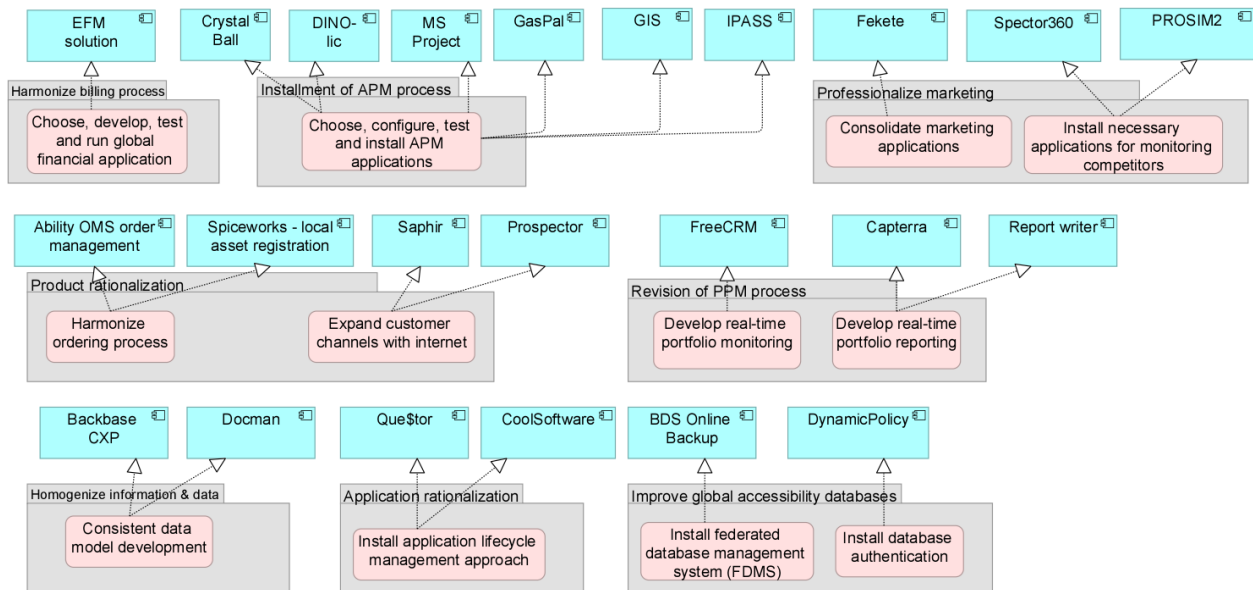
Figure 56 : Archipharma application realization view
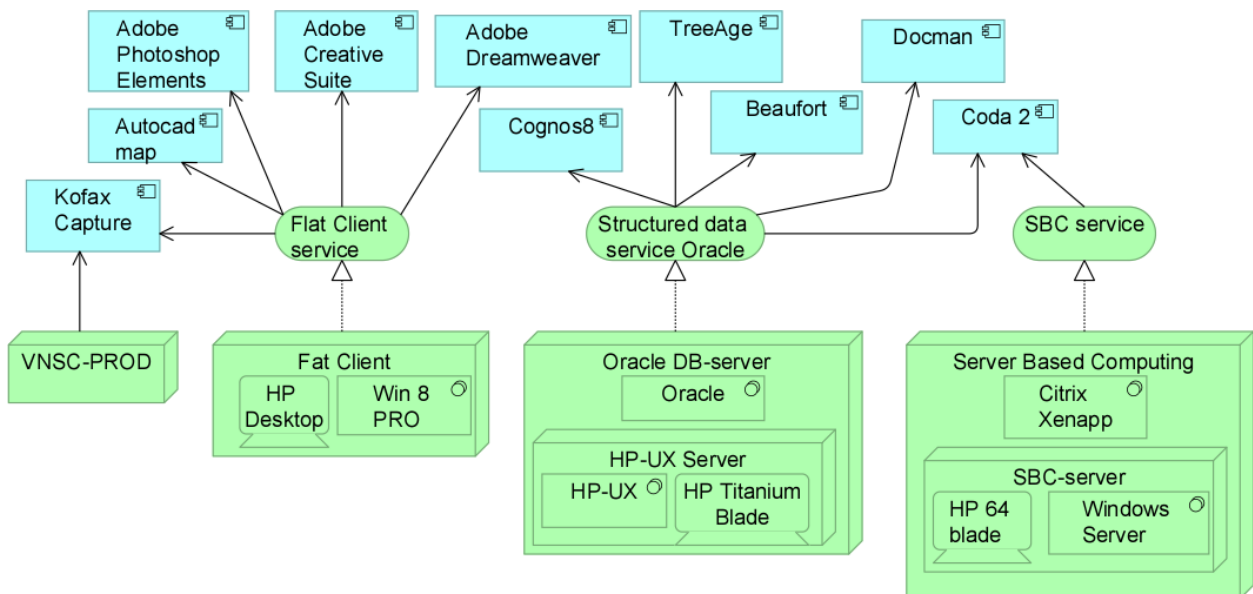
Figure 57: Archipharma Infrastructure Usage View

Figure 58: Archipharma Capability View

Step 3B : Technical Uncertainty Scoring

There are four separated component assessment for TU:

1. Skills required
2. Hardware dependencies
3. Software dependencies (other than application software)
4. Application software

From all the projects, 12 projects are specified having application dependencies (Figure 56). Therefore, the score for these 12 projects is varied from 1 to 3; depend on the complexity of related application. Afterwards, the score is calculated using equation 3.1 in Section 3.3.3.

Output3B: Archipharma's TU score (Table 33)

The last step in this factor is to calculate the final score by multiplying the score (fourth column of Table 33) and the weight (third column of Table 33). This factor also negative, because it indicates the uncertainty of the current condition.

Table 33: ArchipharmaTU's score

No	Project Name	Weight TU	EA-based TU	TU-Score
1	Align marketing processes	-1	0	0
2	Analyze billing process variance	-1	0	0
3	Analyze current marketing processes	-1	0	0
4	Analyze current product portfolio	-1	0	0
5	Analyze data sources	-1	0	0
6	Analyze heterogeneous data sources	-1	0	0
7	Analyze heterogeneous information sources	-1	0	0
8	Choose, configure, test and install APM applications	-1	1	-1
9	Choose, develop and install enterprise-wide PPM software	-1	1	-1
10	Choose, develop, test and run global financial application	-1	2	-2
11	Consistent data model development	-1	1	-1
12	Consolidate marketing applications	-1	0	0
13	Data cleaning	-1	0	0
14	Data mapping	-1	0	0
15	Define valuation model	-1	1	-1
16	Design and populate application portfolios	-1	0	0
17	Design data architecture	-1	0	0
18	Design enterprise-wide APM process	-1	0	0
19	Develop application rationalization roadmap	-1	1	-1
20	Develop database authentication protocols	-1	0	0
21	Develop integrated reporting	-1	0	0
22	Develop real-time portfolio monitoring	-1	1	-1
23	Develop real-time portfolio reporting	-1	1	-1
24	Expand customer channels with internet	-1	2	-2
25	Harmonize local PPM approaches	-1	0	0
26	Harmonize ordering process	-1	1	-1
27	Harmonize process variants	-1	0	0
28	Identify obsolete applications	-1	1	-1
29	Identify products for termination, migration and consolidation	-1	0	0
30	Information cleaning	-1	0	0
31	Information harmonization	-1	0	0
32	Information mapping	-1	0	0
33	Install application lifecycle management approach	-1	1	-1
34	Install database authentication	-1	1	-1
35	Install enterprise-wide PPM approach	-1	0	0

36	Install federated database management system (FDMS)	-1	0	0
37	Install necessary applications for monitoring competitors	-1	1	-1
38	Install process for monitoring competitors	-1	1	-1
39	Integrate marketing processes	-1	0	0
40	Inventory all PPM processes	-1	0	0
41	Inventory applications	-1	0	0
42	Migrate and eliminate identified applications	-1	1	-1
43	Phase out Amsterdam billing applications	-1	0	0
44	Phase out London billing applications	-1	0	0
45	Phase out New York billing applications	-1	0	0
46	Prepare and adapt databases	-1	0	0
47	Publish database information	-1	0	0
48	Rationalize product portfolio	-1	1	-1
49	Redesign portfolio into limited set of highly configurable products	-1	1	-1
50	Valuate applications	-1	1	-1

4.3.4   IS Infrastructure Risk (IR)

Step 4A   : Create Layered Architecture

Output4A   : Layered Architecture

In order to scoring the IR, Archipharma's layered architecture is made to provide the overview of the infrastructure (Figure 59). Layered architecture is created based on the required application to accommodate the proposed projects. However, not all of them are modeled for the simplicity of the layered architecture, only the related application that changes the application layer and infrastructure layer. The required new application components are colored red if they have moderate changes that imply changes in other computer service. The yellow color is used to show relatively smaller changes compare with the red one. By using the layered architecture (Figure 59), IR scoring process could be carried out.
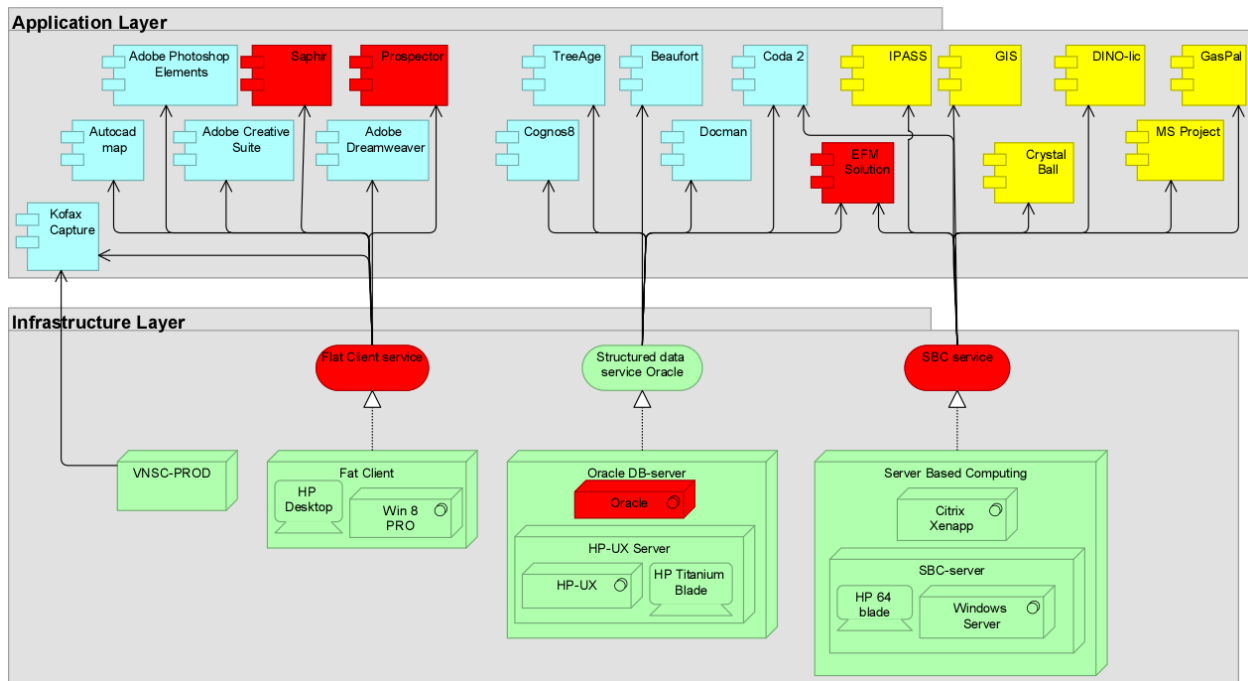
Figure 59: ArchiPharma's Layered Architecture

The IR score in this case is ranging from 0 to 3, because the change in the infrastructure is not considered as a substantial one. Two projects (project no 10 & 24 in Table 34) are scored 3, because for both of the projects, an up-front investment is necessary for buying an application to accommodate the projects. Next, Two projects (project no 8 & 42 in Table 34) are assessed lower (score 2), because the changes are considered smaller although some up-front investment is still necessary. Afterwards, 13 projects are scored 1 by considering that the changes in the computer service are required and the up-front investment is relatively small. Lastly, the projects that could use the existing services and facilities are scored 0.

Step 4B   : IS Infrastructure Risk Scoring

Output4B   :IR's score (Table 34)

The final score of this factor is obtained by multiplying the weight (third column of Table 34) and the score (fourth column of Table 34), which shown in Table 34.

Table 34: Archipharma's IR score

No	Project Name	Weight IR	EA-based IR	IR-Score
1	Align marketing processes	1	0	0
2	Analyze billing process variance	1	0	0
3	Analyze current marketing processes	1	0	0
4	Analyze current product portfolio	1	0	0
5	Analyze data sources	1	0	0
6	Analyze heterogeneous data sources	1	0	0
7	Analyze heterogeneous information sources	1	0	0

8	Choose, configure, test and install APM applications	1	2	2
9	Choose, develop and install enterprise-wide PPM software	1	1	1
10	Choose, develop, test and run global financial application	1	3	3
11	Consistent data model development	1	1	1
12	Consolidate marketing applications	1	1	1
13	Data cleaning	1	0	0
14	Data mapping	1	0	0
15	Define valuation model	1	0	0
16	Design and populate application portfolios	1	0	0
17	Design data architecture	1	0	0
18	Design enterprise-wide APM process	1	0	0
19	Develop application rationalization roadmap	1	0	0
20	Develop database authentication protocols	1	1	1
21	Develop integrated reporting	1	0	0
22	Develop real-time portfolio monitoring	1	1	1
23	Develop real-time portfolio reporting	1	1	1
24	Expand customer channels with internet	1	3	3
25	Harmonize local PPM approaches	1	0	0
26	Harmonize ordering process	1	1	1
27	Harmonize process variants	1	0	0
28	Identify obsolete applications	1	0	0
29	Identify products for termination, migration and consolidation	1	0	0
30	Information cleaning	1	0	0
31	Information harmonization	1	0	0
32	Information mapping	1	0	0
33	Install application lifecycle management approach	1	1	1
34	Install database authentication	1	1	1
35	Install enterprise-wide PPM approach	1	1	1
36	Install federated database management system (FDMS)	1	1	1
37	Install necessary applications for monitoring competitors	1	1	1
38	Install process for monitoring competitors	1	0	0
39	Integrate marketing processes	1	1	1
40	Inventory all PPM processes	1	0	0
41	Inventory applications	1	0	0
42	Migrate and eliminate identified applications	1	2	2
43	Phase out Amsterdam billing applications	1	0	0

44	Phase out London billing applications	1	0	0
45	Phase out New York billing applications	1	0	0
46	Prepare and adapt databases	1	0	0
47	Publish database information	1	0	0
48	Rationalize product portfolio	1	0	0
49	Redesign portfolio into limited set of highly configurable products	1	0	0
50	Valuate applications	1	0	0

4.4   Financial Consequence

In the original method, NPV is used to evaluate the financial perspective of the project. However, in the Archipharma case, the data that could be used to represent the financial perspective of the proposed projects is its benefit. The list of project's benefit is presented in Table 35 and obtained from Archipharma's module in BiZZdesign :

Table 35: Archiparma's project benefit

No	Projects	Benefit
1	Align marketing processes	500
2	Analyze billing process variance	1200
3	Analyze current marketing processes	500
4	Analyze current product portfolio	500
5	Analyze data sources	500
6	Analyze heterogeneous data sources	450
7	Analyze heterogeneous information sources	500
8	Choose, configure, test and install APM applications	10000
9	Choose, develop and install enterprise-wide PPM software	2100
10	Choose, develop, test and run global financial application	-500
11	Consistent data model development	2300
12	Consolidate marketing applications	5000
13	Data cleaning	1500
14	Data mapping	2900
15	Define valuation model	1000
16	Design and populate application portfolios	2000
17	Design data architecture	750
18	Design enterprise-wide APM process	7000
19	Develop application rationalization roadmap	1200
20	Develop database authentication protocols	1800
21	Develop integrated reporting	8000
22	Develop real-time portfolio monitoring	6000
23	Develop real-time portfolio reporting	2000

24	Expand customer channels with internet	1500
25	Harmonize local PPM approaches	1200
26	Harmonize ordering process	10500
27	Harmonize process variants	2600
28	Identify obsolete applications	1750
29	Identify products for termination, migration and consolidation	500
30	Information cleaning	1000
31	Information harmonization	5000
32	Information mapping	400
33	Install application lifecycle management approach	2500
34	Install database authentication	150
35	Install enterprise-wide PPM approach	4000
36	Install federated database management system (FDMS)	250
37	Install necessary applications for monitoring competitors	2000
38	Install process for monitoring competitors	2000
39	Integrate marketing processes	2000
40	Inventory all PPM processes	250
41	Inventory applications	750
42	Migrate and eliminate identified applications	7500
43	Phase out Amsteram billing applications	1700
44	Phase out London billing applications	1500
45	Phase out New York billing applications	2000
46	Prepare and adapt databases	1100
47	Publish database information	1500
48	Rationalize product portfolio	2500
49	Redesign portfolio into limited set of highly configurable products	700
50	Valuate applications	1500

4.5   Project prioritization

After calculating the three-domain assessment, the next step is to calculate the project prioritization. The importance weight of each domain is set up. For Archipharma, it is set that the weight for business, technology and financial domain respectively are 0.4, 0.3 and 0.3. Table 36 shows the summary of each domain assessment score and the project total score. The score in the business and technology domain (third and fourth column of Table 36) is calculated using equation 3.2, while the total score (sixth column of Table 36) using equation 3.3.

Table 36: Archipharma's Project score

No	Project Name	Total Business	Total Technology	Financial Assessment	Total Score
1	Harmonize ordering process	64	-3	10500	3174.7
2	Choose, configure, test and install APM applications	53	0	10000	3021.2
3	Develop integrated reporting	63	0	8000	2425.2
4	Migrate and eliminate identified applications	52	-1	7500	2270.5
5	Design enterprise-wide APM process	42	1	7000	2117.1
6	Develop real-time portfolio monitoring	67	0	6000	1826.8
7	Consolidate marketing applications	67	-2	5000	1526.2
8	Information harmonization	49	-1	5000	1519.3
9	Install enterprise-wide PPM approach	63	-1	4000	1224.9
10	Data mapping	45	1	2900	888.3
11	Harmonize process variants	51	-3	2600	799.5
12	Install application lifecycle management approach	66	0	2500	776.4
13	Rationalize product portfolio	38	-2	2500	764.6
14	Consistent data model development	52	3	2300	711.7
15	Choose, develop and install enterprise-wide PPM software	69	-2	2100	657
16	Develop real-time portfolio reporting	66	0	2000	626.4
17	Integrate marketing processes	63	-2	2000	624.6
18	Phase out New York billing applications	63	-5	2000	623.7
19	Install process for monitoring competitors	55	-4	2000	620.8
20	Install necessary applications for monitoring competitors	54	-3	2000	620.7
21	Design and populate application portfolios	44	1	2000	617.9
22	Develop database authentication protocols	46	1	1800	558.7
23	Identify obsolete applications	45	1	1750	543.3
24	Phase out Amsterdam billing applications	63	-5	1700	533.7
25	Expand customer channels with internet	65	-2	1500	475.4
26	Phase out London billing applications	63	-5	1500	473.7
27	Valuate applications	56	-1	1500	472.1
28	Publish database information	49	2	1500	470.2
29	Data cleaning	45	1	1500	468.3
30	Harmonize local PPM approaches	55	0	1200	382
31	Develop application rationalization roadmap	52	1	1200	381.1
32	Analyze billing process variance	41	1	1200	376.7

33	Prepare and adapt databases	42	0	1100	346.8
34	Define valuation model	45	1	1000	318.3
35	Information cleaning	43	1	1000	317.5
36	Inventory applications	43	2	750	242.8
37	Design data architecture	42	3	750	242.7
38	Redesign portfolio into limited set of highly configurable products	36	-4	700	223.2
39	Align marketing processes	52	-1	500	170.5
40	Identify products for termination, migration and consolidation	50	1	500	170.3
41	Analyze current marketing processes	48	1	500	169.5
42	Analyze data sources	35	2	500	164.6
43	Analyze heterogeneous information sources	34	3	500	164.5
44	Analyze current product portfolio	33	1	500	163.5
45	Analyze heterogeneous data sources	34	3	450	149.5
46	Information mapping	46	3	400	139.3
47	Inventory all PPM processes	42	2	250	92.4
48	Install federated database management system (FDMS)	43	-1	250	91.9
49	Install database authentication	48	-2	150	63.6
50	Choose, develop, test and run global financial application	63	-2	-500	-125.4

From the result, it can be seen that *'harmonize ordering process'* is the project with the highest score, while *'choose, develop, test and run global financial application'* has the minimum project's score. Archipharma needs to take a look at the project with the low score and analyze the condition that leads to the minimum score. In this case, project no 50 in Table 34 has the lowest financial assessment and is considered quite risky (negative score) in the technology domain. By applying the proposed method, Archipharma could analyze the proposed projects from various perspectives and utilize EA in the assessment process. In addition, Table 37 is given for the reader to easily interpret the final result. It shows the range of Project's score that has a minimum score of -156,5 and the maximum score of 3185.

Table 37: Archipharma's project range score

Domain	Archipharma's importance weight	Min Score	Max Score	Total Score	
				Min	Max
Business	0.4	-5	80		
Technology	0.3	-15	10	-156.5	3185
Finance	0.3	-500	10500		

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From the project's score, we could divide the list of the projects into three categories of prioritization. The first priority is the list of the projects with the total scores of more than 650. The second priority if the score range is between 300 and 650. For third priority if the projects have scored lower than 300.

1st Priority: >650

2nd Priority: 300- 650

3rd Priority: <300

We make three priorities to ease the decision maker if they want to analyze further the proposed projects. For example, they should pay more attention to the third priority during the execution / implementation phase of the project, or if there is a budget limitation, the last prioritized projects become the candidates to be eliminated.

4.6   Project Visualization

Figure 60 overviews all Archipharma's project plotted in a bubble chart that is made using BizzDesign's Architect tools. Most of the projects in the bubble chart are plotted in the '**must have'** quadrant. It means that most of the proposed projects have a high score on its contribution to the business and technology domain. Generally, we could conclude that the proposed projects affect both business and technology performance to ultimately achieve their goals. However, Figure 60 shows too many overlaps between the data because of the number of the projects that should be plotted (50 projects). Therefore, in the following paragraph, we illustrate three more bubble charts based on the three priorities categories of the project.
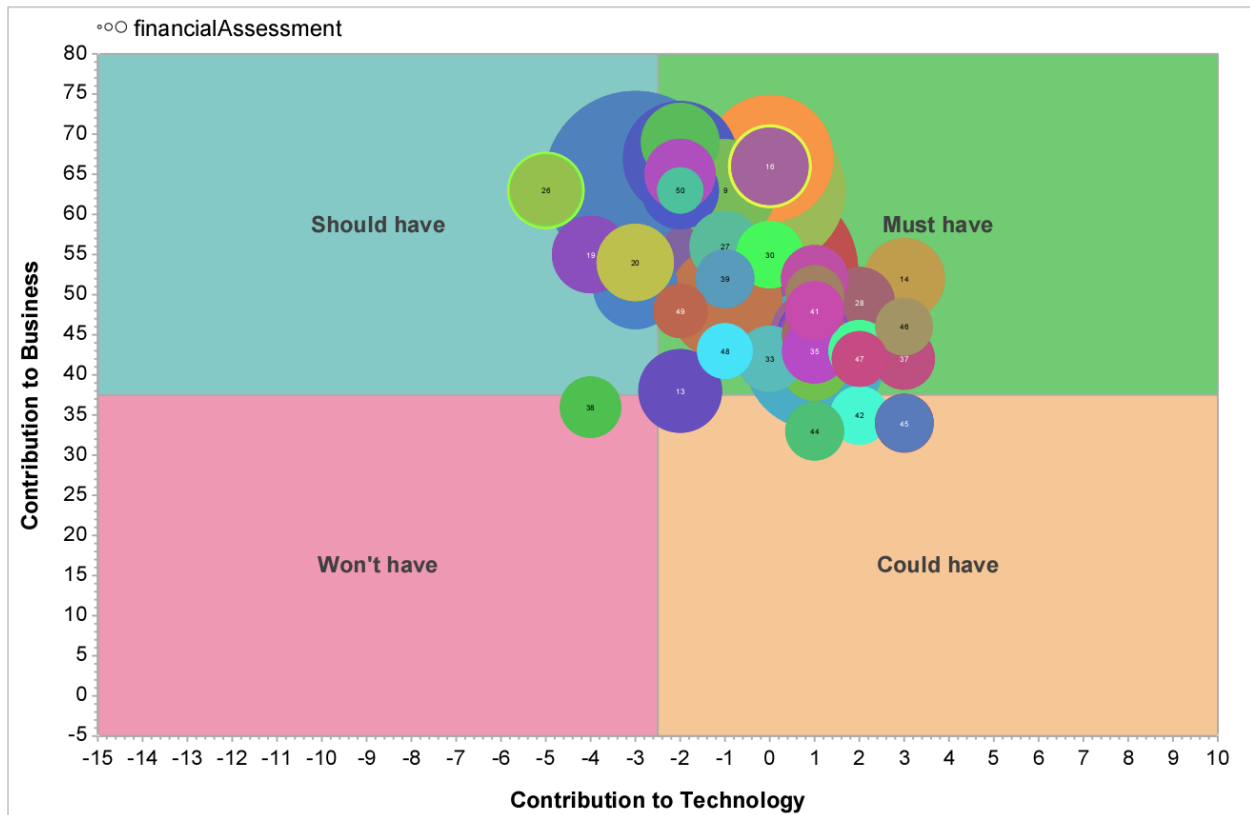
Figure 60: Archipharma's projects overview

Another bubble chart is made to plot the projects that belong to the first priority (score > 650). Figure 61 shows most of the projects is plotted in the '**must** have' quadrant. This picture summarizes a simple explanation for the decision maker that fifteen (15) projects are the top priority, have high score for both contributions to the business and technology domain, and also illustrates its benefit by the size of the circle.
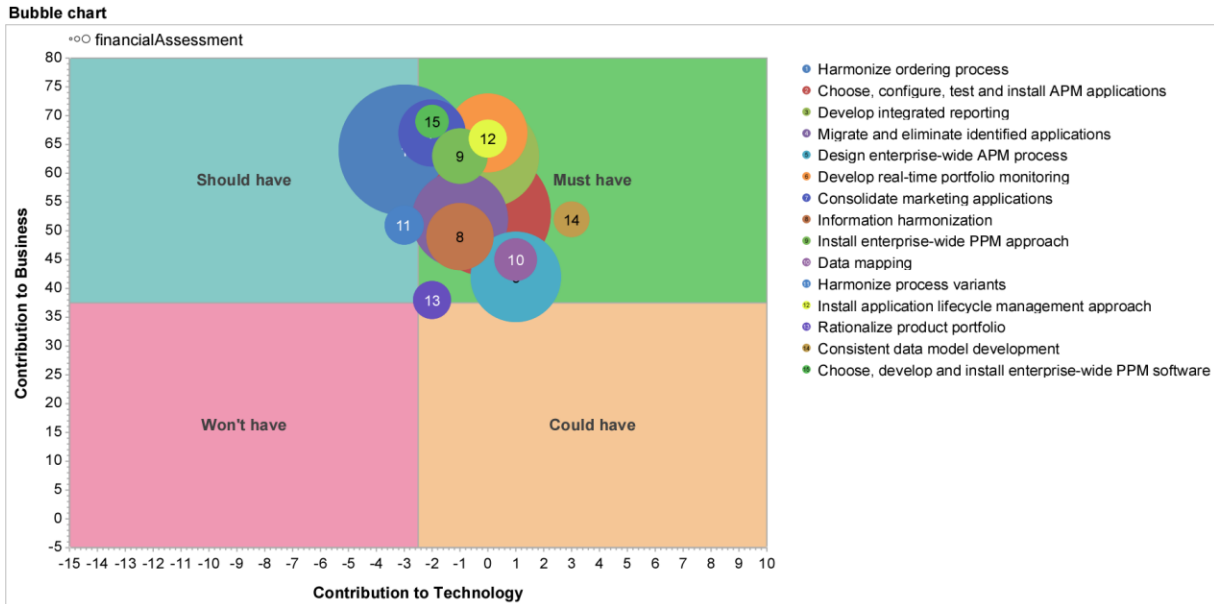
Figure 61 : First Priority Project's Overview

For the second priority projects (score between 300 and 650), Figure 62 represents the position of the proposed projects in '**Must** have' and '**Should** have' quadrant. Generally, most of the projects here are still considered as a top priority. It is because some projects still have a lower score in the technology domain that could be caused by several reasons such as: the risk to implement it from the IT perspective, current technology in the company is not yet ready to support the projects or the alignment with IT strategy.
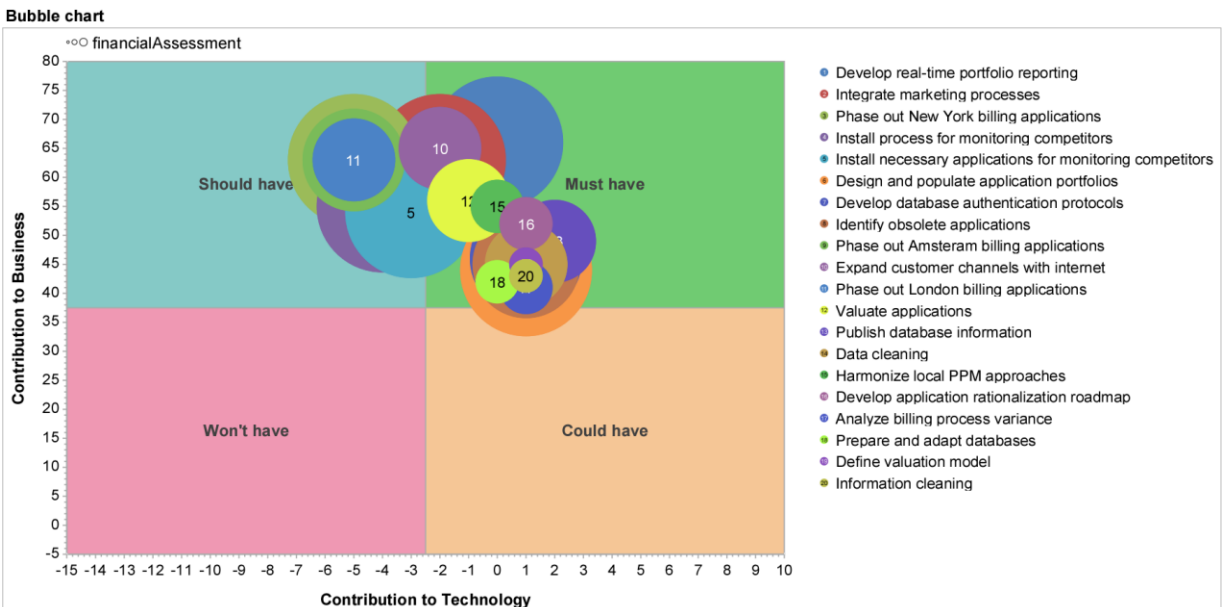
Figure 62 : Second Prioritize Project's Overview

99
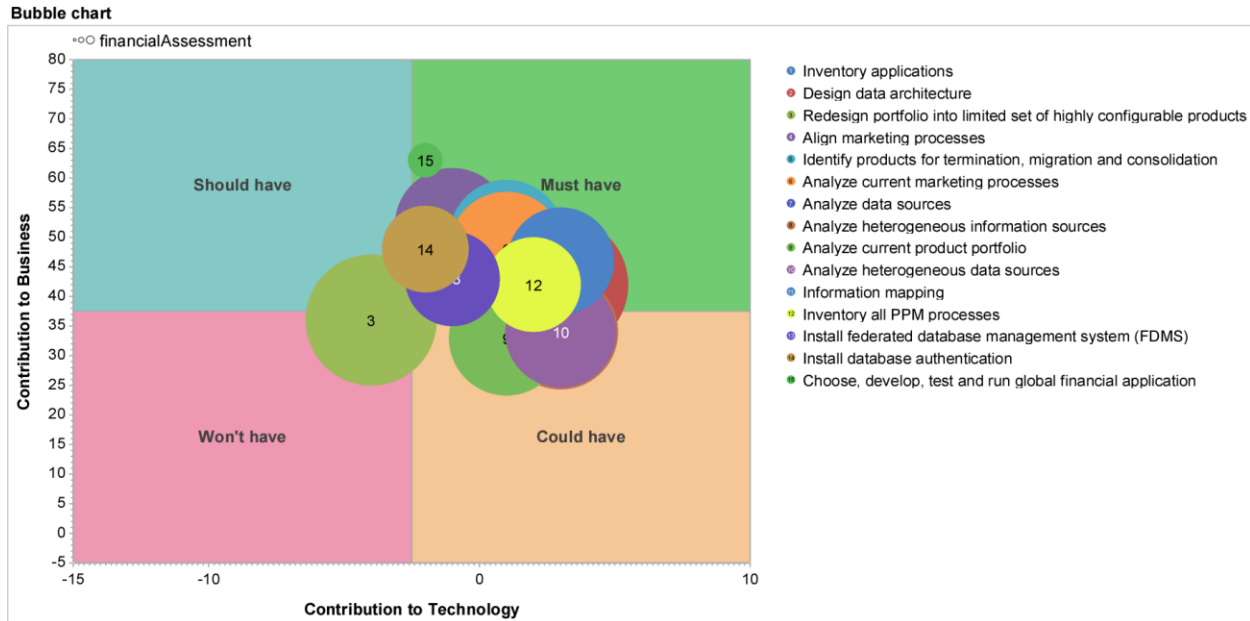
Figure 63 : Third Prioritize Project's Overview

The projects in the third Priority are mostly plotted in the '**Must** have', '**Could** have' and '**Won't** have' quadrant. Although the projects are belong to the third priority, but they still have relatively good position in the quadrant. The projects are considered desirable, but could be eliminated if another limitation, like budget limitation becomes an obstacle to execute it.

4.7   Summary

This chapter has discussed the use of an EA-based Investment Portfolio method on the ArchiPharma case study. All the following steps in the three domains of the proposed method is applied in the case. It shows that the proposed method could facilitate a decision making process in terms of giving suggestions on the prioritized projects that should be carried out by an organization. By applying the method, we demonstrate the concrete use of EA to evaluate the projects as well as to provide a room for the decision maker to give their own justification in the scoring process.

5. Evaluation

This chapter covers the fifth activity in the design science research methodology, which is evaluation. It measures how well the artifact supports a solution to the problem (Peffers et al., 2008). An evaluation can be conducted in many ways such as; comparison of the artifact's functionality with the solution objectives, objective quantitative performance measures, the result of satisfaction surveys, client feedback or simulations (Peffers et al., 2008). In order to evaluate EA-based Investment Portfolio method, which is proposed in this research, qualitative interviews in IS research (Myers & Newman, 2007) were conducted. Section 5.1 discusses the evaluation method that is carried out in this research and the interview setting. Afterwards, Section 5.2 describes the result.

5.1 Evaluation method and interview setting

According to Hevner et al., (2004), IT artifacts can be evaluated in relevant quality attributes that show the utility, quality, and efficacy of a design artifact. Accordingly, we define five (5) criteria that are used as a guideline to structure the questions in the interview session (shown in table 35). The first criterion aims to get the information from the interviewees about the current practice of project portfolio valuation and the use of EA. It also serves as a starting point of the interview session so that, the interviewees become familiar with the topic of discussion.

Afterwards, the ease of understanding, practical use / applicability and usefulness are selected as the relevant quality attributes in order to evaluate the proposed method. Through this step, we examined whether or not the proposed method is easy to understand and, which step in the method that needs to be elaborated further. Due to the final goal of the research which is to improve the decision making process in an organization, the applicability of the proposed method was also evaluated as the third criterion. Next, the usefulness of the method was also investigated.

The last criterion of the interview structure is feedback from the interviewees. It is aimed to create open discussions with them through which new insights could be obtained such as the possibility of improvement, the possibility of future work/research or any other comment that could come up during discussion. Table 38 shows the questions in accordance with the criteria.

Table 38 : Evaluation criteria

No	Criteria	Questions
1.	Current practice and an-EA based method	1. What are methods do you think are often used in practice to prioritize projects? 2. What do you think about the use of EA to prioritize projects? Do you think it's beneficial?
2.	Ease of understanding	3. Is the proposed method easy to understand? Is there any step that needs to be elaborated more?
3.	Practical use or applicability	4. Do you think it is feasible to implement the proposed method in a project portfolio valuation process? From your experience, have you ever use a project portfolio valuation yourself? Is it possible to incorporate the proposed method into it?
4.	Usefulness	5. Do you think the method is useful in practice? Why?
5.	Discussion /Feedback	6. What measures will you suggest to improve the proposed method?

5.1.1 Interview setting

One of the evaluation forms in the design science research methodology is gathering the client feedback. As qualitative interview is a powerful research tool of gathering data that is used extensively in IS research (Myers & Newman, 2007), it thus was applied in this research to gather feedback from the potential users of the proposed method. Furthermore, as the research is conducted at the R&D (Research & Development) department of BiZZdesign, the potential user of the proposed method is the BiZZdesign's consultants who will use the method to help the customer.

There are three (3) types of qualitative interviews (Myers & Newman, 2007): Structured interview, Semi-structured interview and Group interview. In the structured interview, a complete script is prepared beforehand and no room for improvisation. For semi-structured interview, some questions are prepared beforehand and potentially have an improvisation. Lastly, in a group interview, a group of people are interviewed at one time with structured or unstructured way.

In this study, we conducted semi-structured interviews to carry out the evaluation process. It is the most widely used in the qualitative research in information systems field (Myers & Newman, 2007). Moreover, we also could have a room for improvisation because although the scripts of the questions are prepared beforehand, it is possible to dig up information from the interviewees. The improvisation is situational and depends on the answer or feedback from the interviewee.

The participant of the interview session is four practitioners in the fields of project portfolio management and EA. All of the respondents are the consultants from BiZZdesign. Two of them

are research consultants and the other two are business consultants. The interview session were held separately and lasted approximately an hour. It started with 20-30 minutes of presentation, then interviewed question script and discussion in the remaining 30 minutes.

5.2 Result and analysis

After conducting four interview sessions, the result is reviewed an analyzed in this section. The transcript of the interview session is given in Appendix 5. A summary of the interview session is given in table 39.

From the interview sessions, four different aspects are discussed regarding the following proposed method:

1. Practice of project portfolio valuation

The common practice of project portfolio valuation according to the four interviewees is by using gut feeling in the basis of their personal belief and experience. Other common practice is also by comparing the cost and benefit that the companies will get by undertaking the projects. This practical analysis is documented in a business case document. A business case summarizes the estimation of the benefit and cost that the company will get after executing the projects. The cost and benefit method to evaluate the projects is compared in the financial term like ROI. Another aspect to prioritize the project is also based on the urgency of the projects. In addition, a political issue also could be taken when a decision maker has a specific interest in a specific project or program.

2. Benefit of using EA

All of the interviewees argued that it is beneficial to use EA in the project portfolio valuation. The companies could get more benefit by having higher maturity level of EA. Iacob et al. (2012) stated that an EA-mature organization is one that uses EA in multiple ways, from IT decision making to organizational re-alignments and business redesign and transformation. Four of the interviewees said that by using the architecture, a company could have better overview of their current state and future / to-be situation. Afterwards, they could analyze where and how to prioritize the changes or transformation that needs to be done in order to reach their to-be situation. Furthermore, it could help to analyze the impact of the project and its dependency as well.

The second benefit is better traceability. For instance; the companies could check the contribution of the projects to their actual goals and evaluate which projects that fit within their roadmap. Thirdly, architecture gives a better cost estimation. By using EA, the companies could be more specific in their choices and put cost calculation in the architecture.

3. Method's requirement

By looking the answers of question three to five, most of the interviewees stated that the proposed method is easy to understand, feasible to implement and useful in practice. However, they mentioned the requirements or the conditions that should be fulfilled in order to use the method properly. Firstly, it requires the time and the patient of the user to do all the steps in the method. The companies should spare some time to carry out all the scoring process. The second requirement is the knowledge. The user should have the knowledge of project portfolio management, BPMN and Enterprise Architecture or Archimate. In this requirement, if the user has knowledge of EA, it could be assumed the architecture that is used as an input to assess the project is correct. Lastly is the collaboration between project manager and architect. So, the scoring process is more accurate in the sense of interpreting the architecture model.

From all of the requirements, the interviewees saw the use of the method is more useful in a bigger organization. The proposed method is more beneficial for a big organization that needs to manage a huge number of projects.

4. Improvement and feedback

To simplify the method and provide guidance in the decision-making process are the main feedback from the interviewees as an improvement for the proposed method. The simplistic approach of the method could be very beneficial for being used in practice. Theoretically, the interviewees saw the method is thorough enough, but the complexity needs to be reduced to be more usable. From the discussion, several mentioned possibilities are automate a certain step by using tools support, make a scoring form in a tools support, and improve the flexibility in choosing the factors / criteria which will be assessed. By having a simplify version, the method could be easier to use and less time consuming.

The second improvement is for the last step of the method when prioritizing the projects. A guidance on interpreting all the four quadrants in the bubble chart for the decision maker. In the discussion, the interviewees gave input to make a guidance, for instance; to use MoSCoW (Must do, should do, Could do, Won't do) method or to analyze the result by giving suggestion which project needs to be invested, migrated, tolerated or eliminated.

5.3 Summary

The evaluation of the proposed method is presented in this chapter by means of semi-structured interviews. In general, positive feedback is obtained from the interviewees. The proposed method is a comprehensive one and supports the subjective decision that usually used in practice. Moreover, it also provides the stepwise or thorough guideline to be implemented, including the scoring illustration using the information obtained from EA. However, practically there are some improvements that could be made regarding the complexity of the method.

Table 39 : Interview session summary

Criteria	Research Consultant Interviewee 1	Research Consultant Interviewee 2	Business Consultant Interviewee 3	Business Consultant Interviewee 4
Current Practice and an EA-based method	1. Gut Feeling, Cost & Benefit. 2. It's beneficial: **better overview, traceability, cost estimation**	1. Gut Feeling, Cost & Benefit, the urgency of the projects (type of the projects) 2. It's beneficial : **better overview** (organization), **analyzing process** (e.g. project dependency, impact analysis)	1. Gut Feeling, Cost & Benefit, the urgency of the projects (type of the projects) 2. It's beneficial : gives extra logical thing to prioritize projects, feasible to encapsulate data, give the **overview (current state organization)**	1. Gut Feeling, Cost & Benefit. 2. It's beneficial, if they have **high-maturity level of EA** to see the projects that fit within their roadmap
Ease of Understanding	3. The **idea is easy to understand.** ✓ Steps are too much. ✓ It gives enough guidelines from the academic perspective ✓ **It needsexpert** to be applied in practice	3. The **method is easy to understand**, ✓ More attention to the motivation of using three domains (business, IT and financial) ✓ **Interpretation of the quadrant** in the bubble chart	3.**Easy to understand**, ✓ Elaborate more on the explanation of **business and IT domain for** people who do not know that terms	3. It is **not easy to understand**. ✓ The user of the method needs to know about **ArchiMate, BPMN, and project portfolio management.**
Practical use or applicability	4. It is **feasible to implement** ✓ Could be collaborated with **Capability based planning** as a pre-selection of projects (what should be implemented first).	4. It is **feasible** ✓ Need **some time** to do the analysis and scoring. ✓ It could be corporated with **artificial intelligence** (scoring by certain architecture pattern)	4. The **simple version** of the method could **feasible** to use for the customer.	4. It is **feasible** ✓ Possible to implement the method, do not have seen method to valuate project ✓ Could support the subjective decision
Usefulness	5. It is **useful** in practice as long as there's someone has the ✓ **patience,**	5. It is **useful** because: ✓ It's feasible to implement	5. **Useful**, because it's necessary. EA could be used as a basis-information of the	5.**Useful**, if the company have **high-level maturity of EA** ✓ It could give overview

		Three domain are the **factors that most organization look at**.	information, which is occasionally overlooked by an organization.	what project fit in their roadmap.
	✓ **knowledge and** ✓ **time** to do the method properly			
Discussion/feedback	6. Simplistic approach to use in practice ✓ It could be with the table ✓ Use it in **different kind of cases** to see the problem of the method implementation	6. Guidance of interpreting the result of ranking (bubble chart)	6. Guidance in decision-making process (e.g. MoSCow method)	6. **Simplify the method use** (to make easier and less time consuming)

6. Conclusion

This chapter summarizes all findings in the study. Section 6.1 delivers the answer for all research questions that have been addressed throughout the study. Afterwards, Section 6.2 reviews both contributions of the research; theoretically and practically. Finally, Section 6.3 and 6.4 discuss the limitation and recommendations of the research.

6.1 Answers to Research Questions

As described in Section 1.2, the goal of this research is to get an approach that improves decision making in the project portfolio valuation using Enterprise Architecture. Therefore, the main objective we define as means to meet the goal is:

To Develop an EA-based method for project portfolio valuation

Afterwards, three research questions are formulated to achieve the main objective of the study in a structured way. The following paragraph presents the answer of each research question as the finding of the research.

RQ1. Which project portfolio valuation techniques can be the basis for the EA-based method?
RQ1.1. What are the existing techniques for project portfolio valuation?
RQ1.2. What are the criteria for choosing the project portfolio valuation technique?

The first research question is answered by conducting literature studies. The various existing techniques for project portfolio valuation are discussed in Section 2.4. Three different approaches are used to categorize the valuation techniques; financial approaches, multi-criteria approaches, and portfolio approaches.

The financial approaches evaluate the project by seeking the return value of the investment in terms of financial resource. The second approaches give a mechanism to assess the project from both financial and non-financial consequences which usually cannot easily expressed in monetary terms. The last approaches are a well-known decision-making tool in the management literature (Renkema & Berghout, 1997). Portfolio approaches facilitate the evaluation of all projects in the organization based on several evaluation criteria. Therefore, four methods in the portfolio approaches are evaluated to choose a basis method. All of them are assessed based on three criteria: the evaluation criteria using in the method, the ease of use, and the possibility of using information from architecture. Table 5 (Section 2.4.4) shows the analysis of the four portfolio methods. Finally, Investment portfolio method (Berghout & Meertens, 1992) is chosen as the possible basis / reference method with the use of information economics method (Parker et al., 1988) for measuring business and technology domain.

RQ2. How can EA support the project portfolio valuation?

RQ2.1. What is the relationship between EA and portfolio valuation?

RQ2.2. What information could be taken from EA to support project portfolio valuation?

Two approaches are conducted to address the second research question. Firstly, we seek the relationship between EA and project portfolio valuation. The concept about related fields gives the background knowledge about the use of EA in project portfolio valuation. Subsequently, we describe the concrete form of how EA support the project portfolio valuation.

The relationship concept between EA, portfolio valuation and its related fields is discussed in Section 2.1. From the literature, we found the ideal concept that should be applied by the organizations is the use of EA as a driver to achieve their goals. Three fields that should align in an organization are: Strategy, EA and Project Portfolio Management (PPM). In this context, we put project portfolio valuation in the field of PPM, since project portfolio valuation is part of the PPM's process. The alignment of these three fields in the organization will give the most beneficial situation. EA gives an overview of the organization from various viewpoints. It could capture the strategy of the organization in terms of modeling the strategic goals, motivation, requirements and the to-be situation. Project Portfolio Management realizes the strategy into concrete projects and programs that should be managed effectively. Op't Land et al., (2009) use the term "*dashboard*" for EA which give the relevant aspects of the current and to-be situation. The use of *dashboard* in the PPM will provide benefits for the organization. For instance: if the goal of the organization changed, then EA could capture it and analyze its impact related to the projects/programs that also need to be changed or even dismissed.

After understanding the background concept of relating fields, the next step is to explore the information that could be taken from EA to support project portfolio valuation. Table 2 in Section 2.3.2 shows the list of viewpoints that gives the information to support project portfolio valuation depending on the concern of the stakeholder. Focus of this study is the valuation or assessing process in the PPM, which we called as Project Portfolio Valuation. Thus, the stakeholder, for instance the project management office should choose the viewpoint that supporting the valuation process. In practice, the project management office should cooperate with the architect to interpret the architecture view.

RQ3. How to design an EA-based method for project portfolio valuation?

An EA-based Investment Portfolio method was designed to answer this question. Chapter 3 describes all the domain, factor and step by step procedure as a guidance to apply the proposed method. The proposed method is designed by studying the characteristic of the reference method (Investment Portfolio and Information Economics method) combined with the specification of Enterprise Architecture. A thorough process or step by step that shows

what the data input is and what the supposed output should be is also provided to make the method feasible to use in practice.

In order to validate the proposed method, two activities are carried out. Firstly, we applied EA-based Investment Portfolio method in the ArchiPharma case study in Chapter 4. By applying in a case, we could review the feasibility of the method, the assumption that should be made accordingly and the data required to evaluate the projects in the organization. Secondly, interview sessions are conducted with the experts and practitioners (Table 39), which is elaborated in Chapter 5.

Borrowing the conclusion of Information Economic method (Parker et al., 1988), EA based Investment Portfolio method also helps develop the consensus and enhance each group's awareness of the others' concerns and evaluations. With the use of EA, the management, specifically the project manager, should collaborate with the architect during the evaluation process to make a more precise justification to decide the score. Finally, EA-based Investment portfolio method is proposed to support the decision making process by giving recommendation from the list of prioritized projects.

6.2 Research Contribution

The study contributes to the area of Project Portfolio Management and Enterprise Architecture theoretically and practically. Theoretically, the thesis provides a method of combining EA in the process of project valuation. In Chapter 3, EA-based Investment Portfolio has a thorough guideline in its steps. It adds more knowledge on EA-based method for project portfolio valuation that is still lacking in a number of research work and practices. Furthermore, the proposed method also providing the illustration of scoring process based on EA.

Practically, two points are indicated from the research. Firstly, it reveals the importance of collaboration between EA and PPM fields that could give a higher benefit for an organization. Theoretically, this is not a new concept, but practically not many organizations are aware of it. By giving the argument from relevant literature and taking into account the solution of the study, the practitioner could improve their ways of working to eventually achieve the goals.

Secondly, it provides a solution for the organization in terms of giving an advice of the prioritized projects. Most of organizations, especially the big ones, feel difficult to decide the projects that will give the most value added to the organization with thorough consideration. The method makes the decision making process less-subjective, while still facilitates the manager to use their opinion. This also could be seen as an initial research on practical EA-

based method for project portfolio valuation. The solution could be adapted by BiZZdesign's consultant to help their customers accordingly.

6.3 Research Limitations

Several limitations are identified as follows:

1. The process of project valuation is based on Investment Portfolio method. The selection of the reference method is based on the evaluation criteria (Table 6) and also considering the research focus of the BiZZdesign. Thus, the proposed method seems to be complex, yet comprehensive.

2. In the demonstration phase (Chapter 4), the proposed method is implemented in a case study (Archipharma case). Some of the input data regarding the case is based on assumption because the limited information. It is sufficient to prove the efficacy of the proposed method, however using real requirement's information could bring more clarity.

3. Due to time limitation, we conducted the interview only with the practitioner from BiZZdesign. However, we see this is adequate for this study, because both the research and business consultants also have experience of working with several customers from different industry sector.

6.4 Recommendations for Future Research

With regard to the finding of the research and evaluation process, four points are highlighted in this section for future research. First recommendation is to test the method in several real case-studies to improve the practical guidance. With the time limitation of carrying this research, the demonstration of the proposed method is only restricted in one anonymous case-study. Although it is sufficient to show the feasibility of the method, other aspects such as: the condition of justified decision and the problems that might occur in a specific situation could be further improved. In addition, a simple version of the method also could be developed.

Secondly, further research to develop the simple version of the method would improve the applicability of the method. The simplification could be in the form of grouping some factors in business and technology domain. Furthermore, both of the process of choosing the factors and scoring process can be automated.

The last two recommendations are associated with the possibility of collaboration between EA-based Investment Portfolio method and other method to improve its efficacy. Firstly, the proposed method could corporate EA-based Investment Portfolio method with Capability-Based Planning method (Anastasios, 2014; The Technical Cooperation Program (TTCP), 2004).

The chosen project from the output of CBP method could be used as a 'pre-selection' project, since it should be implemented first. Lastly, if the method has already been used widely, the possibility of further development by including artificial intelligence (Chan et al., 2002; Mouzoune, 2012) to generate an automatic scoring process based on a certain pattern of the architecture.

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Appendix 1

Information Economic's Business Domain (Assessment)

1.1 Strategic Match worksheet

SCORE (0-5)
0. The project has NO direct or indirect relationship to the achievement of stated corporate (or departmental) strategic goals.
1. The project has no direct or indirect relationship to such goals, but will achieve improved operational efficiencies
2. The project has no direct relationship to such goals, but the project is prerequisite system (precursor) to another system that achieves a portion of a corporate strategic goal.
3. The project has no direct relationship to such goals, but the project is a prerequisite system (precursor) to another system that achieves a corporate strategic goal.
4. The project directly achieves a portion of a stated corporate strategic goal .
5. The project directly achieves a stated corporate strategic goal.

1.2 Competitive Advantage worksheet

SCORE (0-5)
0. The project does not create data access or interchange between this enterprise and its customers, suppliers, and collaborative unit.
1. The project does not create data access or interchange, per above, but does improve the competitive position of the enterprise by improving operating efficiencies that beat on competitive performance.
2. The project does not create data access or interchange, per above, but does improve the competitive position of the enterprise by improving operating efficiencies in a key strategic area.
3. The project provides some degree of outside access or data exchange and moderately improves the competitive position of the enterprise.
4. The project provides a moderate degree of outside access or data exchange and substantially improves the competitive position of the enterprise by providing a level of service beyond most competitors.
5. The project provides a high degree of outside access or data exchange and greatly improves the competitive position of the enterprise by providing a level of service unmatched by competitors.

1.3 Management Information support worksheet

SCORE (0-5)
0. The project is unrelated to management information support of core activities (MISCA).
1. The project is unrelated to MISCA, but does provide some data on function that bear support core activities.
2. The project is unrelated to MISCA, but does provide information on function that directly support core activities.
3. The project is unrelated to MISCA, but provides essential information on functions identified as core activities. Such information is operational in character.
4. The project is essential to providing MISCA in the future.
5. The project is essential to providing MISCA in a current period.

1.4 Competitive Response worksheet

SCORE (0-5)

0. The project can be postpone for at least twelve months without affecting competitive position, or existing systems and procedures can produce substantially the same result and will not affect competitive position.
1. The postponement of the project does not affect competitive position, and minimal labor costs are expected to be incurred to produce substantially the same result.
2. The postponement of the project does not affect competitive position; however, labor cost may escalate to produce substantially the same result.
3. If the project is postponed, the enterprise remains capable of responding to the needed change without affecting its competitive position; lacking the new system, the enterprise is not substantially hindered in its ability to respond rapidly and effectively to change in the competitive environment.
4. The postponement of the project may result in further competitive disadvantage to the enterprise; or in a loss of competitive opportunity; or existing successful activities in the enterprise may be curtailed because of the lack of the proposed system.
5. The postponement of the project will result in further competitive disadvantage to the enterprise; or in a loss of competitive opportunity; or existing successful activities in the enterprise must be curtailed because of the lack of the proposed system.

1.5 Project or organizational risk worksheet

SCORE (0-5)

0. The business domain organization has a well-formulated plan for implementing the proposed system. Management is in place, and processes and procedures are documented. Contingency plans exist for the project, there is a project champion, and the product or competitive value added is well defined for a well-understood market.

1 through 4.

Values for 1-4 may be adopted for situations that blend elements of preparedness with element of risk. The following checklist can be used for this purpose.

	Yes	No	Not Known
Well-formulated business domain plan			
Business domain management in place			
Contingency plans in place			
Processes and procedures in place			
Training for users planned			
Management champion exists			
Product is well defined			
Well-understood market need			

For each "no" or "not known" 0.5 point may be added.

5. The business domain organization has no plan for implementing the proposed system. Management is uncertain about responsibility. Processes and procedures have not been documented. No contingency plan is in place. There is no defined champion for the initiative. The product or competitive value added is not well defined. There is no well-understood market.

Information Economic's Technology Domain (Assessment)

1.6 Strategic IS Architecture worksheet

SCORE (0-5)
0.   The proposed project is unrelated to the blueprint.
1.   The proposed project is a part of the blueprint, but its priorities are not defined.
2.   The proposed project is a part of the blueprint, and has a low $ payoff; it is not prerequisite to other blueprint projects, nor is it closely linked to other prerequisite projects.
3.   The proposed project is an integral part of the blueprint, and has medium $ payoff; it is not prerequisite to other blueprint projects, but is loosely linked to other prerequisite projects.
4.   The proposed project is an integral part of the blueprint, and has a high $ payoff; it is not prerequisite to other blueprint projects, but is closely linked to other prerequisite projects.
5.   The proposed project is an integral part of the blueprint, and is one that is to be implemented first; it is prerequisite projects to other prerequisite projects.

1.7 Definitional Uncertainty worksheet

SCORE (0-5)
0.   Requirements are firm and approved. Specifications firm and approved. Investigated area is straightforward. High probability of no changes.
1.   Requirements moderately firm. Specifications moderately firm. No formal approvals. Investigated area is straightforward. Low probability of nonroutine changes.
2.   Requirements moderately firm. Specifications moderately firm. Investigated area is straightforward. Reasonable probability of nonroutine changes.
3.   Requirements moderately firm. Specifications moderately firm. Investigated area is straightforward. Changes are almost certain almost immediately.
4.   Requirements not firm. Specifications not firm. Area is quite complex. Changes are almost certain, even during the project period.
5.   Requirements unknown. Specifications unknown. Area may be quite complex. Changes may be ongoing, but the key here is unknown requirements

1.8 Technical Uncertainty worksheet

SCORE (0-5)	
A. Skills required are available in the technology domain	
B. Dependency on specific hardware not now available	
C. Dependency on software capabilities not now available	
D. Dependency on application software development	

Total (A+B+C+D)/4 = Rating:

A. Skills required
  0. No new skills for staff, management. Both have experience.
  1. Some new skills for staff, none for management.
  2. Some new skills required for staff and management.
  3. Some new skills required for staff, extensive for management.
  4. Extensive (new) skills required for staff, some for management.
  5. Extensive (new) skills required for staff, and management.

B. Hardware dependencies
  0. Hardware is in use in similar application.
  1. Hardware is in use, but this is a different application.
  2. Hardware exists, and has been tested, but not operationally.
  3. Hardware exists, but not utilized yet within organization.
  4. Some key features are not tested or implemented.
  5. Key requirements are not now available in MIS configuration.

C. Software dependencies (other than application software)
  0. Standard software, or straight-forward or no programming required.
  1. Standard software is used, but complex programming is required.
  2. Some new interfaces between software are required and complex programming may be required.
  3. Some new features are required in operating software, and complexintefaces between software may be required.
  4. Features not now supported are needed, and moderate advance in local state of the art is required.
  5. Significant advance in state of the art is required

D. Application Software
  0. Programs exist with minimal modification required.
  1. Programs are available commercially with minimal modifications or programs available in-house with moderate modifications, or software will be developed in-house with minimal complexity.
  2. Programs are available commercially with moderate modifications, or in-house programs are available but modifications are extensive, or software will be developed in-house with minimal design complexity but moderate programming complexity.
  3. Software is available commercially but the complexity is high, or software will be developed in-house and the difficulty is moderate.
  4. No package or current in-house Software exists. Complexity design and programming are required, with moderate difficulty.
  5. No package or current in-house Software exists. Complexity design and programming is required, even if contracted outside.

1.9 IS infrastructure Risk worksheet

SCORE (0-5)

0. The system use existing services and facilities. No investment in IS prerequisite facilities (e.g., database management) is required; no up-front costs not directly a part of the project itself are anticipated.

1. Change in one element of the computer service delivery system is required for this project. The associated up-front investment other than direct project costs is relatively small.

2. Small change in several elements of the computer service delivery system are required. Some up-front investment is necessary to accommodate this project. Some later investment for subsequent integration of this project into the mainstream of the IS environment may be necessary.

3. Moderate changes in several elements of the computer service delivery system are required. Some up-front investment is necessary to accommodate this project; some later investment for subsequent integration of this project into the mainstream of the IS environment will be necessary.

4. A moderate change in elements of the computer service delivery is required, in multiple areas. Moderate to high up-front investment in staff, software, hardware, and management is necessary to accommodate the project. This investment is not include in the direct project cost, but represents IS facilities investment to create the needed environment will be necessary for the project.

5. Substantial change in elements of the computer service delivery is required, in multiple areas. Considerable up-front investment in staff, software, hardware, and management is necessary to accommodate the project. This investment is not include in the direct project cost, but represents IS facilities investment to create the needed environment for the project.

Appendix 2

Corporate Values

2.1 Investment Quadrant

DOMAIN	LIKELY VALUE	RESULTING WEIGHT
BUSINESS DOMAIN		
1. Strategic Match	Low	0
2. Competitive Advantage	Low	0
3. Management Information	Medium	2
4. Competitive Response	Highest	8
5. Organizational Risk	Medium	-2
TECHNOLOGY DOMAIN		
1. Definitional Uncertainty	Medium	-4
2. Technical Uncertainty	Medium	-4
3. Strategic IS Architecture	High	8
4. IS Infrastructure Risk	Low	0
Total Value		18
Total Risk and Uncertainty		-10

2.2 Strategic Quadrant

DOMAIN	LIKELY VALUE	RESULTING WEIGHT
BUSINESS DOMAIN		
6. Strategic Match	High	4
7. Competitive Advantage	Highest	6
8. Management Information	Medium	2
9. Competitive Response	High	4
10. Organizational Risk	Low	-1
TECHNOLOGY DOMAIN		
5. Definitional Uncertainty	Medium	-2
6. Technical Uncertainty	Low	-1
7. Strategic IS Architecture	Low	1
8. IS Infrastructure Risk	Low	1
Total Value		18
Total Risk and Uncertainty		-4

2.3 Infrastructure Quadrant

DOMAIN	LIKELY VALUE	RESULTING WEIGHT
BUSINESS DOMAIN		
1. Strategic Match	High	4
2. Competitive Advantage	Low	0
3. Management Information	High	4
4. Competitive Response	Medium	2
5. Organizational Risk	High	-4
TECHNOLOGY DOMAIN		
1. Definitional Uncertainty	High	-4
2. Technical Uncertainty	Medium	-2
3. Strategic IS Architecture	Highest	8
4. IS Infrastructure Risk	Low	0
	Total Value	18
	Total Risk and Uncertainty	-10

2.3 Breakthrough Quadrant

DOMAIN	LIKELY VALUE	RESULTING WEIGHT
BUSINESS DOMAIN		
1. Strategic Match	Highest	6
2. Competitive Advantage	Low	0
3. Management Information	High	4
4. Competitive Response	Low	0
5. Organizational Risk	High	-4
TECHNOLOGY DOMAIN		
1. Definitional Uncertainty	Medium	-2
2. Technical Uncertainty	Medium	-2
3. Strategic IS Architecture	Highest	6
4. IS Infrastructure Risk	Medium	-2
	Total Value	16
	Total Risk and Uncertainty	-10

Appendix 3
Archiparma strategic value project's script

```
////////////////////////////////////////////////////////////////////////////////////
//strategicValueProject calculates for each program/project its strategic value.
//              This value is determined by the goals it (indirectly) realizes.
//
//              Paths taken into account are any paths where (composed) projects/programs
//              realize goals/requirements directly or through realizing
//              plateaus/deliverables/capabilities.
//              Goals/requirements can realize/influence other goals/requirements
//
//              Cycles are not allowed
//
//              More than one path can connect project and goal. All paths are taken
//              into account and strategic values are summed up.
//
////////////////////////////////////////////////////////////////////////////////////
functionstrategicValueProject() {
        forall "ArchiMate:IMWorkpackage" object in modelpackage {
                currentPath = List();
                amount = calculateAssignedValue( object, currentPath, 1 );
                if ( ! ( amount == undefined ) ) {
                        result = Structure();
                        result.add("object", object);
                        result.add("value", amount);
                        output result;
                }
        }
        return undefined;
}

functioncalculateAssignedValue( concept, currentPath, part ) {
        // first check whether there is a loop
        if ( currentPath.contains(concept) ) {
                error "Cycle found while performing analysis." , concept;
                stop;
        }

        percentage = part;
        amount = 0;
        // if the concept is a motivational element for which priority is greater than 0,
        // then calculate percentage * total cost
```

```
if ( concept is "ArchiMate:MotivationElement" && ( concept.attrValue("priority") > 0 ) ) {
                amountTotal = concept.attrValue( "priority" );
                amount = amount + amountTotal * percentage;
        } else {
                // check whether the concept gets amount assigned from above
                outgoingRels = outgoingRels( concept );
                if ( !outgoingRels.empty() ) {
                        forallrel in outgoingRels {
                                newPercent = percentage;
                                if ( !( rel is "ArchiMate:CompositionRelation" ) ) { // if this is
not a composition relation then calculate the new strength/percentage.
                                        percent = rel.attrValue( "infStrength" ); // strength of
the influence is current percentage times the strength on the relation
                                        newPercent = newPercent * percent;
                                }
                                theOtherEnd = rel.relatedTo( concept );
                                if ( concept is "ArchiMate:IMWorkpackage" ||  // check
whether the related concept "fits" in the predefined allowed paths: it has to  be a goal,
principle, requirement(, capability), plateau, or workpackage
                                        concept is "ArchiMate:MotivationRequirement" ||
                                        concept is "ArchiMate:MotivationGoal" ||
                                        concept is "ArchiMate:MotivationPrinciple" ||
                                        concept is "ArchiMate:IMPlateau" /**||
                                        concept is "ArchiMate:RCCapability"**/) {
                                                currentPath.add(concept);
                                                subtotal = calculateAssignedValue(
theOtherEnd, currentPath, newPercent );
                                        }
                                        amount = amount + subtotal;
                                }
                        }
                }
        return amount;
}
```

Appendix 4

Archiparma Risk Analysis

No	Project Name	Risk	Risk impact	Risk probability
1	Align marketing processes	high	major	moderate
2	Analyze billing process variance	very low	minor	rare
3	Analyze current marketing processes	high	moderate	moderate
4	Analyze current product portfolio	very low	insignificant	rare
5	Analyze data sources	high	extreme	unlikely
6	Analyze heterogeneous data sources	medium	extreme	rare
7	Analyze heterogeneous information sources	medium	minor	likely
8	Choose, configure, test and install APM applications	high	extreme	moderate
9	Choose, develop and install enterprise-wide PPM software	high	extreme	unlikely
10	Choose, develop, test and run global financial application	medium	moderate	unlikely
11	Consistent data model development	high	minor	very likely
12	Consolidate marketing applications	high	moderate	very likely
13	Data cleaning	high	moderate	very likely
14	Data mapping	high	moderate	very likely
15	Define valuation model	very low	insignificant	rare
16	Design and populate application portfolios	high	moderate	moderate
17	Design data architecture	medium	extreme	rare
18	Design enterprise-wide APM process	medium	extreme	rare
19	Develop application rationalization roadmap	high	moderate	likely
20	Develop database authentication protocols	very high	major	very likely
21	Develop integrated reporting	very low	insignificant	unlikely
22	Develop real-time portfolio monitoring	low	insignificant	likely
23	Develop real-time portfolio reporting	high	moderate	likely
24	Expand customer channels with internet	high	extreme	moderate
25	Harmonize local PPM approaches	very low	minor	rare
26	Harmonize ordering process	high	moderate	moderate
27	Harmonize process variants	high	moderate	very likely
28	Identify obsolete applications	medium	major	unlikely
29	Identify products for termination, migration and consolidation	high	moderate	moderate
30	Information cleaning	very high	extreme	very likely
31	Information harmonization	high	extreme	moderate
32	Information mapping	medium	minor	likely
33	Install application lifecycle management approach	high	moderate	likely
34	Install database authentication	high	moderate	moderate
35	Install enterprise-wide PPM approach	high	major	likely
36	Install federated database management system (FDMS)	medium	moderate	unlikely

37	Install necessary applications for monitoring competitors	medium	extreme	rare
38	Install process for monitoring competitors	medium	minor	moderate
39	Integrate marketing processes	high	extreme	unlikely
40	Inventory all PPM processes	high	moderate	moderate
41	Inventory applications	high	major	likely
42	Migrate and eliminate identified applications	medium	minor	likely
43	Phase out Amsteram billing applications	high	extreme	unlikely
44	Phase out London billing applications	medium	moderate	unlikely
45	Phase out New York billing applications	low	insignificant	likely
46	Prepare and adapt databases	low	major	rare
47	Publish database information	very low	minor	rare
48	Rationalize product portfolio	medium	minor	likely
49	Redesign portfolio into limited set of highly configurable products	high	moderate	moderate
50	Valuate applications	very high	extreme	likely

Appendix 5

Interview's Transcript

Interview Session I	
Interview role :	Bizzdesign's Research Consultant
Interview date :	Thursday, 09/07/2015 (11:00-12:00)

1. What are the methods do you think is often used in practice to prioritize the projects?

People have their own objectives and might prioritize more organically, in the sense that they have a gut insting that this project needs to be done. I think a lot of research is lacking on how to objectively prioritize. It is also about goals, how to objectively prioritize goals not only for project.

It is done by trade-off, in the sense that benefit that you expect get from it, compare with cost that you have. Technically company have budget. If project is part of department, then department has specific budget. For example you now you have 10 thousand euro, so you need to get as much estimated value out of it, for that money. So, you will implement project that fit within that.

I don't know if there's prioritization. But, Budget is the important aspect that people consider when they select a project. The one that fit with the budget and deliver the most value in the end. At least these are from what I read, although I'm not an expert on prioritizing project.

2. What do you think about the use of architecture to prioritize the projects ? Do you think it's beneficial ?

I think it's highly beneficial. Because you can see exactly what you will invest money in, you know exactly what the impact you will have. You can do the traceability of the project to the actual goals, to see the projects are actually realize the goals that you think.

Usually when you make project proposal, you also make a business case. In most cases you need to say what is contributing to goals that need to achieve. But, sometimes it might not be correct what they propose in the business case. Because they think it contributes something, but it might not really. So, by using architecture you can actually see, that one project actually contributes to realize specific goals. And you can be sure of it. You know exactly what change need to be done. So, you can get better overview and traceability from using architecture. And better Cost estimation, I would say as well. Because you know exactly what is to invest money in to change. So those will be the main three I would say: cost, overview and traceability.

3. Is the method is easy to understand? Is there any step need to elaborate more?

The idea of the method is easy to understand. There are a lot of steps, but it is also to be expected. In any case, there are two different ways, you either develop something for university project which this is or you develop something that will be used by companies. If you want do something for the companies, the complexity needs to be reduce, needs to be more usable. But, from the university point of view, I would say this is a method that thorough enough, have enough information and enough guidelines for people to be able use.

So, it is easy to understand, but depend on who is looking at it. From practitioners point of view, it might be too complicated to follow all the steps. But from your explanation, the steps do not really per se need more elaboration. It was easy to understand, only the name of the factor from the domain, but with explanation it was fine.

4. Do you think it is feasible to implement the method in the valuation process? From your experience, have you ever use a project portfolio yourself, is this method could be incorporated with it ?

I think it is feasible to implement it. It could be incorporated with Capability Based Planning method, which also doing by another student in the BiZZdesign. The idea that you have goals, and you have capability to

realize those goals. Capability is specified with architecture. Capability is abstraction of architecture. It says what you can do, but not specifically how. It's the same idea with application, but you did not say which application. Then technically, without looking the architecture, project realize the capability.

So, at the moment, the idea is about dependency, you have main capability and several capabilities that depend on the main one. Because you made capability based planning and road map, the question of when each capability will be done is depend on the each project that will be done. So, the idea the dependency its like a tree, start somewhere and having a branch. The idea if you invest the capability that further away, it means that you kind of realize what is the need of other capability and so on. By having this reasoning, you need to do the capability at the edge and works away towards the middle that also could help of at least making pre-selection of the project. You start choosing the project that responsible for the capabilities that is further away and then walks away toward the inside. You make the basis with the one in the outside, and the one in the inside can get benefit from it. So, some sort out dependency idea for that. If we actually manage the link of these, it will be very useful for both parts. It will be useful for Capability based planning and also useful for you because you can have pre-selection of the projects should implement first.

5.	**Do you think the method is useful in practice?why?**

I think the method is useful in practice as long as someone has the patient and the time to do it properly and the knowledge. Because I think in order to do this, because the example is quite a simple example, and I think organization usually has more complex architecture than that. So, someone really need put quite some time and you need to assume that the architecture is correct. So, you need to make sure that the architect did a good job and program manager also, I guess this is the person that responsible. He knows how to interpret the architecture, and takes the time to do it.

I would say also collaboration with an architect that should be done to get the most benefit. But definitely the time and the patient to do the step by step not skip anything. It should have benefit but with high investment in time to do this properly. So, for smaller organization it might not be that useful. I think it more useful if you have a lot of projects, and you do not really know how to make a choice. It will worth it in a bigger organization and you have way more choices with still limited resources. For example if you have 500 projects you don't know exactly to see which project fit where and which one have the most contribution to an organization. So, for the bigger organization is more useful than for the smaller one. Because in the smaller organization you do not have the time and the people to do this. Maybe also do not have the program manager and even do not have the architecture.

6.	**What do you think should become the improvement of the method?**

For practice maybe more simplistic approach to do it. Some sort of way to simplify; to make a table that can be filled in easier, just abstract from all these steps and try to make it easier. In a sense maybe, for all the business things that you group it in one thing and a bit abstract from the steps itself. I do not know how to explain it. For example is Balance score Card, that they have four perspectives into one table. And other approaches and combine things into one table. You do not need to do the four steps, since the step is similar except you need to do in a specific thing, like one step you need to see business layer, and for the other you need to look at function. So it is different in what you need to look at, but what you need to fill in should be the same. In any case some sort of simplification of this method could be very beneficial for being used in practice.

From my experience with Capability based planning method, the improvement also could come up when you talk with someone in the company. Because we see it would be ideal, but in reality could be that they do not have the information or this is not realistic to score like this. In any case a simplification and testing the method in a real case, these are the improvement I could see. You also need to use it a few times, to become an expert

Interview Session II	
Interview role :	Bizzdesign's Research Consultant
Time :	Friday, 10/07/2015

1. What are the methods do you think is often used in practice to prioritize the projects?

I think Business case document is often used. That is the only one I can think of at the moment what is really use in practice. People are asked to define a business case and I think you can find multiple templates for business cases. Based on the business case the decision is made. I think only few organization will also use a business case later on to monitor the project and evaluate it at certain moment. For other method, I expect somehow that's the method people simply prioritize based upon what they think or what they feel. Personal opinion is the beliefs of the officer also a factor on the prioritization and selection of the projects.

Depend on the organization or decision maker. I think usually you will have around information is gathered. People are asked to define business cases or proposal and notify them. Business case are project proposal that will be analyzed and then decision will be made, but I think it could be an objective decision based upon objective but also subjective element will play role. I mean, the personal belief will also play role. So even you have a nice method, I think such a method should always give a room for this subjective. In your method, you come up with a proposal for the decision maker. You don't say you should do this. But according to, and when analyzing these factors, then we came up with these score and ranking, and of course, it's up to the decision maker to select some projects. It takes other things may come up and lead to another decision, maybe your chart may suggest. Basically, the only one that is often people used is the business case.

2. What do you think about the use of architecture to prioritize the projects? Do you think it's beneficial?

If you have an EA which is a bit mature, then it describes your organization, describes how different element in your organization are related. So, in that way it is I would say it easier for impact analysis and prioritize where changes are needed. For example, you know a problem with an application and that application contributes to certain products. Then, if you know that there may be problems with the products, you can analyze the impact. Also the other way around, you can look your architecture, where you can do improvement and focus projects for that. And also to analyze dependency between projects. Architecture very useful. If a project is decided to improve an application and other project to remove server which is running. It is very simplistic example, but from your architecture, this is clear. And you can analyze this.

So, I think is beneficial. It helps analyze the impact of the projects and the other way around. It may help you decide where changes improvements are needed in your organization to make a better decision. You also saw the picture about the modeling of the strategy architecture, and then you can analyze which part of your organization will contribute for this strategy. Which project directly contributes to your strategy is. And the other aspects was you can analyze potential dependency or for that between projects, because is common practice to define a projects start architecture and also target architecture by analyzing these architecture you can see if things are overlap or the chance of dependency, finish for example.

3. Is the method is easy to understand? Is there any step need to elaborate more ?

The method, I think is easy to understand. Something that could may give more attention. I notice in your presentation is that you have three aspects that you look at the business contribution, IT contribution and financial. And I think it would be good to provide some motivation why these three. It took me a little while to realize, these also the proposal of the method. For example a question that pop up, I don't know it is relevant, why they look to business and IT contribution. People say business is in the lead, so business contribution is important. At the other hand, I can imagine if you look at IT. And why look separately at the financial aspect, is that not part of the business and IT aspect. Just question that pop up. These question could answer in the beginning, explain why working on these three aspects, and maybe also implies that the method can be used in certain situation and may not be useful in others situation. I don't know you analyze or look at it, but whether the method for example suitable for certain of projects or can be generally apply.

The step that needs to elaborate is about how I should interpret the quadrant, if the project is in the one of the quadrant. For example, what does it mean if the project is illustrated in certain quadrant. This suggestion is something for the decision maker. For example type of analysis tolerate, invest, migrate or eliminate. How this in your case is. What does it mean. Does this define something different? It would be nice if you give the suggestion. With the ranking the one in the top is the one that you should choose. Maybe some extra help for decision-maker.

4.	**Do you think it is feasible to implement the method in the valuation process? From your experience, have you ever use a project portfolio yourself, is this method could be incorporated with it?**
	Yes, but something I difficult to access is how much time to do it. For the bigger projects, you need some-time to do the evaluation. What I like about this is that you come up with score, what the score means and also the relation with EA. You cannot derive the score most case automatically from the architecture, but It should not be difficult by looking into your architecture to see what scoring should pick. That's nice, because it's mean you can use your architecture and at the same time, it does not take so much time to come up with scoring project. What I don't know is how good the method is. You need benchmarking. And the criteria you look is relevant and it's based on the information economics method. But for sure it's feasible to implement the method. For example, the method of Beddel, you could use the method to derive automatically the alignment of the strategy (one of the factor). On the other hand, I doubt it is, because it requires mature architecture. You can define your architecture in different ways. The valuation technique that could combine. We could interpret certain pattern, algorithm could be defined to make the score.
5.	**Do you think the method is useful in practice?why?**
	Yes, and then why. The first one is already in the question four, since it's feasible to implement the method. Second reason is three main factors (business, IT, financial) are among three factors that most organizations look at. Sometimes risk has separate sector, but, you already corporate that in the method. So I think you look at the right things. But the question is always, how much is it to do the method. But on the other hand, you explain how you can interpret your architecture or look at the architecture to provide the score, So you provide that link. So I think that something should be very much doable to do the method. I don't know how good is the result are of method, but practice will show.
6.	**What do you think should become the improvement of the method ？**
	Some additional explanation of the result, on how you interpret the result of the ranking of the method. Some explanation on the philosophy behind the method. Are there any principals or assumptions starting point. Maybe it could be in the thesis. I think it's good to know this, because it also gives some times more confidence of the method. This applicable for the situation because I believe In that idea. For example, experiment has done with that method.

Interview Session III	
Interview role :	Bizzdesign's Junior Consultant
Time :	Wednesday, 15/07/2015
1. **What are the methods do you think is often used in practice to prioritize the projects ?**	
I think, they are primarily financial oriented, so based on Cost and benefit. This will cost us 10.000 euro per month but in half year it will generate this and this ten thousand euro of value. It is just black and white, this should go, but this is not. But, I've also works on application development projects, realizing part of the application architecture, there they use prioritizing method with an agile/ scrum. They decide together what to build first. What generate the highest business value. For example, they decided first build the front-end of the application. So, ones that live, because they need to go live very soon. They can at least have people registrating their data. It is like minimum viable products method, what should we build in terms of small part functionally , works for just a little bit then build on that further.	
So, based on financial data and also based on urgency. Not really on maybe also strategic value like we should build this first because this enable to have better customer interaction, but more based on urgency. I think more on the context of application development. And I have not seen so many methods to actually prioritize. It is mostly manager who invent their own project and have a lot of freedom upon which one they should and	

which one they shouldn't do. They responsibilities towards their manager. But, it's very qualitative; a lot of projects also being introduce are quite experimental. So, maybe also the nature of the project is considered when doing it. So, it could Just experiment , they should do this for learn, or just implementation stuff that need to be done. So, type of the project might also effect being used to prioritize projects. So, when stuff really need to change, you might not set your resource on experimental projects, but on project that implementing or executing something. But, if you want to innovative, you might set an experimental project.

2. What do you think about the use of architecture to prioritize the projects ? Do you think it's beneficial ?

Yes, it will be beneficial. Nowadays, I also started to developing sort of solution; BiZZdesign project portfolio management solution . Of course I think is beneficial, because when you use EA to prioritize projects, you can actually reflect on the current state of your organization and have more of a grip about the changes that will occur that architecture. So, it is like general benefit of EA we all know about multiplied by project portfolio management. It is logical extra thing to do when prioritizing project. Of course you need to do the financial stuff about the benefit and the cost. And also the strategic value stuff about to which extend this is also contribute to business goals. This also part of the architecture when you use motivation extension. You can almost encapsulate almost every factors within architecture even data.

So, I think architecture will be very important vehicle or instrument in actually rating the project. You want to know, this is the landscape , these are the changes might occur based on several drivers or internal drivers, then what should we do now. But I'm also still getting into this subject. Manager will already know up-front where the changes actually take place, they already see the bigger picture, that is main benefit that crucial when using EA. That is already selling point in general, but also project portfolio management I guess.. But, it needs a good method like you are working on.

3. Is the method is easy to understand? Is there any step need to elaborate more?

I really like the picture in the left bottom of your presentation that you trace every step of the method. So, I aware that you have 5 steps within business domain and 4 steps within technology domain. But, for me for example; what is technology domain actually means. Of course because I know about archimate, probably about application and infrastructure. Most of the time, you see a lot of framework use for example: business layer, information layer or technology layer. But, you just have business domain and technology domain. So, maybe the division; I don't mean that you should divide the technology domain become two. But, what the domain actually cover, what's in there. Especially for people who don't know about EA, I think they won't understand the word. I assume that you have a mature audience know.

For me it's understandable, yes definitely. I also like the process view you deploy in the whole method. So, that you, for every step you zoom in and out on the process that actually valuating the projects in the different perspective. So, I think, that's really strong characteristic of the method you introduce. So, keep that focus on the approach, steps/ activities. I also like the fact that you mention the type of data input within the steps, like the corporate goal. That's also really strong. So, maybe there should be an addition to actually explain the bigger picture.

4. Do you think it is feasible to implement the method in the valuation process? From your experience, have you ever use a project portfolio yourself, is this method could be incorporated with it?

I do not have experience, but I might actually do it in a while. I have a customer now; we set up foundation for business execution. And we develop an architecture vision; we made a sketch of the business, application and technology domain. Now we're helping the CIO to define the projects that need to be executed to implement and realize architecture and capability they want to achieve. I really see this working, maybe little for simpler version of this method. But, your first step is defining the project itself. So, depending of the problems you want to solve, you need to think of several projects. For example a new CRM, new customer service process, standardizing a process, or integrating data. But, actually needs a lot of guidance about what is the most urgent thing, what is the most valuable thing. And I think maybe a little bit, simpler version of the method might be really feasible to use for the customer. So, yes, I think it is feasible; actually a lot of companies need this. A lot of companies just using their gut feeling into decide on projects. A lot of projects in organization are dashboard driven, the managers who have the loudest voice, have their projects being implementation. Whether they providing the company with a right strategic value or right capabilities are about dashboard

	driven.
5.	**Do you think the method is useful in practice?why?**
	It is useful because it is necessary. But, it should crisp like you have 4 stages, and every stage have several steps. The extra steps might not be necessary, like making better for practice. A lot of potential. Because most of the time from the first question, decide project based on gut feeling, no method at all and financial number supporting whether to do it or not. As long as it is beneficial, the consideration is not the content of the project or the direction of the project. You should think about the content of the project, because often it overlook in a company. So, it is useful, because it is necessary. When you use EA to evaluate and prioritize project you actually use all the information available in the organization to make decision.
6.	**What do you think should become the improvement of the method?**
	Something about the decision making should be added. In a bubble chart, for example: to kill the project in the left bottom corner, or green light in the top right. What are the criteria when you are not going to do it. For example is the MoSCoW. Put a lot of matrix, have people make decision. For example, one of the dashboards is the business transformation readiness assessment.

Interview Session IV	
Interview role :	Bizzdesign's Business Consultant
Time :	Thursday, 16/07/2015
1. **What are the methods do you think is often used in practice to prioritize the projects?**	
I really think it's a lot about gut feeling, furthermore I think, in my experience is mostly the financial. So, it's about what is the project cost and in what way is beneficial to organization. Mostly this benefit are not so strictly to be identified financial, in the sense that this project has an ROI in such number, but mostly is more about gut feeling, what is worth to the company, less mathematical, and more based on feeling or experience. It's mostly not in monetary term, except for the cost that mostly very important.	
2. **What do you think about the use of architecture to prioritize the projects? Do you think it's beneficial?**	
Yes, I think it's beneficial, but mostly for company with high maturity level in architecture. Because, for example for the organization where I'm working now, has very low maturity level of architecture. They don't use it, or make it or knew what it is. So, if I would go to them and say how they prioritize the project, do you use architecture, it will not really relevant. But, if an organization does have architecture and does work with the architecture as a way of filling in the future and how to go there, then I think It will be definitely beneficial for them.	
3. **Is the method is easy to understand? Is there any step need to elaborate more?**	
No, I don't think it's easy to understand. It's a quite vast. I think for people like us as consultant, or people that knew about architecture, and know about archimate, it's manageable. It is better to understand, but, even then still like theory of everything. Academically, I think it's really good. I think it's really vast and probably also could work for most of the organizations. But, a lot of work before you can prioritize your projects. Statistically, it is doing a great job, and could be working for a lot of manager that statistically thinking. But it's not easy to understand.	
I think it requires experience with the method. In order to make it easier to understand, you could present it with one example of one real-time project. In the sense that, some easy of understand example will help or maybe you could skip some steps to make it easier or simpler. I think in some cases, like management doesn't really know how to score these things, if the evaluation like this score, like point 2 and point 3, and point 5. It's still some sort of gut feeling, although it will make the decision become less-subjective. I also think one important aspect, that not really measurable is like political factors. In my experience, a lot of managers and probably even portfolio manager have some sort of agenda for choosing one or two projects to be prioritized. So, I think a lot of manager, like the fact the decision are subjective, like only personal interest in their choice.	
I really agree this method make the prioritization more objective, probably the strength of the method. But in some cases in practice, people just want to make a subjective choice. From academic perspective, it's perfect / superb. The managers probably can make a good subjective choice. So, in addition of subjective opinion it can really work, but to contradictive, then they probably don't really like the method so much. But, it still gives a	

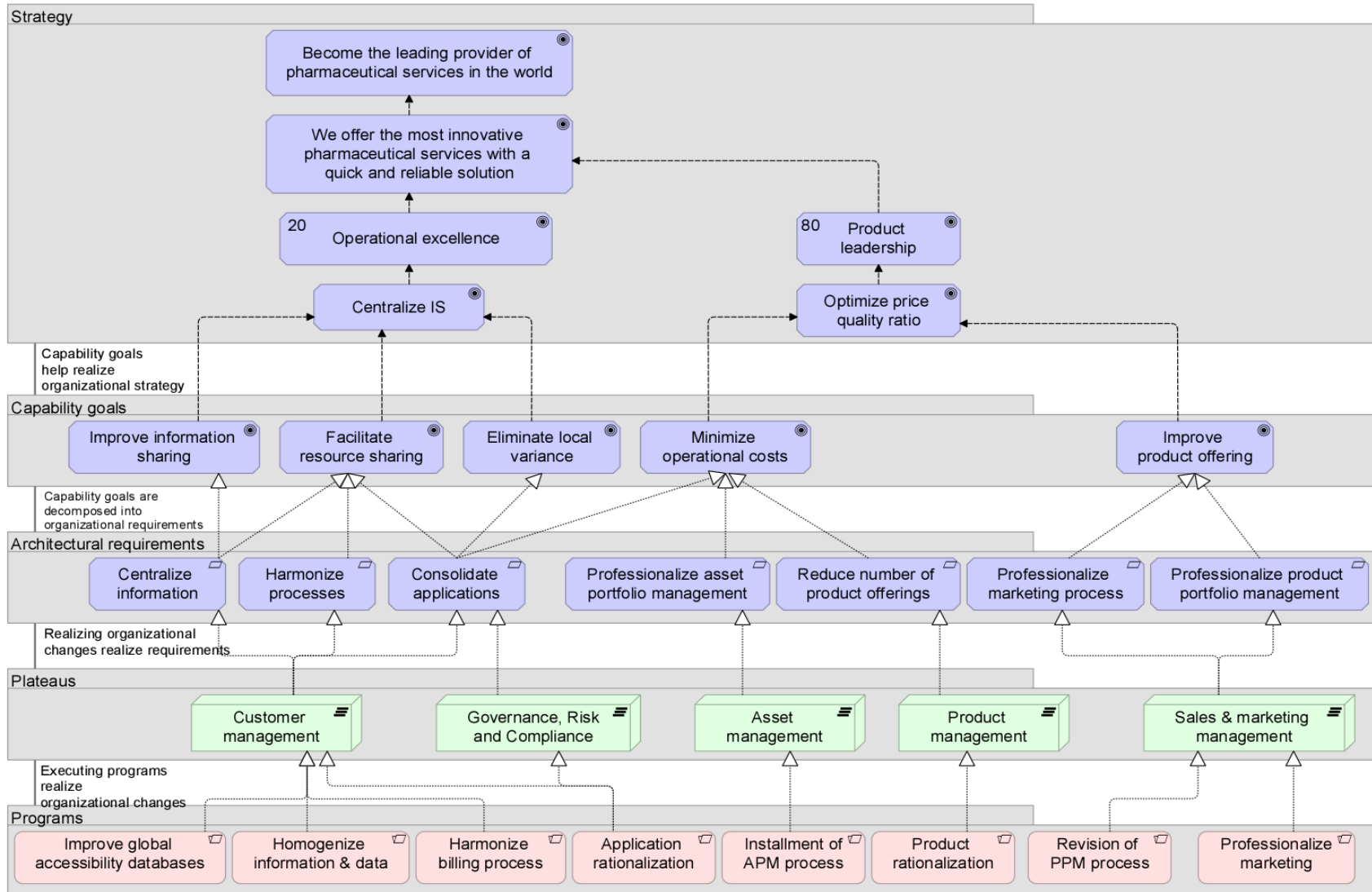|	
	room for subjectivity.
4.	**Do you think it is feasible to implement the method in the valuation process? From your experience, have you ever use a project portfolio yourself, is this method could be incorporated with it?** *Yes, I think it is possible to implement the method. From previous question's discussion, I think, it could be incorporated with the subjective opinion of the managers. I have seen some methods, it's from Chris Pots, I followed his course about mastering enterprise investment, and he has a method to prioritize projects based on several values. But, in practice, I haven't ever used or seen a particular method. That is also because maybe I'm not yet that experienced, like working with thousand companies. So, in my experience I haven't seen method that was used for project portfolio.*
5.	**Do you think the method is useful in practice? Why?** *Yes, if the companies have high level maturity in EA then yes, I think it's useful. Because, If they have high level maturity in EA, then I would probably think that they have like architecture roadmap for the future, so they know where they want to go based some strategic choices. And I think with this method, we can actually see what projects fit-in to get there. So, architecture is about to design and how we would go there. But, how we would go there in practice, that's this method is really useful. And also, to see what projects do not really contribute to the roadmap, so we might kill them.*
6.	**What do you think should become the improvement of the method?** *If you can make it somehow easier or less-time consuming, I think that would be the improvement that I can think of now. Because I can imagine the project portfolio managers don't have, for instance any experience with architecture or archimate or bpmn. I think in this method, you always need more people. Unless you have manager that also has experience with architecture, archimate, bpmn. Because people that have a lot experience about architecture, they probably don't know about ROI or NPV.*

Appendix 6

Archipharma's Architecture

6.1 Archipharma's Program Motivation View

6.2 Archipharma application realization view